MINISTRY OF TRANSPORT, VIETNAM

SPECIAL ASSISTANCE FOR PROJECT IMPLEMENTATION (SAPI) FOR ITS INTEGRATION PROJECT ON NEW NATIONAL HIGHWAY NO.3 & NORTHERN AREA OF VIETNAM

MAIN REPORT

AUGUST 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.
NEXCO EAST ENGINEERING CO., LTD.
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Special Assistance for Project Implementation (SAPI)
for ITS Integration Project on
New National Highway No.3 & Northern Area of Vietnam
Summary

➢ 1 Background and Necessity

National Highway No.3 is a critical arterial road links Ha Noi the capital of Vietnam with Thai Nguyen the strategic point of industry and economy in the northern region. Its traffic volume has been growing at a 10% annual rate and further growth is expected in the future. To deal with this problem, introduction of ITS for smooth traffic control is now under discussion.

At the same time, designing and construction of expressway network is underway nationwide in Vietnam. In the Ha Noi Metropolitan Area, a high quality road network consist of in radial sections including expressways as well as National Highway No.3 and Ring Road No.3 bundles them has been constructed, and it will be completed by the end of 2013.

With the start of services of such high quality road network including the expressways, the increase in traffic accidents has become a major problem in Vietnam. On the HCMC – Trung Luong Expressway of length 40 km in the South of Vietnam, during 18 months from its commencement in February 2010, 113 occurrences of traffic accident has been reported and accident rate has become a high value at 1.8 affairs/km/year.

It is estimated that the inexperience in high speed driving is a cause of such high rate of traffic accident and it should be expected that it decreases gradually keeping pace with ripeness in high speed driving. In either case, it is necessary to take a measure against such undesired condition. In particular, prompt response to an accident is extremely important, because the potentiality of serious injuries and fatalities is high in the traffic accidents on expressways. A significant effect is expected to be achieved by introduction of ITS for quick identification and notification of accident occurrence or its situation.

In addition, insufficiency in the development of road network in Vietnam makes it difficult to find a detour in the event of a traffic accident. For this reason, a high effect is expected in rapid notification of accident occurrence and information provision of the few detours that is to be realized by ITS.

Use of expressway has begun only recently in Vietnam, and occurrences of significant congestions have not been reported. However, it is estimated that congestion will take place around the exit gates to ordinary roads, with the increase in daily use of expressway and traffic volume on it in the future, not only at the occurrence of traffic accident but also at the commute time in the morning/evening of weekday and in the evening of holiday. It is expected to secure smooth traffic by taking advantage of ITS to support the selection of appropriate entrance/exit gate, to provide the information of traffic restriction and to collect the traffic data.

The barrier tollgates have been installed on many arterial roads in Vietnam and these are operated by a flat tariff system. On the other hand, a distance proportional tariff system is being applied to the expressways which are under construction at present and many tollgates are being built at their entrances and exits. Significant effects are expected to be provided by system introduction of ETC (Electronic Toll Collection) for non-stop processing and increase of tollgate capacity, because the tollgates are prone to be disincentive against the smooth traffic and the superior route selectivity.

However, when introducing, it becomes important requirement for it to be able to process both the flat tariff and the distance proportional tariff simultaneously. It is expected to realize the smooth and sustainable road operation in the future through harmonization among the flat tariff and the road pricing in the metropolitan areas and the distance proportional tariff for intercity traffic.

On the other hand, in Vietnam, expressway network being constructed by sections funded by different donors, it has become an important issue how operate such sectioned road network. It is required to set up cooperative management system among many different road operators. In such situation, ITS introduction is under discussion for realizing road operation in efficient and integrated form. Striving toward the development of the ITS Standards in Vietnam, the issues on inter-operability of data, compatibility of equipment components and connectability of communication network are to be resolved.

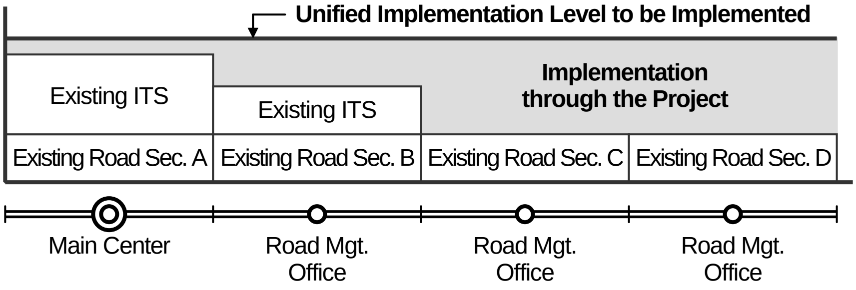
In the “Study for Supporting ITS Standards & Operation Plan Development in Vietnam”, which was conducted following VITRANSS2, ITS operation framework, key policies on system and the Draft ITS Standards are shown as the results. However, these results have not been formulated and integration on ITS has not been established. Consequently, it has become critically important:

- To establish a procedure to integrate ITS implementation over different road sections
- To show the way to utilize ITS for expressway operation and addressing traffic problems.

Necessity of ITS Integration Project

The Project aims to unify the ITS implementation levels covering the whole road network including a number of expressway sections, to verify/establish a procedure for integrating systems, to build up the Northern Regional Main Center, to initiate expressway operation/ maintenance (O&M) using ITS and to show the way to utilize ITS for solving traffic problems in the metropolitan areas.

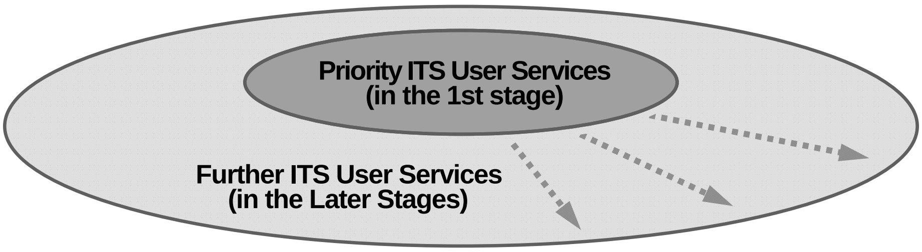
Figure 1 Unification of Implementation Levels through the ITS Integration Project



Source: ITS Standards & Operation Plan Study Team

The Project is to initiates the priority ITS user service focusing on the road operation aiming at extension to the further ITS user services in the later stages based on the ITS Master Plan.

Figure 2 Initiation of ITS User Services



Source: ITS Integration Project (SAPI) Study Team

➢ 2 Objective of Study

Objective of the Study is to integrate and secure compatibility of ITS over the whole Ha Noi Metropolitan Area achieving the following items:

- Evaluation of the ITS Integration Project and development of a specific plan for project implementation
- Consensus building on the specific plan with parties concerned in Vietnam
- Conforming ITS of National Highway No.3 to previous study results and the developed specific plan.

➢ 3 Study Scope

1) Study Area

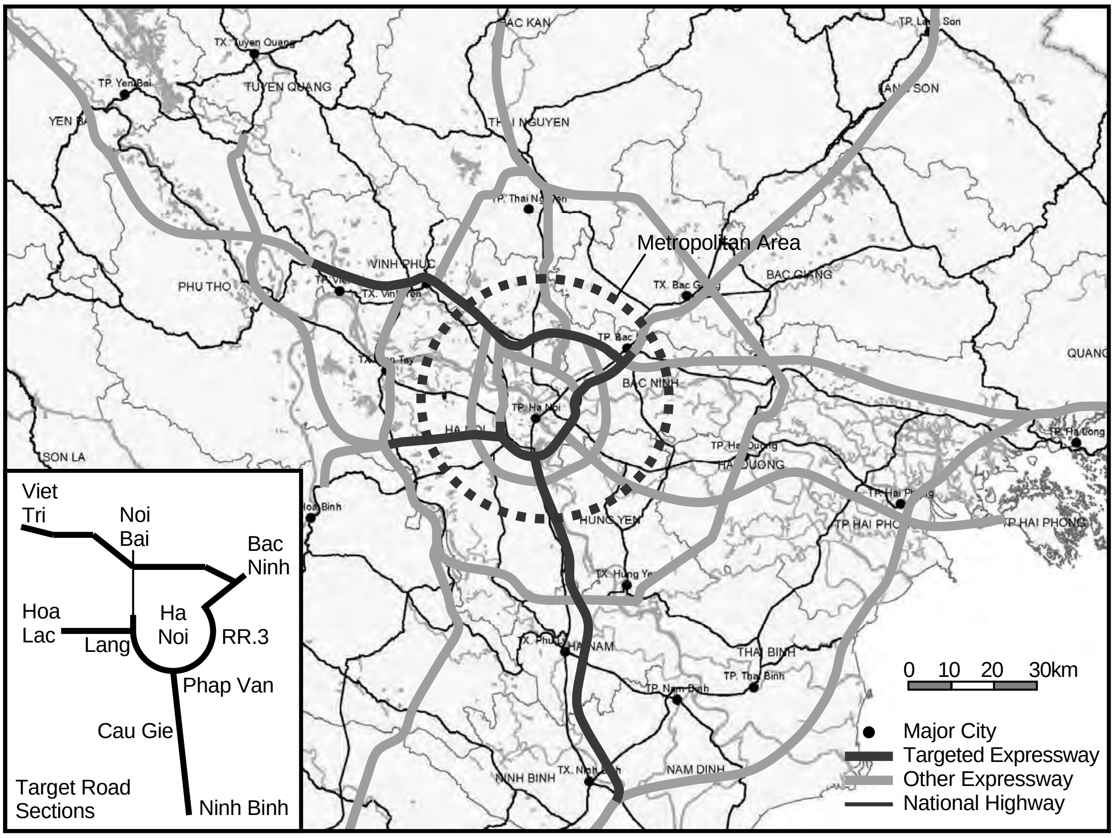
Ha Noi Metropolitan Area is to be defined as the study area. The target road network of the Project is to be formed by selections of the road sections below, which are shown in the official letter 2584/VEC-DA from VEC to MOT, evaluating effects of the project implementation.

(1) Base case for the target road sections of the Project: Expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section, and all connections to candidate locations of the Regional Main Center and the road management offices

(2) Expressway sections to be integrated under the Northern Regional Main Center other than (1).

Total length of the expressway network in the northern area, which is composed of (1) and (2), can be assumed to be around 1000 km.

Figure 3 Road Sections in Study Area



Target Road Sections of the Project (Base Case)	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Phap Van–Cau Gie	30 km
Cau Gie–Ninh Binh	50 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Noi Bai–Viet Tri	80 km
Total	268 km

Source: ITS Integration Project (SAPI) Study Team

2) Systems to be Discussed

The scope of the Study embraces to discuss and evaluate the ITS Integration Project focused on the following four systems:

- System for road traffic information/control
- System for non-stop toll collection
- System for heavy truck control
- Communication system.

These are based on the ITS user services shown in the ITS Master Plan.

Table 1 Definition of Three Priority ITS User Services

Traffic Information/Control

Service descriptions:

This service provides accurate surveillance of traffic conditions on expressway and adjacent arterial roads. This service assists prompt action of the road operator and the emergency vehicles by notifying occurrence of traffic accidents, broken-down vehicles and other obstacles. This service allows drivers en route and in advance to avoid the influence of the incidents by providing accurately updated information. This service also allows appropriate interchange/route selection by providing drivers en route with information; such as crowdedness and travel-time. This service makes it possible to measure actual traffic volume continuously for developing rational road construction/improvement plan.

Functional packages to be included in the system:

(1) Voice communication
(2) CCTV monitoring
(3) Event detection (by image)
(4) Vehicle detection
(5) Traffic analysis
(6) Weather monitoring
(7) Traffic event data management
(8) Traffic supervision
(9) VMS indication
(10) Mobile radio communication
(11) Traffic information
(12) Integrated data management

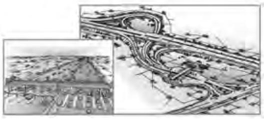
Non-stop Toll Collection

Service descriptions:

This service enables toll collection without stopping vehicles: ETC (Electronic Toll Collection). This service relieves bottlenecks at the tollgates and allows smooth incoming and outgoing at the interchanges. This service reduces the number of tollbooths and solves the problem of land acquisition for the tollgates in suburban areas where traffic congestion will become an issue in near future. This service realizes simple vehicle inspection at the border crossings, and provides road or vehicle operators with the time of vehicle passage at the tollgates. Computerized toll management can vastly reduce uncollected toll revenue due to the failure in counting/classifying vehicles and can realize appropriate sharing of the toll revenue among different road operators.

Functional packages to be included in the system:

(13) Tollgate lane monitoring
(14) Vehicle/class identification
(15) Lane control
(16) Road-to-vehicle communication
(17) IC-card recording
(18) Toll data management
(19) OBU management



Heavy Truck Control

Service descriptions:

This service eliminates overloading of heavy trucks by automatic execution of vehicle weighing at interchanges. It restrains damage to the road structure and extends its durable lifetime. This service restrains congestion caused by heavy trucks and allows freight trans-port to improve safety by eliminating overloading. This service allows prompt action of the road operator at the occurrence of serious accidents caused by heavy trucks and hazardous-material trucks and appropriate vehicle operation by keeping track of the trucks on the expressway network.

Functional packages to be included in the system:

(20) Axle load measurement
(21) Measurement lane monitoring

Note: (22) Communication System, (23) Communication Ducts and (24) Base Structures are to be discussed additionally to the functional packages above.

Source: ITS Integration Project (SAPI) Study Team

3) Study Outputs

The following items are to be developed in the Study:

- Feasibility Study Report
- Basic Design Report
- Project Implementation Plan
- System Operation Management Plan
- Revision of Draft ITS Standards.

4 Concepts of Project

It is proposed essentially for the ITS Integration Project to be accomplished in accordance with the following concepts:

- Integration of ITS on target road network
- Improvement in quick response to incident occurrence
- Increase in route selectivity by introducing ITS
- Setting a direction for combined toll rate system
- Setting up of cooperative management system for road network
- Launching of stepwise implementation of ITS

5 Approach for System Integration

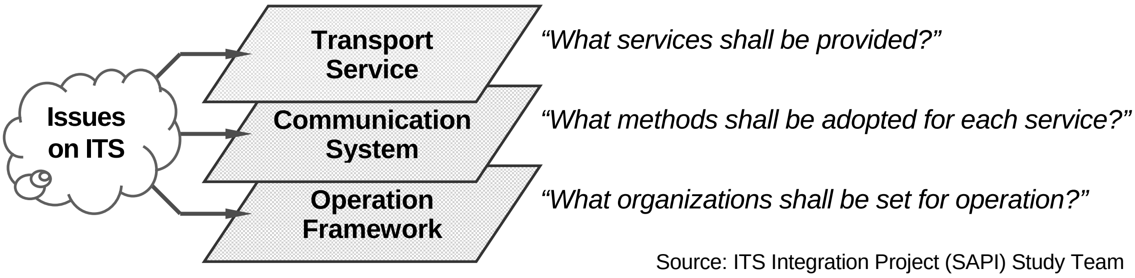
The following approaches are adopted for discussing the system integration of ITS in the Study:

- Three points of view for discussion
- Concept of of stepwise introduction of ITS user services
- Sharing of understanding based on system architecture
- Stepwise system implementation by package: implementation package and functional package
- Procedure for system integration among different expressway projects.

1) Three Points of View for Discussion

In the Study, issues on ITS introduction were discussed from the following three points of view: transport service, communication system and operation framework.

Figure 4 Viewpoints for Discussing Issues on ITS Introduction



Source: ITS Integration Project (SAPI) Study Team

2) Stepwise Introduction of ITS User Services

In the ITS Master Plan, the road map has been proposed based on the time period divided into three stages (1st Stage: up to 2015, 2nd Stage: from 2015 to 2020, 3rd Stage: from 2020 to 2030).

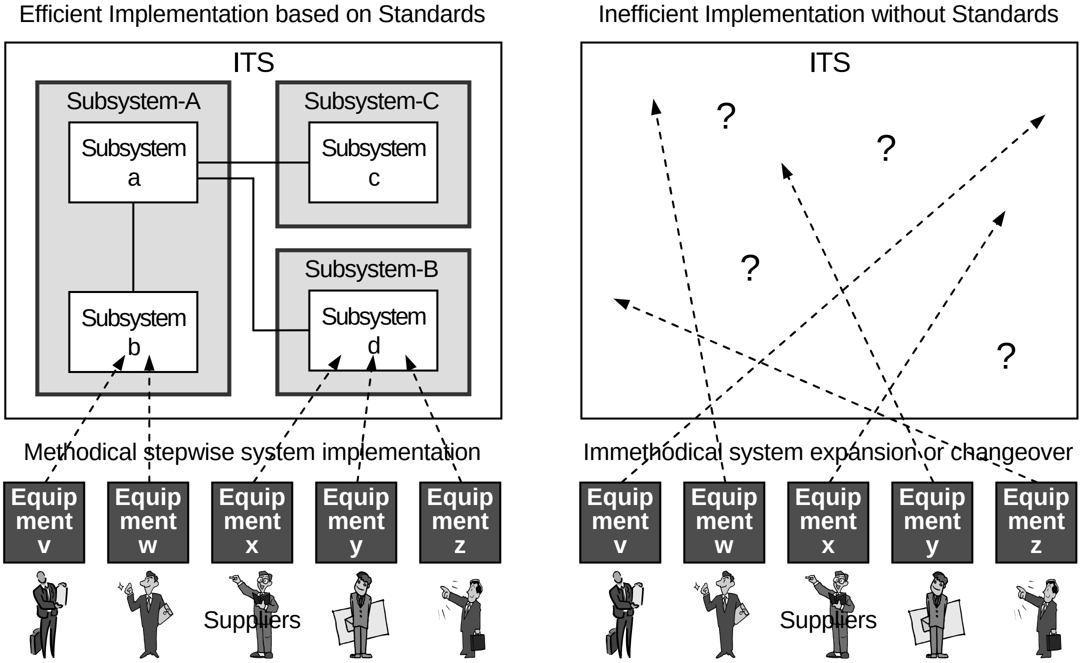
Figure 5 Road Map of ITS for Inter-city Road Network

Source: VITRANSS2 Study Team

3) Understanding based on System Architecture

ITS is to be illustrated using the system architecture consists of simple graphical symbols and texts in the Study in order to share understanding of system configuration among all persons in charge and easily and clearly to verify the substitution of an unknown device by the supplier in actual implementation.

Figure 6 Efficient ITS Implementation by Sharing Understanding

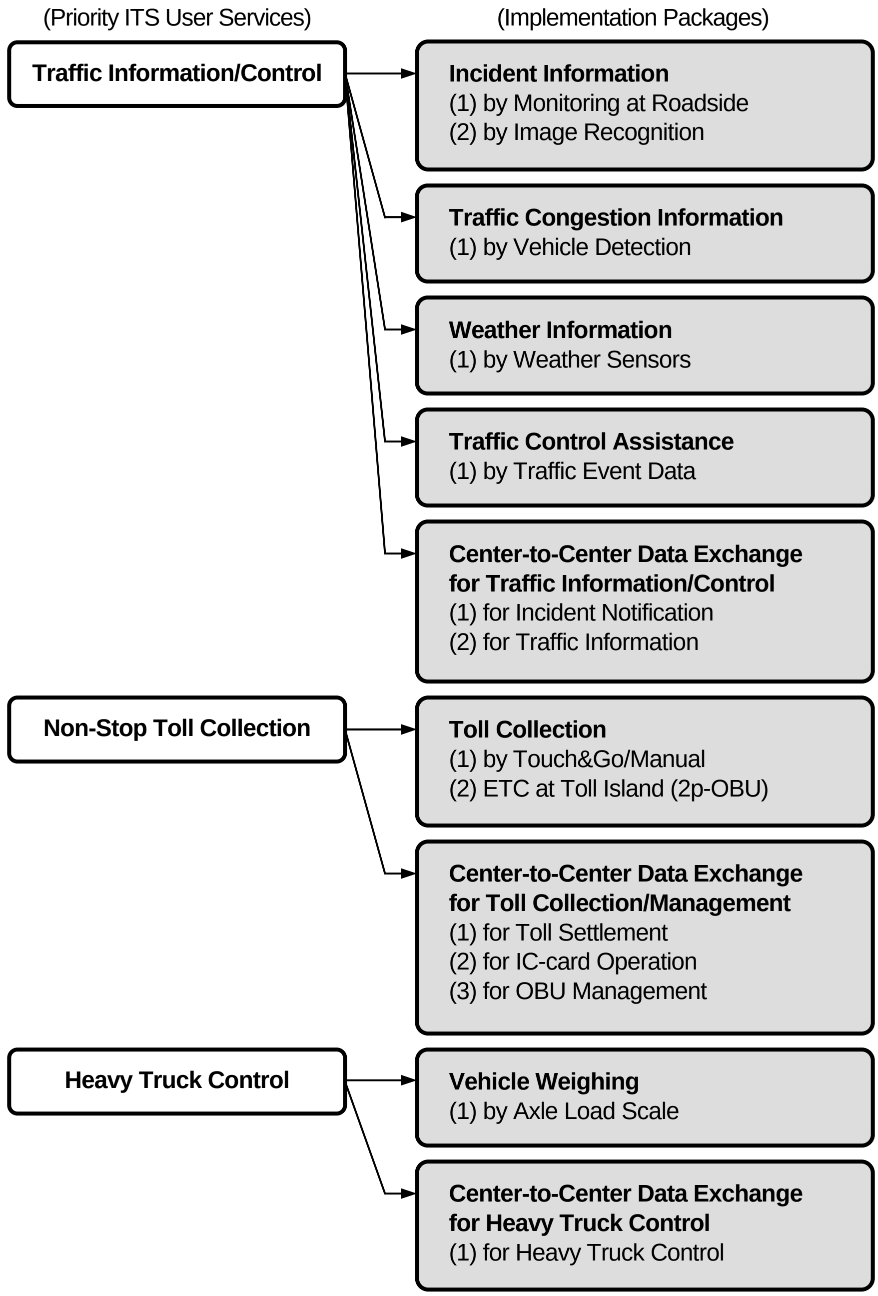


Source: ITS Integration Project (SAPI) Study Team

Implementation Packages

Implementation packages are to be prepared for discussing the contents of ITS to be introduced. In the Study, the system to be implemented in the Project is assumed to be composed of the implementation packages shown in the figure below for providing the three priority ITS user services to the road users and operators. Center-to-center data exchange is the implementation package necessary for all of the three services. Each implementation package can be actualized by one or more implementation methods.

Figure 7 Implementation Packages for Priority ITS User Services



Source: ITS Integration Project (SAPI) Study Team

Functional Packages

As is evident from the foregoing table, the system architecture and the implementation packages of ITS are assumed to be composed of functional packages in the Study. Based on the functional packages, the roles of organizations for implementing/operating/maintaining ITS are to be discussed, the quantities required for the Project are to be calculated and the costs are to be estimated. Correspondences between the functional packages and the implementation packages aforementioned are shown in the table below.

Figure 8 Functional Packages corresponding to Implementation Packages

ITS
(System Architecture)

(Implementation Packages)

(Functional Packages)	Incident Information	Traffic Congestion Information	Weather Information	Traffic Control Assistance	C-to-C Data Exchange for Traffic Information/Control	Toll Collection	C-to-C Data Exchange for Toll Collection/Management	Vehicle Weighing	C-to-C Data Exchange for Heavy Truck Control
(1) Voice Communication	xx			xx	xx				
(2) CCTV Monitoring	xx	xx							
(3) Event Detection (by Image)		xx							
(4) Vehicle Detection		xx							
(5) Traffic Analysis		xx							
(6) Weather Monitoring			xx						
(7) Traffic Event Data Management	xx	xx	xx	xx					
(8) Traffic Supervision	xx	xx	xx	xx					
(9) VMS Indication	xx	xx	xx	xx					
(10) Mobile Radio Communication				xx					
(11) Traffic Information					xx				
(12) Integrated Data Management					xx		xx		xx
(13) Tollgate Lane Monitoring						xx			
(14) Vehicle/Class Identification						xx			
(15) Lane Control						xx			
(16) Road-to-Vehicle Communication						xx			
(17) IC-card Recording						xx			
(18) Toll Data Management						xx	xx		
(19) OBU Management							xx		
(20) Axle Load Measurement								xx	
(21) Measurement Lane Monitoring								xx	

Source: ITS Integration Project (SAPI) Study Team

4) Stepwise System Implementation by Package

In the Sutdy, it is assumed that stepwise system implementation for traffic information/control, toll collection/management and vehicle weighing is to be launched in the Project based on the functional packages as shown in the figure below.

Figure 9 Stepwise System Implementation Schedule (Excerpt)

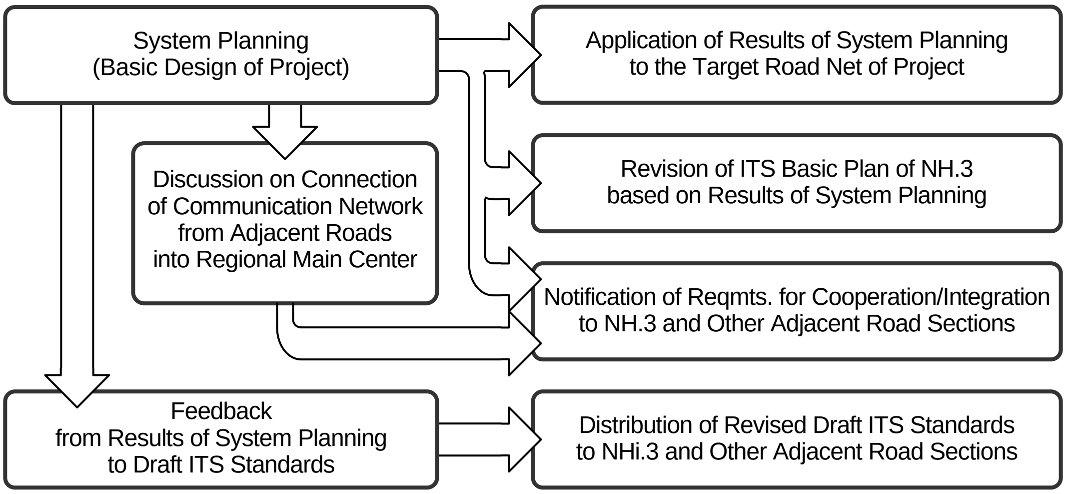
Functional Package	1st Stage		2nd – 3rd Stage
	In the Project		
(1) Voice Communication	• Terminal installation in the Regional Main Center, road management offices and toll offices		
(2) CCTV Monitoring	• Camera installation at 2km intervals continuously along through lanes		• Camera installation at shorter intervals continuously along through lanes • Concurrent use of camera with event detection and vehicle detection
(3) Event Detection (by Image)	• Camera installation on several ramps for trial use	• Camera installation on ramps for practical use	• Camera installation around incident-prone sections on through lanes for practical use
(4) Vehicle Detection	• Detector installation at midway between a pair of interchanges on the through lanes		

Source: ITS Integration Project (SAPI) Study Team

5) System Integration among Different Expressway Projects

In the Study, cooperation and integration of the system has been promoted by discussing harmonization among the target road network of the Project and adjacent road sections in system planning. The Draft ITS Standards has been revised by feedback from the study results and will be distributed to the National Highway No.3 and other adjacent road sections.

Figure 10 Procedure for System Integration among Target Road Network of Project and Adjacent Roads



Source: ITS Integration Project (SAPI) Study Team

➢ 6 Document Organization

General discussion results on ITS, expressway operation framework and feasibility of the Project were mentioned in the main report, the review of current conditions & legal affairs and the system operation/ management plan.

Specific discussion results on the feasibility of the Project were shown in the documents of the feasibility study drawings and the environmental & social study report. Discussion results on the basic design of the Project were shown in the documents of the basic design report, the basic design drawings and the basic design specifications.

Additionally, referring to these study results, the existing documents were revised, which comprised the summary of ITS Master Plan, the Draft ITS Design Standards, the Draft ITS Message/Data Standards, the Draft ITS Communication System Plan and the Draft ITS General Specifications.

Figure 11 Document Organization of Study Results

- **Main Report**
  - Approach for System Integration of ITS
  - Existing Conditions of Road/Traffic/ITS
  - Basic Understanding of Total Expressway Operation
  - Framework of Expressway Operation using ITS
  - System Operation/Management Plan
  - Key System Policies
  - Feasibility Study of Project
  - Location of Northern Regional Main Center
  - Environmental Social Consideration Study of Project
  - Basic Design of Project
  - Project Implementation Plan
  - Review of ITS Basic Plan for New National Highway No.3
  - Required Conditions for Project Implementation
  - Revision of Draft ITS Standards
- **Review of Current Conditions & Legal Affairs**

Appendix-1

- **System Operation/Management Plan**

Appendix-2

- **Feasibility Study Drawings**
- **Environment & Social Study Report**

Appendix-3

- **Basic Design Report**
- **Basic Design Drawings**
- **Basic Design Specifications**

Appendix-4, 5

- **ITS Basic Plan for National Highway No.3**
  (Revised Version)

Appendix-6

- **Summary of ITS Master Plan**
  (Revised Version)
- **Draft ITS Design Standards**
  (Revised Version)
  (1) Traffic Information/Control System
  (2) Automated Toll CollectionManagment System
  (3) Vehicle Weighing System
- **Draft ITS Message/Data Standards**
  (Revised Version)
- **Draft ITS Communication System Plan**
  (Revised Version)

Appendix-7

- **Draft ITS General Specifications**
  (Revised Version)
  (1) Voice Communication
  (2) CCTV Monitoring
  (3) Event Detection (by Image)
  (4) Vehicle Detection
  (5) Traffic Analysis
  (6) Weather Monitoring
  (7) Traffic Event Data Management
  (8) Traffic Supervision
  (9) VMS Indication
  (10) Mobile Radio Communication
  (11) Traffic Information
  (12) Integrated Data Management
  (13) Tollgate Lane Monitoring
  (14) Vehicle/Class Identification
  (15) Lane Control
  (16) Road-to-Vehicle Communication
  (17) IC-card Recording
  (18) Toll Data Management
  (19) OBU Management
  (20) Axle Load Measurement
  (21) Measurement Lane Monitoring
  (22) Communication System
  (23) Communication Ducts
  (24) Base Structures

Appendix-8

Source: ITS Integration Project (SAPI) Study Team

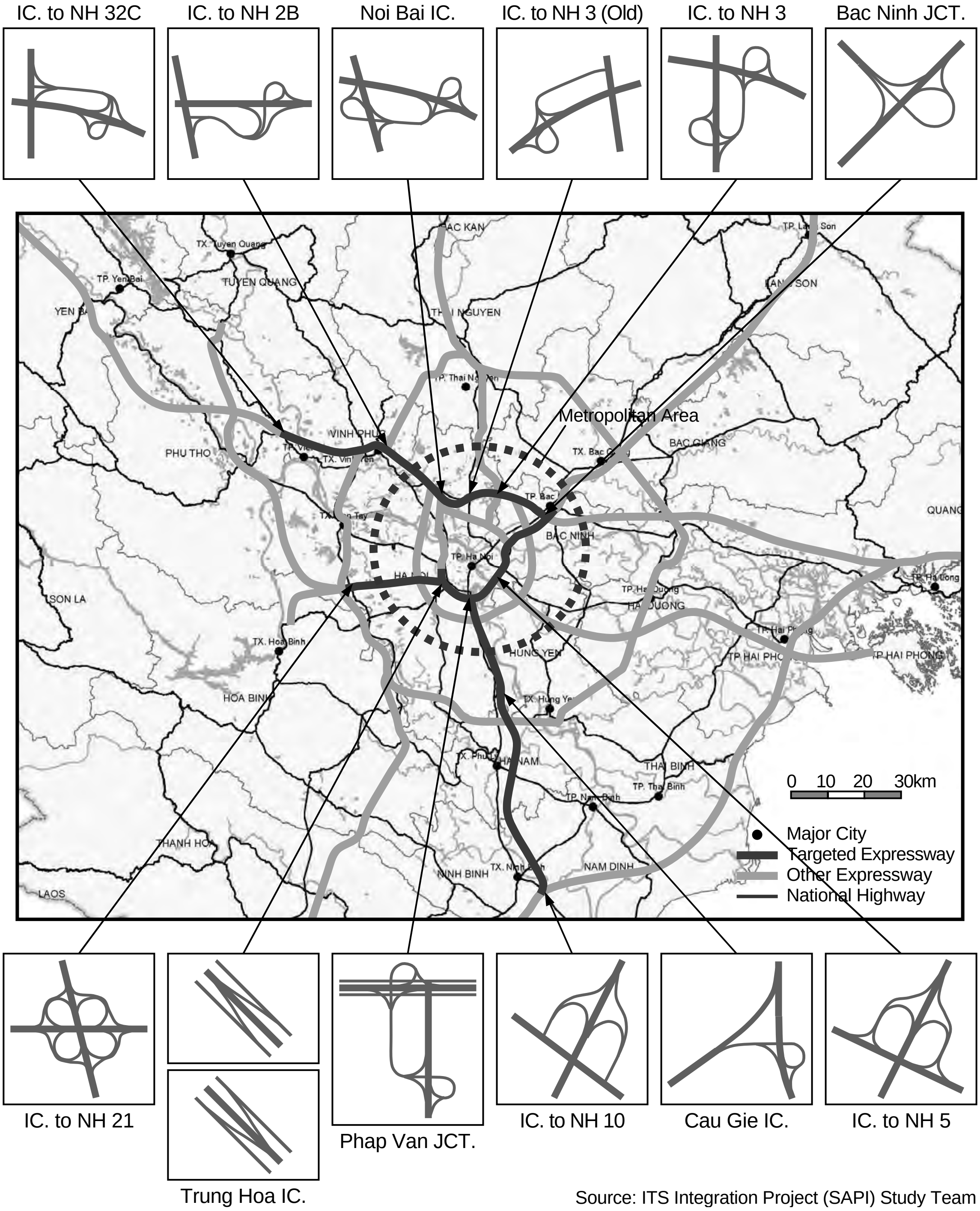
➢ 7 Existing Conditions of Road/Traffic/ITS

The existing conditions were surveyed in the Study covering the road network, road traffic, communication network and power supply, ITS implementation and pre-existing study results, legal affairs relevant to ITS.

1) Road Network

The target road network of the Project, major interchanges and junctions are shown below.

Figure 12 Road Network and Interchanges



Source: ITS Integration Project (SAPI) Study Team

Outline of Road Sections

In this section, outline of the target expressays surveyed in the Study are shown in the table.

The outline has suggested that the characteristics of expressway (especially, number of lane and road structure type) are much reflected to the scale of construction cost per kilometer, which can be said especially for the case of expressways of Mai Dich – Thanh Tri and Lang – Hoa Lac.

Table 2 Outline of Road Sections (1)

Expressway	**Mai Dich - Thanh Tri(Ring Road 3)**	**Lang - Hoa Lac**
Length	27 km	28 km
Design Speed	100 (km/h)	120 (km/h)
Number of Lane	TL: 4, ESL: 2	TL: 6 (with median strip), ESL: 2, FRL: 6
Rivers to Pass	Lich River, Red River, Duong River	Nhue River, Day River, Tich River
Road Structure	- Section: Mai Dich - Linh Dam: Elevated - Section: Linh Dam - Thanh Tri Bridge: Embankment	Embankment
Access Control	Full Access Control	Full Access Control
Expected Function	Expected to alleviate the existing traffic congestion and to support the future urban development outside the built-up area.	Linking Hanoi area to Hoa Lac area, where regional development related to High-tech Park, Industry Park and National University is expected in future.
Expressway	**Phap Van – Cau Gie**	**Cau Gie – Ninh Binh**
Length	30 km	50 km
Design Speed	from 60-100 upgrade to 120 km/h	120 km/h
Number of Lane	TL: 4 (or 6)	TL: 4 (or 6)
Rivers to Pass	Lich River	Duy Tien River, Chau Giang River; Day River
Road Structure	Embankment	Embankment
Access Control	Full Access Control	Full Access Control
Expected Function	Expected to reduce transport cost and travel times for the movement of passengers and cargo between North to South (share traffic volume with the arterial NH.1A)	Expected to reduce transport cost and travel times for the movement of passengers and cargo between North to South (share traffic volume with the arterial NH.1A)
Expressway	**Ha Noi – Bac Ninh**	**Noi Bai – Bac Ninh**
Length	20 km	33 km
Design Speed	80 (km/h)	120 (km/h)
Number of Lane	TL: 4	TL: 4, ESL: 2
Rivers to Pass		-Ca Lo River
Road Structure	Almost Embankment	Embankment
Access Control	Full Access Control	Full Access Control
Major Function	Expected to alleviate the existing traffic congestion and to support regional development and cargo transportation to Lang Son border with China.	Expected to alleviate the existing traffic congestion and to support regional development and cargo transport related to Noi Bai Airport and Cai Lan Port.
Expressway	**Noi Bai – Viet Tri**	
Length	80 km	
Design Speed	100 (km/h)	
Number of Lane	TL: 4 (or 6)	
Rivers to Pass	Red River, Pho Day River, Ca Lo River	
Road Structure	Embankment	
Access Control	Full Access Control	
Expected Function	Expected to reduce transport cost and travel times for the movement of passengers and cargo between Chinese border at Lao Cai and Hanoi area.	

Note: TL: Through lanes, ESL: Emergency stop lanes, FRL: Frontage road lanes.

Source: Compiled by ITS Integration Project (SAPI) Study Team

2) Road Traffic

Existing conditions of the road traffic surveyed in the Study are shown in the following.

In Vietnam, use of expressway has begun only recently and occurrences of significant congestions have not been reported, while traffic volume has been increasing. In addition, a negative influence upon the use of expressway by collecting toll seems still large in this country. For example, it is reported that the traffic volume on the HCMC – Trung Luong Expressway, which was 32,000～35,000 vehicles/day in the period of free toll, decreased dramatically to 18,000 vehicles/day when toll collection was started.

The summary of of estimated traffic demand in the table below shows the traffic volume per lane of each section of the target road network of the Project estimated in consideration of the influence of toll mentioned above. As the results of estimates for the years 2015 and 2020 in this table, the value of the traffic volume per lane is not excess of 2,000 pcu/lane in any section and the possibility of occurred congestion is not so high. However, in order to respond to the occurrence of congestion in the future, it is extremely important to collect the data of traffic using ITS.

Table 3 Summary of Estimated Traffic Demand by Road Section

		Traffic Volume per Day				Traffic Volume per Peak Hour (pcu)	Traffic Volume per Lane (pcu/lane)
		Psgr.Car (Vehicles)	Bus (Vehicles)	Truck (Vehicles)	Total (pcu)		
Mai Dich - Thanh Tri	2015	15,633	6,733	12,950	58,367	7,588	1,138
	2020	25,317	9,550	16,500	82,192	10,685	1,603
Lang - Hoa Lac	2015	15,675	2,000	10,325	41,325	5,372	537
	2020	12,550	1,550	8,275	32,975	4,287	429
Phap Van - Cau Gie	2015	9,400	15,800	9,300	67,500	8,775	878
	2020	15,100	19,700	11,450	87,250	11,343	1,134
Cau Gie - Ninh Binh	2015	11,200	18,900	11,600	81,650	10,615	1,061
	2020	24,550	33,300	21,300	150,400	19,552	1,955
Ha Noi - Bac Ninh	2015	12,450	4,450	9,825	43,225	5,619	562
	2020	15,900	5,125	12,750	54,213	7,048	705
Noi Bai - Bac Ninh	2015	5,267	900	6,133	19,783	2,572	386
	2020	8,467	1,433	9,100	30,250	3,933	590
Noi Bai - Viet Tri	2015	3,767	500	900	6,817	886	89
	2020	7,533	633	1,833	12,783	1,662	166

Source: ITS Integration Project (SAPI) Study Team

Furthermore, in the Study, a survey of traffic condition was performed focused on the ring-shaped part of the target road network. The survey was carried out in the way to record data of vehicle position/speed (probe data) using the smart-phone with the function of GPS. The results are shown in the following.

As evidenced obviously by the Table 5, the necessary time for a longer distance of the clockwise route is shorter than the necessary time for a shorter distance of the anti-clockwise route. At the same time, it can be observed the values of average speed of the clockwise route are between 60 and 70 km/h (excluding the result in a.m. of the Weekday 2), whereas the values of average speed of the anti-clockwise route are between 35 and 40 km/h.

Table 4 Summary of Traffic Conditions on Ring-shaped Road Network

		Anti-clockwise Route (Noi Bai→Trung Hoa→Sai Dong)			Clockwise Route (Noi Bai→Bac Ninh→Phap Van)		
		Drive Distance (km)	Duration Time (min)	Average Speed (km/h)	Drive Distance (km)	Duration Time (min)	Average Speed (km/h)
Weekday 1	am	44	69	38.6	65	60	63.3
	pm		85	30.5		67	58.4
Weekday 2	am		70	37.4		106	36.8
	pm		78	33.7		58	66.7
Holiday	am		61	43.3		52	74.5
	pm		67	38.6		55	70.4

Source: ITS Integration Project (SAPI) Study Team

The prime reason of such traffic condition mentioned above is a slow speed in the section under viaduct construction on the Ring Road No. 3. Currently, in this section, the vehicles need to run on the existing frontage road and running speed has been significantly reduced. This condition takes place in common around the exit gates of expressways in the big cities. This fact suggest that there is a high possibility, also in Vietnam, of the occurrence of traffic congestion around the exit gates of expressways in the future.

The land in the northeastern area of Ha Noi is mostly in use of agriculture and the number of trips generated in this area is not so large. Hence, the sections of Ha Noi – Bac Ninh and Noi Bai – Bac Ninh have very few traffic as shown in the picture below.

Figure 13 Existing Condition of Traffic in Northeastern Area of Ha Noi

(Ha Noi – Bac Ninh Section) (Noi Bai – Bac Ninh Section)

Source: ITS Integration Project (SAPI) Study Team

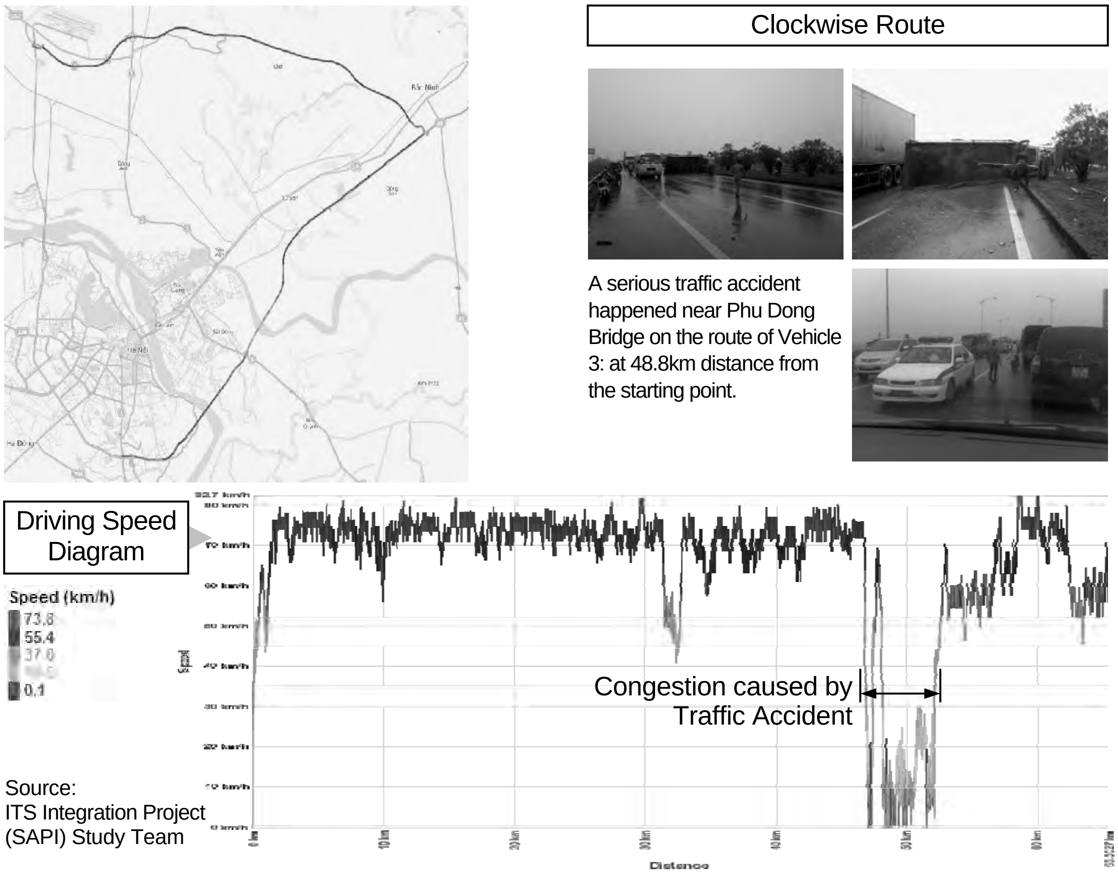
In contrast to this, the southwestern area of Ha Noi are in the midst of developing the new center of metropolis and a large number of high-rise buildings for offices and apartment, large-scale commercial establishment and hotels are being constructed. As a consequence, it has become daily routine that the trips generated this area cause crowdedness. Especially along the Ring Road No.3, the construction of the viaducts couses heavy congestion around intersections.

Figure 14 Existing Condition of Traffic in Southwestern Section of Ring Road 3

Source: ITS Integration Project (SAPI) Study Team

On the other hand, the situation described above has changed completely in the morning of the Weekday 2 when a serious traffic accident has occurred in the vicinity of the Phu Dong Bridge. The average speed of clockwise route falls to 36.8 km/h and the necessary time for going the destination is 106 minutes, which is nearly twice of the necessary time at the other

Figure 15 Traffic Condition of Noi Bai→Bac Ninh→Phap Van in the Morinig on Weekday 2



A serious traffic accident happened near Phu Dong Bridge on the route of Vehicle 3: at 48.8km distance from the starting point.

Source:
ITS Integration Project (SAPI) Study Team

dates. At the site of the accident, heavy truck overturned and blocked more than one lane as shown in the Figure 17. It is judged that reduction of average speed is obviously due to the congestion caused by the traffic accident.

Not only on the date of the survey foregoing, but frequently occur single-vehicle accidents in Vietnam. It is conceivable that such kind of acccidents are caused by the following reasons:

- Inexperience in high-speed driving
- Poor maintenance of the vehicle
- Overloading on the truck.

A traffic accident causes congestion in general and it is considerable that an ambulance is involved in the traffic congestion and is delayed in arrival at the iaccident site. Showtage of tow-cars frequently requires the supports of construction vehicles in Vietnam. The construction vehicles in the picture below was going to the accident site by reverse driving.

Figure 16 Traffic Accident on Thanh Tri Bridge

Source: ITS Integration Project (SAPI) Study Team

In Vietnam where the road network and detour has not been improved sufficiently, it is difficult to escape from the influence of a traffic accident while driving a vehicle like the case above. With such being the situation, it is extremely important to respond promptly to the accident and it is expected, for this reason, that significant effects on identifing quickly the accident occurrence/situation and disseminating the accident information can be achieved by ITS introduction. In addition, it goes without saying that the prompt response will contribute to reduce the number of fatalities caused by the traffic accidents.

Congestion at the tollgates on the expressways around Ha Noi is not so serious. A reason of such condition is the small traffic volume on the expressways and another reason is the monthly tickets used by many drivers, which allow non-stop passage at the tollgates.

Figure 17 Existing Condition of Vehicle Queueing at Tollgate

Source: ITS Integration Project (SAPI) Study Team

A large number of the heavy trucks carrying marine containers move up and down on the expressways mainly from Hai Phong to the inland areas passing by Ha Noi. It is reported that the heavy trucks commit overloading at high rates. Overloading regulation is to be considered as an urgent issue, because overloaded heavy trucks frequently cause traffic accidents by lowering in breaking force and traffic congestion by shortage of accelerating ability .

Figure 18 Heavy Trucks transporting Marine Containers on Expressways

Source: ITS Integration Project (SAPI) Study Team

3) ITS Implementation and Pre-existing Study Results

ITS Implementation

The following items were surveyed for the preparation of the Study.

- Traffic information (by Voice of Vietnam)
- VMS
- ETC

Pre-existing Study Results on ITS

(1) ITS Master Plan

The following items in the ITS Master Plan were reviewed for the preparation of the Study.

- Goals of ITS
- ITS user services
- Road map of ITS implementation
- Implementation packages
- Operation Framework of ITS
- Framework of Road Operation using ITS

(2) Draft ITS Standards

The following documents of the Draft ITS Standards prepared were reviewed:

- Draft ITS Design Standards (volumes organized by three priority ITS user services)
- Draft ITS Message/Data Standards
- Draft ITS Communication System Plan
- Draft ITS General Specifications (volumes organized by the functional packages).

Table 5 Existing Documents and Volumes of Draft ITS Standards

Draft Design Standards (3 Volumes)	(1) Traffic Information/Control (2) Automated Toll Collection/Management	(3) Vehicle Weighing
Draft Message/Data Standards (1 Volume)	Message List	Data Dictionary
Draft Communication System Plan (1 Volume)	General Communication System Plan	Design Standards of Communication System
Draft General Specifications (23 Volumes)	(1) Voice Communication	(13) Tollgate Lane Monitoring
	(2) CCTV Monitoring	(14) Vehicle/Class Identification
	(3) Event Detection (by Image)	(15) Lane Control
	(4) Vehicle Detection	(16) Road-to-Vehicle Communication
	(5) Traffic Analysis	(17) IC-card Recording
	(6) Weather Monitoring	(18) Toll Data Management
	(7) Traffic Event Management	(19) OBU Management
	(8) Traffic Supervision	(20) Axle Load Measurement
	(9) VMS Indication	(21) Measurement Lane Monitoring
	(10) Mobile Radio Communication	(22) Communication System
	(11) Traffic Information	(23) Communication Ducts
	(12) Integrated Data Management	

Source: ITS Standards & Operation Plan Study Team

4) Legal Affairs Relevant to ITS

The following items are reviewed as the legal affairs relevant to ITS:

- States papers and standards in Vietnam
- Existing frameworks relevant to ITS.

➢ 8 Basic Understanding of Total Expressway Operation

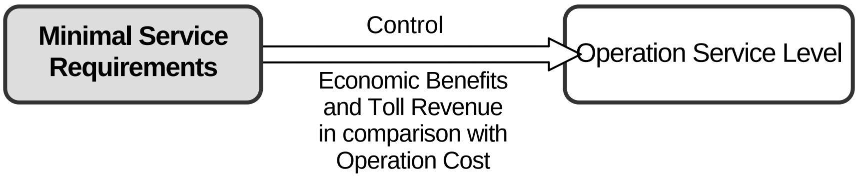
The following items were discussed as basic understanding of the total expressway operation.

- Minimal Service Requirements for Expressway Operation
- Access Control of Expressway Network
- Toll Rate System for Expressway Network
- Outline of Expressway Operation

1) Minimal Service Requirements for the Expressways

In order to enhance a road operator's motivation, minimal service levels required for the expressway operation shall be defined as a standard. The Minimal Service Requirements allow to control the operation service levels provided by a road operator as shown in the figure below. The operator's achievement in expressway operation is to be evaluated in reference to the Minimal Service Requirements.

Figure 19 Minimal Service Requirements for Controlling Operation Service Level



Source: ITS Integration Project (SAPI) Study Team

Table 6 Minimal Service Requirements for Expressway Operation

Accessibility	• Establishment of appropriate access control system to expressway network: - Rejection of vehicles above the dimensional limits to reduce damage to road structure →(a) - Rejection of impermissible type of vehicles including motor bikes →(b) - Rejection of overloading heavy trucks to reduce damage to road structure →(d) - Rejection of vehicles without payment adequate for regulated toll rate →(b) • Establishment of fair and reliable toll collection system based on the latest toll rate regulation for expressway network: - Availability for any drivers who intend to use expressway network rightfully →(b) - Reliability of automated toll collection: Error ratio by frequency less than 0.0001% on checking sufficiency of prepaid balance with reference to the vehicle class defined by the regulation →(b) • Provision of sufficient vehicle processing capacity at the tollgate by non-stop and one-stop toll collection responding to traffic volume: - Non-stop toll collection at average service-time less than 4.5 sec/vehicle →(b) - One-stop toll collection at average service-time less than 9.0 sec/vehicle →(b). • Connectability of communication network in conformity with the Standards. →(e) • Inter-operability of information/data in conformity with the Standards. →(e)
Mobility	• Establishment of road management offices equipped with adequate system for monitoring traffic, patrol crews for restoring road functions and enforcing/releasing traffic restrictions and vehicles for road operation including tow car, police car and ambulance →(a), (c), (e) • Provision of smooth traffic flow by dispatching routine patrol using operation vehicles: more than 4 times a day →(a), (c) • Provision of smooth traffic flow through traffic information/control: responding to locations of the vehicle on the road network and traffic volume →(c) • Maximum speed: 120 km/hr →(c) • Lowest speed to be secured: 50 km/hr (to be not less than maximum speed –70 km/hr, otherwise coming-in traffic shall be restricted) →(c) • Average travel speed: more than 60 km/hr →(c) • Traffic surveillance and information dissemination with update intervals: 5 minutes →(c).
Safety & Response to Incident	• Establishment of adequate organization to keep road structure/facility well-maintained to secure safety for road traffic →(a), (c) • Establishment of appropriate framework to address incidents including traffic accidents notified by emergency calls (including 113 and 115) →(c), (e) • Securing of means for emergency call with a delay time less than 10 minutes from the incident occurrence even in mountainous areas →(c) • Provision of traffic safety by dispatching road operation vehicles to an incident site with a delayed time less than 1 hour from the reception of emergency call →(c) • Enforcement of adequate traffic restrictions responding to the incident occurrences and the traffic conditions →(c) • Information dissemination of incident with a delay time less than 1 hour →(c), (e).
Environmental Protection	• Promotion of installation and dissemination of non-stop toll collection →(b) • Keeping smooth traffic flow by enhancing traffic information/control →(c).

Note: (a), (b), (c), (d), (e) are to be referred to Table 8.

Source: ITS Integration Project (SAPI) Study Team

2) Vehicle Classification

In Vietnam, vehicle classification for national highway is defined in the Circular No.90/2004/TT-BTC of MOF and vehicle classification and toll rate of epxressway is defined in the Circular No.14/2012/TT-BTC of MOF as shown below. The discussion in the Study is based on them.

The vehicle classification is defined by the combination of the number of seats and the loading capacity, focusing on the benefits provided by road use. This classification can be enforced automatically by using license plate scanners based on license plate system.

Table 7 Vehicle Classification in VIETNAM

Vehicle Class		Definition	Unit Toll Rate (VND/km)
Ordinary Vehicle	1	Cars with seats of 12 or less, trucks with a capacity less than 2 tons, mass transit buses	1000
	2	Cars seats between 12 and 30, trucks with a capacity between 2 and 4 tons	1500
	3	Cars with seats of 30 or more, trucks with a capacity between 4 and 10 tons	2200
	4	Trucks with a capacity between 10 and 18 tons, 20ft-container lorries	4000
	5	Trucks with a capacity of 18 tons or more, 40ft-container lorries	8000
MOD Vehicle	6	Military vehicles in the missions	0
Police Vehicle	7	Public security vehicles in the missions	0

Note, MOD: Ministry of Defence

Source: ITS Standards & Operation Plan Study Team

3) Services of Road Operation/Maintenance

Based on the minimal service requirements, the operator is to provide the services shown in the table below. It is assumed as a premise for discussion in the Study that ITS is to be applied to a part of the road operation, which includes road structure/facility management, toll collection/management, traffic information/control and communication system management.

Table 8 Services of Road Operation/Maintenance

Operation	Maintenance
(a) Road Structure/Facility Management Cleaning-up, green space management, disaster recovery, energy and water supply and checkups of structure and facility in order to secure safety and comfort in road use.	Maintenance for restoring structure and facility to their original state of function and performance. - Pavement - Bridge - Tunnel - Semi-underground structure - Architectural structure - Mechanical equipment - Electrical equipment.
(b) Toll Collection/Management Toll collection from the road users and its management.	
(c) Traffic Information/Control (d) Heavy Truck Control Routine patrol, regulation against illegal vehicles and traffic control for safe/comfortable drive and smooth traffic flow.	
(e) Communication System Management Fiber optic cable network system operation and management	

Applicable Scope of ITS

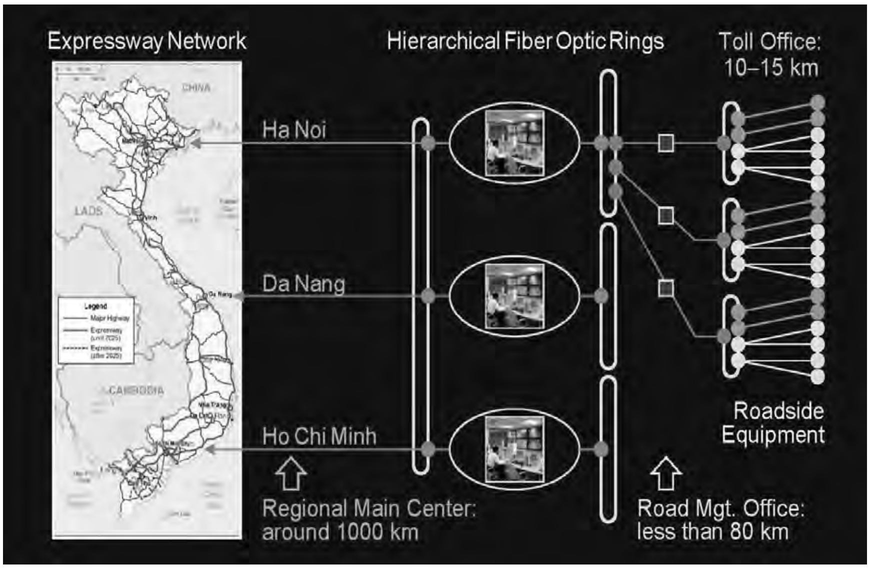
Source: ITS Integration Project (SAPI) Study Team

A single organization can be in charge both of construction and operation/maintenance of the road section; however, some parts of the work can be transferred to the other organization under contract.

4) Location/Structure Outline of Offices

The location/structure outline of the offices for expressway operation is illustrated in the ITS Master Plan as shown in the figure below. The regional main centers are to be located in Ha Noi, Da Nang and Ho Chi Minh.

Figure 20 Structure Outline of Offices for Expressway Operation



Source: VITRANSS2 Study Team

Table 9 Function/Location of Offices

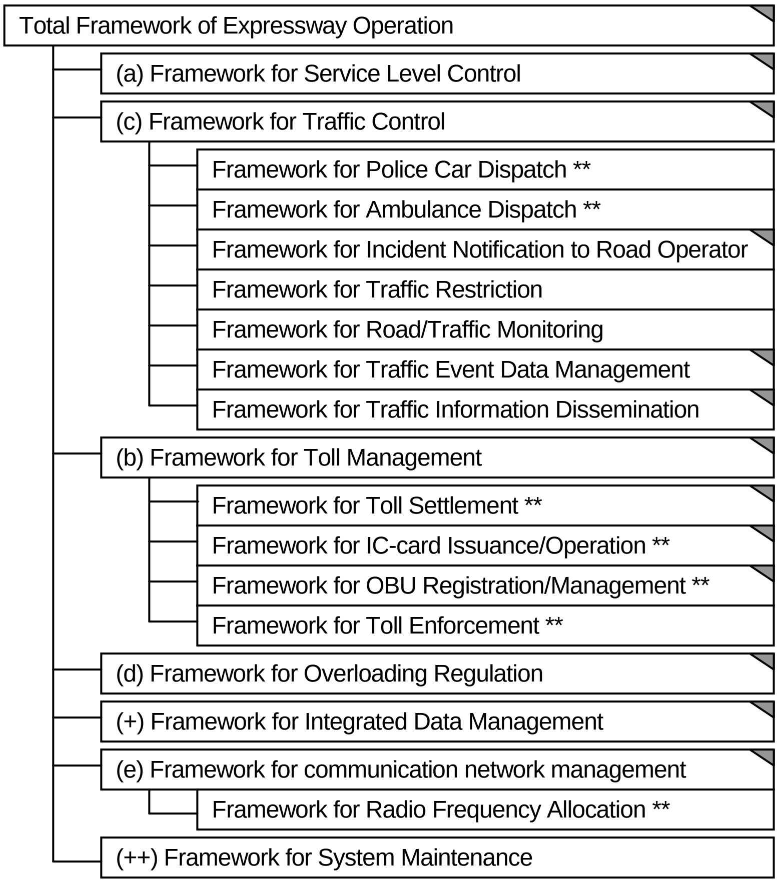
Classification	Functions/Locations
Regional Main Center	This center is to perform the functions of integration of road management offices, traffic regulation, traffic control and traffic information and is to be located in the major cities such as Ha Noi, Da Nang and HCMC.
Road Management Office	This office is to perform the functions of patrol for surveying current road/traffic conditions and integration of communication nodes in a jurisdiction and is to be installed one or more in an expressway section.
Toll Office	This office is to be installed at the tollgate, which has two or more toll booths, and perform the function of toll collection. A communication node, which integrates pieces of roadside equipment for ITS, is to be installed usually in a toll office.

Source: ITS Integration Project (SAPI) Study Team

➢ 9 Frameworks of Expressway Operation using ITS

In this chapter, the following frameworks needed for expressway operation are to be discussed and recommended one is to be itemized for each.

Figure 21 Composition of Frameworks



Note:
◥ : Framework shown in the following page
** : Framework included mainly in organization other than road operator
+ : Integration of data for (b), (c) and (d)
++ : Maintenance covering (b), (c), (d) and (e)

Source: ITS Integration Project (SAPI) Study Team

These frameworks are totally to cover the following five fields, which are the services of the road operation/maintenance aforementioned, and the services of (b), (c), (d) and (e) are to be supported by ITS:

(a) Road structure/facility management
(b) Toll collection/management
(c) Traffic information/control
(d) Heavy truck control
(e) Communication system management.

} To be supported by ITS

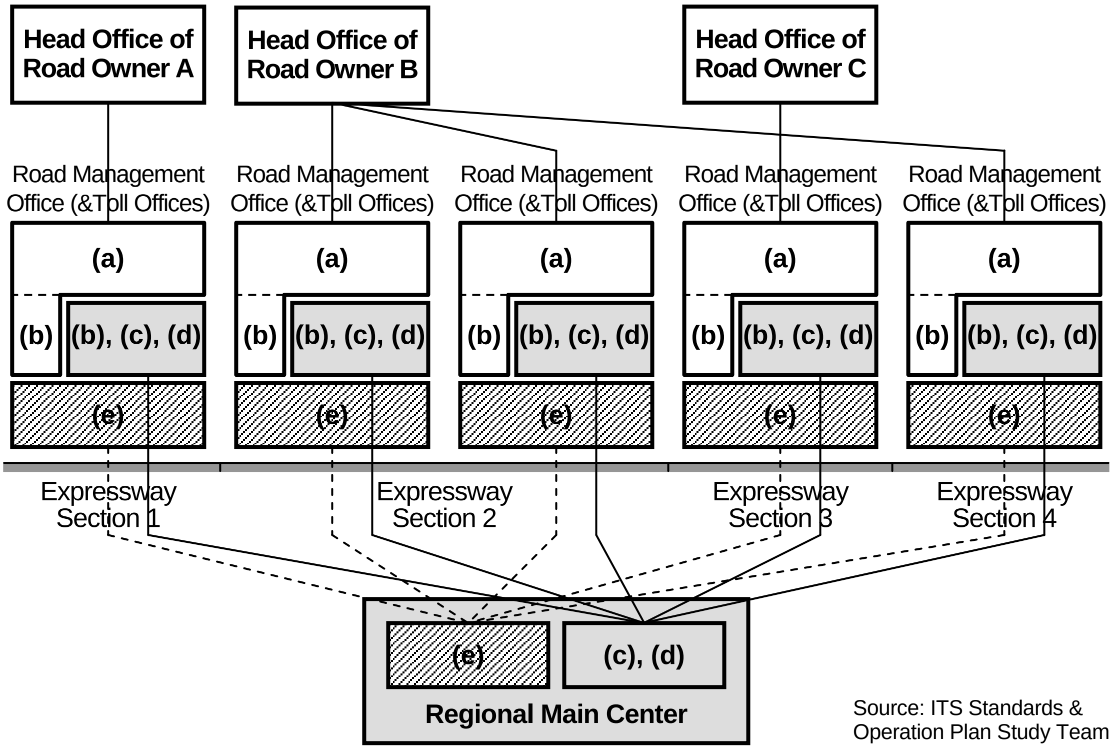
The correspondence between the frameworks and the services of road operation/maintenance can be illustrated in the figure above. The total framework of expressway operation on the top of the figure shows the whole picture of expressway operation using ITS and includes other frameworks conceptually.

1) Total Framework of Expressway Operation

An expressway network will be constructed/operated by section. Hence, road structure/facility management and toll collection/management are to be integrated by the head offices of the road owners, and proper expressway operation and communication network management are to be integrated by the Regional Main Center as shown in the framework below.

- Head office of road owner
  - (a) Road structure/facility management
  - (b) Toll collection/management
- Regional Main Center
  - (c) Traffic information/control
  - (d) Overloading regulation
  - (e) Communication network management

Figure 22 Total Framework or Expressway Operation



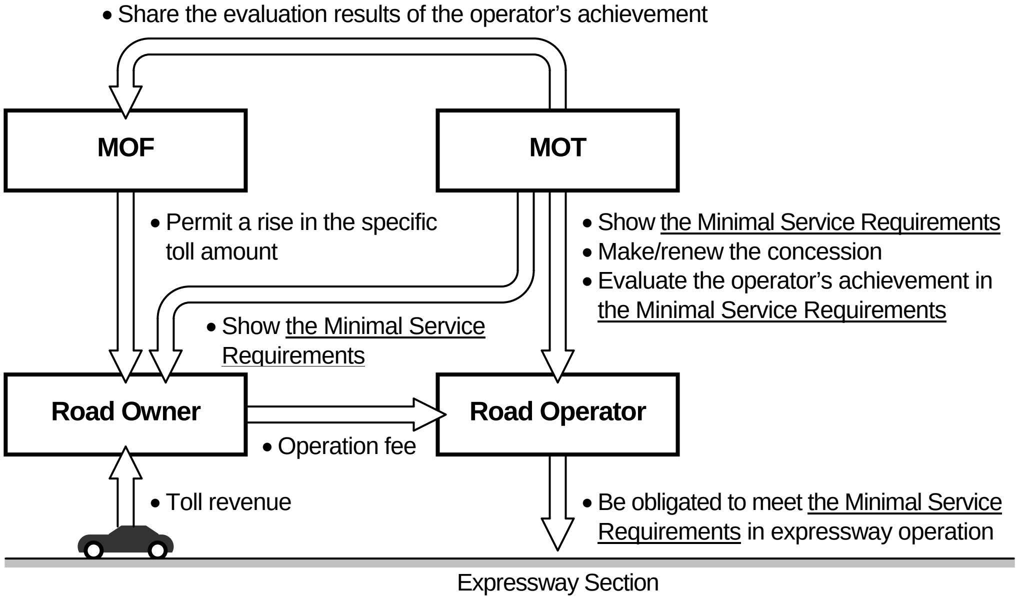
Source: ITS Standards & Operation Plan Study Team

In this framework, some roles of the road operator are to be consolidated to and conducted in the Regional Main Center as shown above. The system needs to be built up in considration of the cooperation among the offices of different purposes and covering the required fields.

2) Framework for Service Level Control

A set of Minimal Service Requirements shall be shown by MOT to the road operator and the road owner in the process of making a concession of expressway operation. The road operator is to be obliged to meet the Minimal Service Requirements. And on the occasion when the concession is renewed, rises in the specific toll amount of the road owner and in the operation fee paid by the road owner to the road operator are to be permitted by MOF based on an evaluation on the degree of the road operator's achievement by MOT in reference to the requirements.

Figure 23 Framework for Service Level Control

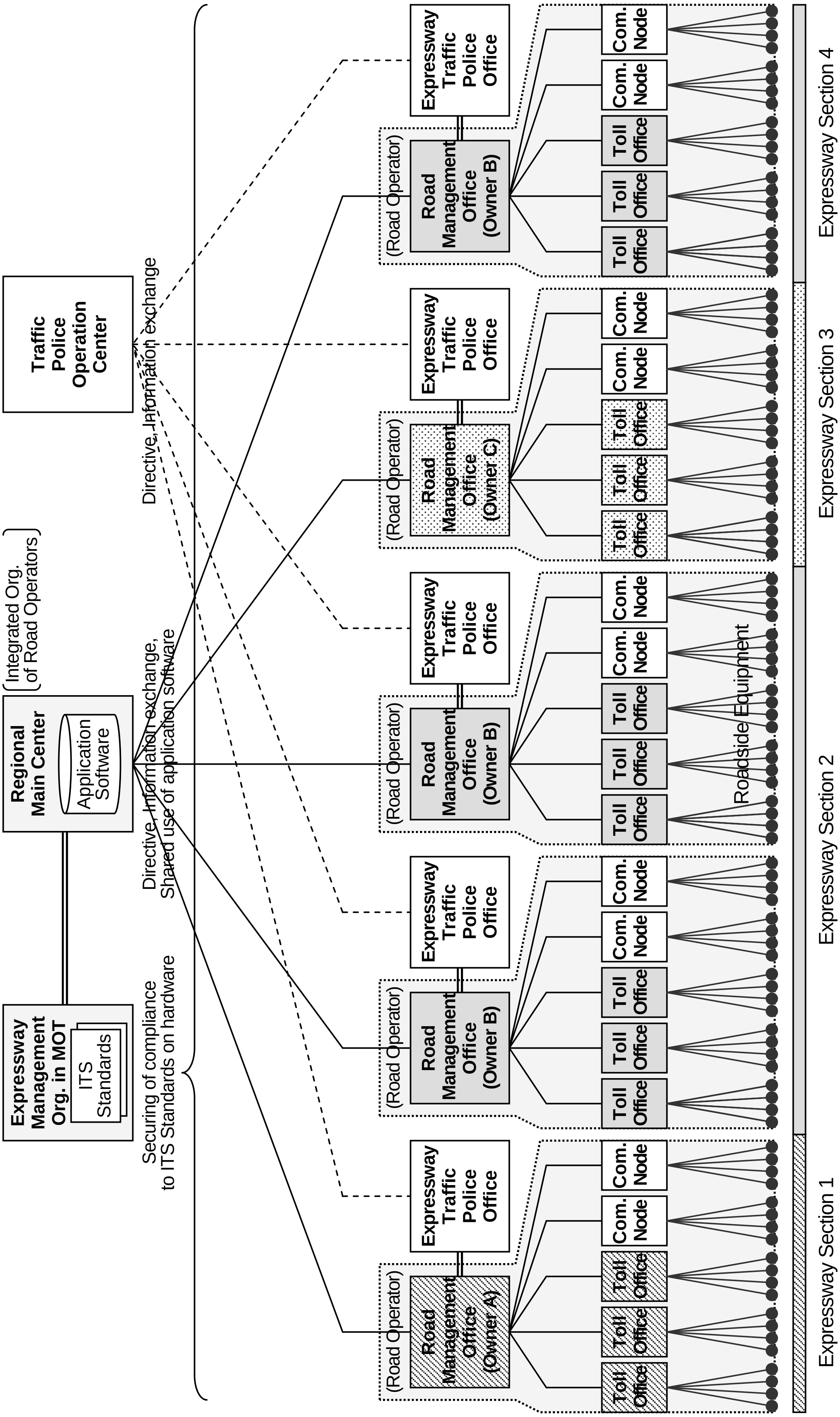


Source: ITS Integration Project (SAPI) Study Team

3) Framework for Traffic Control

The framework for traffic control is shown in the following figure. In this framework, expressway police offices are to be organized respectively for the expressway sections, which are the jurisdictions of road management offices.

Figure 24 Framework for Traffic Control



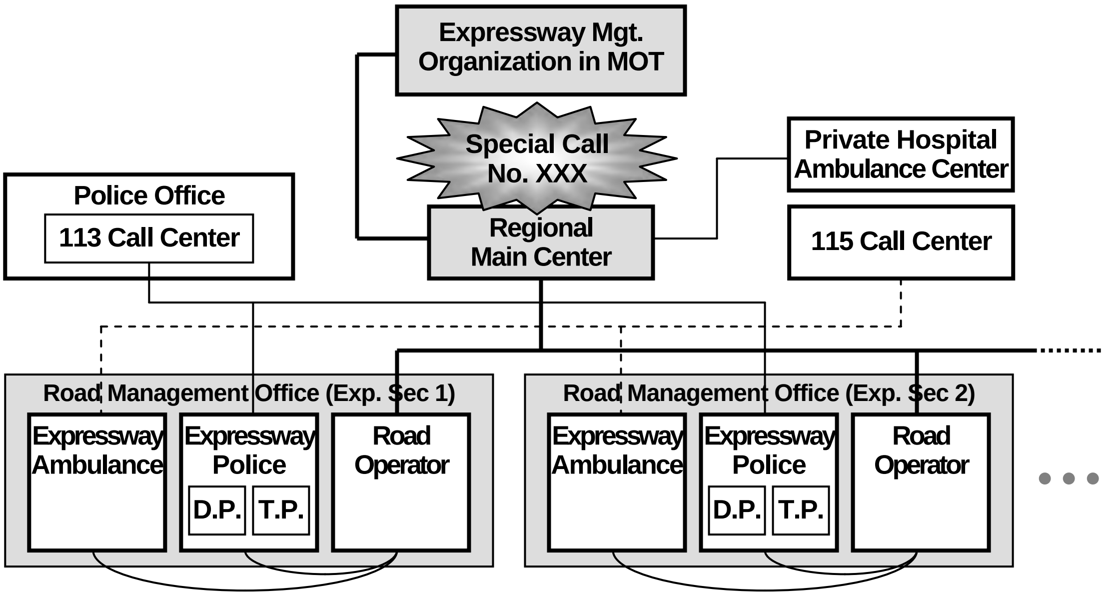
Source: ITS Integration Project (SAPI) Study Team

4) Framework for Incident Notification to Road Operator

The framework below is to be prepared for the road operator to receive notification at the occurrence of incident on the expressway network:

- Main part is to be formed by the expressway management organization in MOT, the Regional Main Center and road management offices
- A special call number is to be prepared for the road operator to receive incident notification
- The Regional Main Center is to cooperate with the Police offices including 113 Call Center
- The Regional Main Center is to cooperate with the Ambulance Centers
- A team consist of the expressway police, the expressway ambulance and road operator is to be assigned to each road management office

Figure 25 Framework for Incident Notification to Road Operator



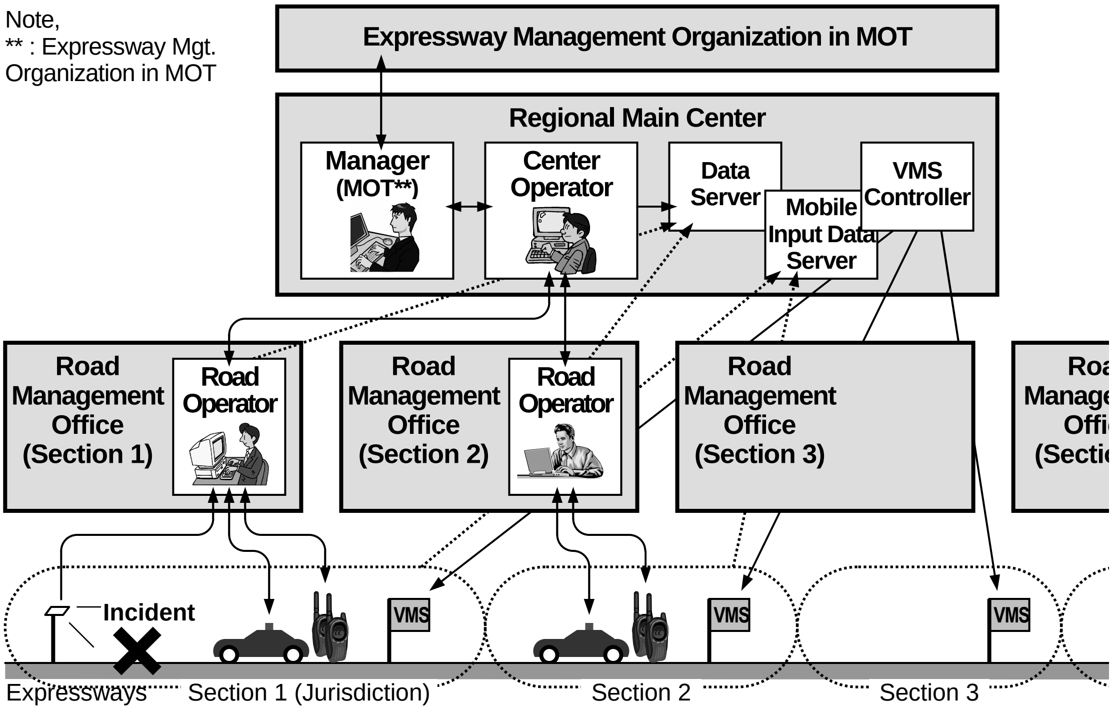
Note: D.P. : Detective police to be dispatched for traffic accidents with fatalities
T.P. : Traffic police to be dispatched for traffic accidents without fatalities

Source: ITS Integration Project (SAPI) Study Team

5) Framework for Traffic Event Data Management

A traffic event data can be input at a road management office or roadside as well as the Regional Main Center. The validity of the data needs to be checked at both the Regional Main Center and the road management office. Especially in case of a closure of expressway, the check is to be done for getting permission by the inspector under the Expressway Management Organization in MOT assigned in the Regional Main Center.

Figure 26 Framework for Traffic Event Data Management

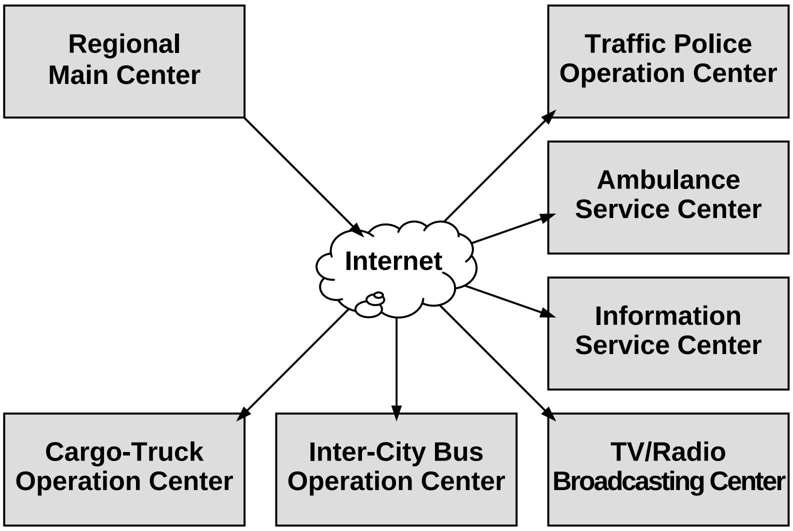


Source: ITS Integration Project (SAPI) Study Team

6) Framework for Traffic Information Dissemination

Traffic Information, which consists of standardised messages and standardised data elements, is to be disseminated to organizations concerned through the Internet.

Figure 27 Framework for Traffic Information Dissemination

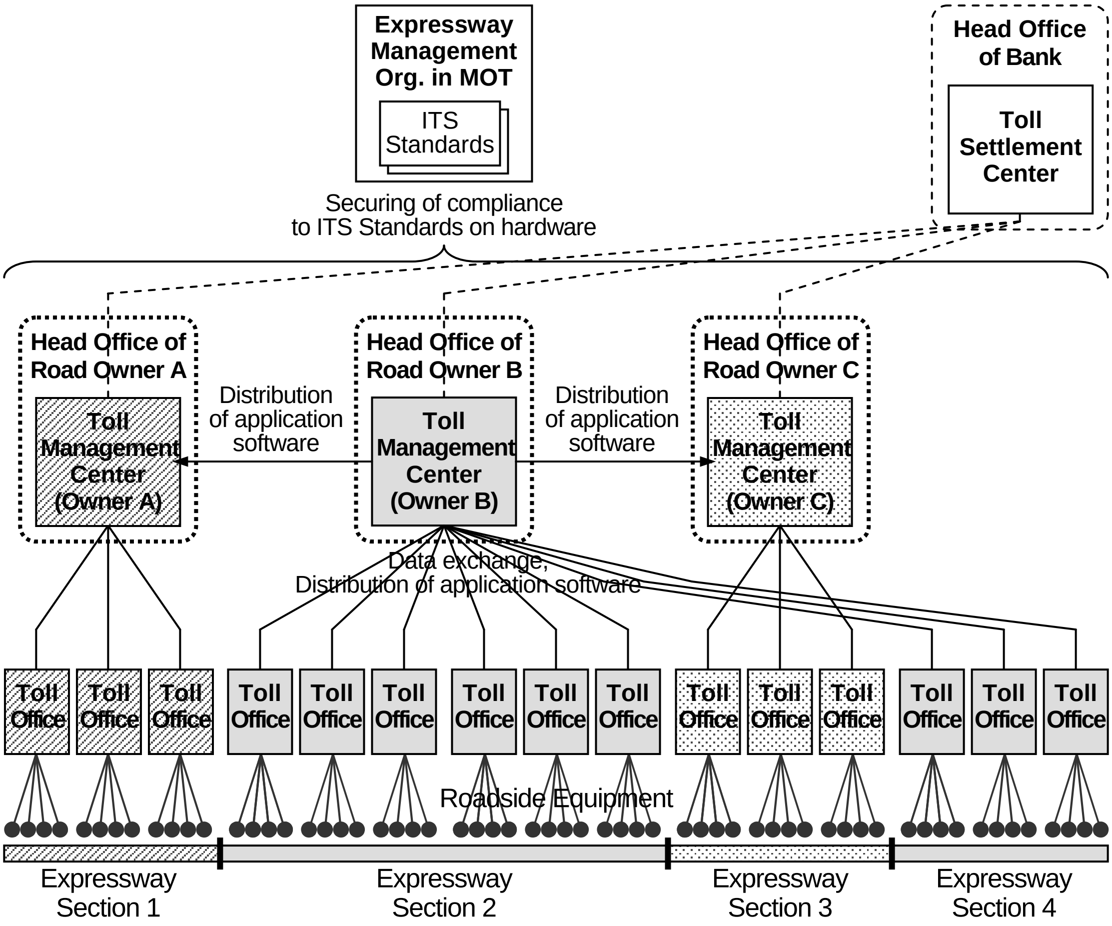


Source: ITS Standards & Operation Plan Study Team

7) Framework for Toll Management

The framework for toll management in the following figure, which includes many different road owners and a bank, is to be defined as a premise for discussion in the Study. The processes at the tollgate including vehicle identification and validity check are to be executed directly by the road owner, and the processes of cash storage and toll settlement is to be transferred to a bank. The Standards on hardware is to be managed by the Expressway Management Organization in MOT and the application software is to be managed/distributed by the Regional Main Center.

Figure 28 Framework for Toll Management



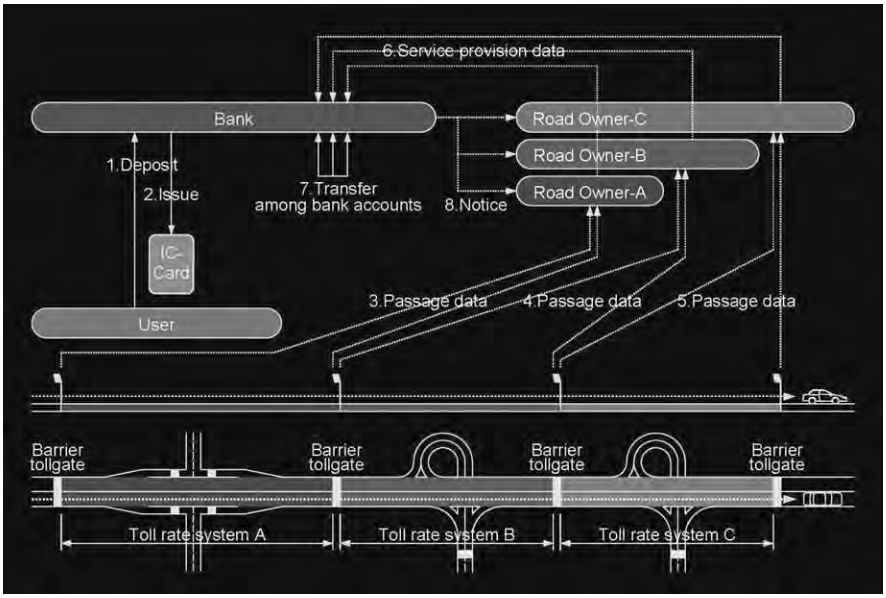
Note: ▌: Barrier tollgates between the expressway sections of different road operators

Source: ITS Integration Project (SAPI) Study Team

8) Framework for Toll Settlement

Toll settlement among different road owners is to be operated a bank or an organization permitted by the State Bank (as the case of Decision No.5190/NHNN-TT). Issue/recharge service for IC-cards is to be provided by a single bank in the 1^{st} stage and by several different banks in later stages. These frameworks for toll settlement are based on utilization of a single kind of IC-card shared by different road owners.

Figure 29 Framework for Toll Settlement

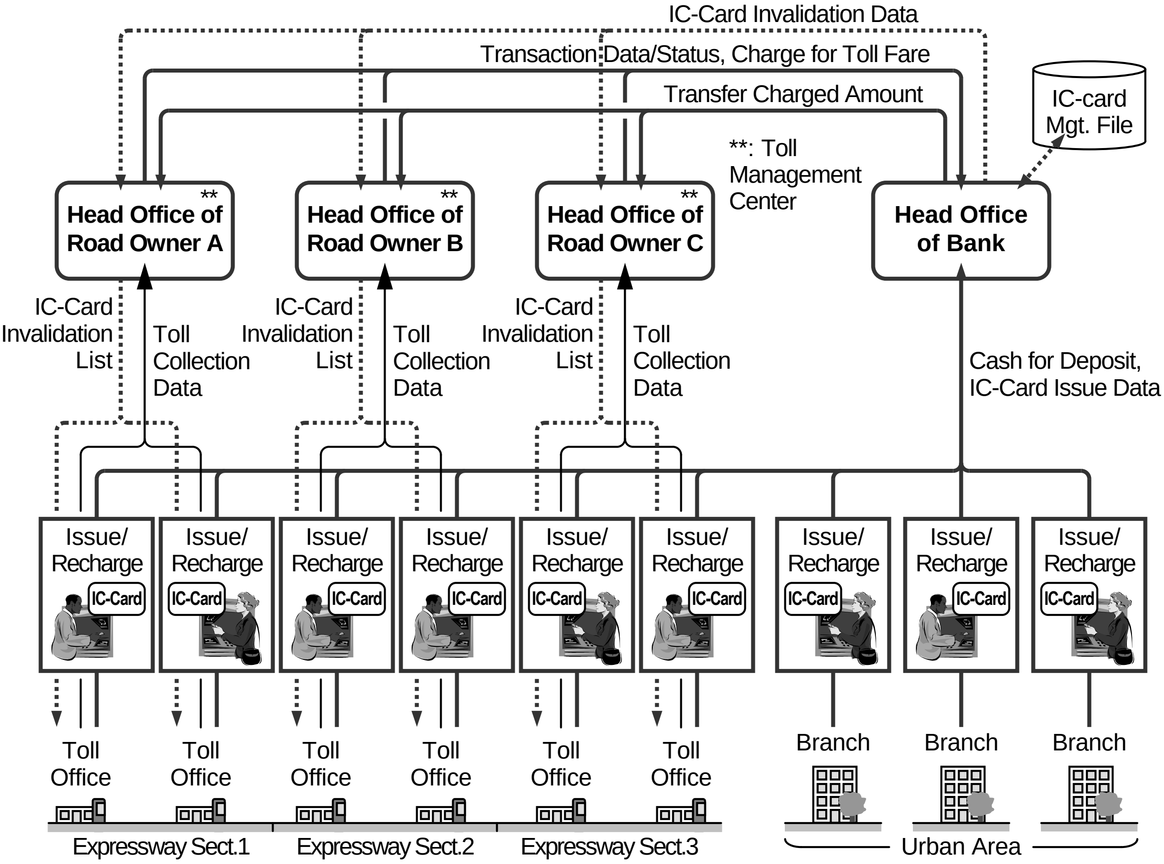


Source: VITRANSS2 Study Team

9) Framework for IC-Card Issuance/Operation

The framework below needs to be established for IC-card issuance/operation in both use of Touch&Go and ETC. Issue/recharge service is provided by a single bank in the 1st stage and by several banks in later stages.

Figure 30 Framework for IC-Card Issuance/Operation

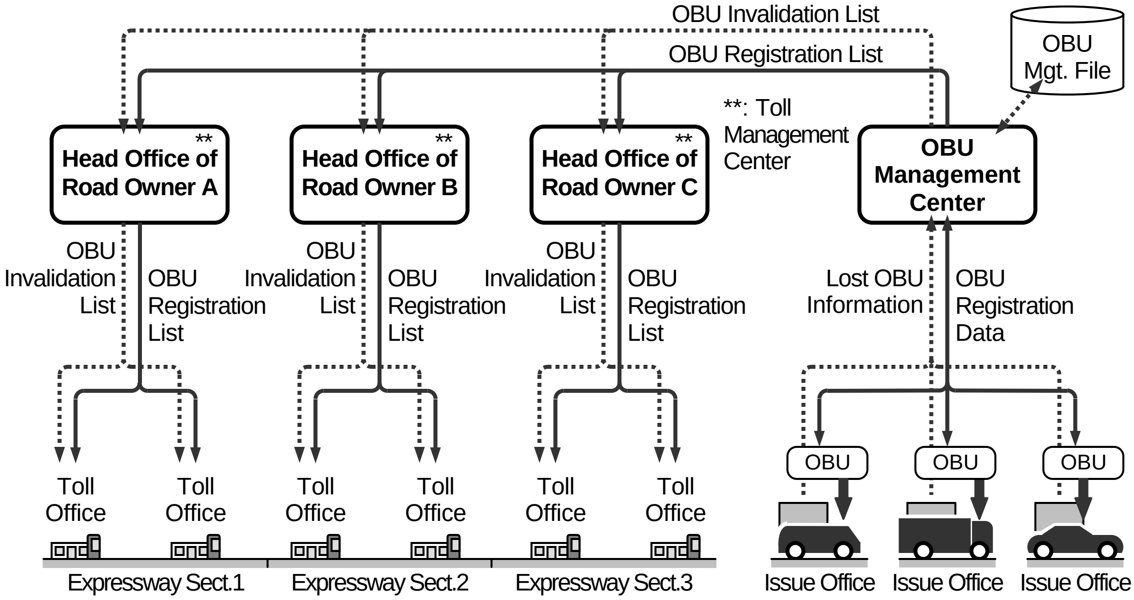


Source: ITS Standards & Operation Plan Study Team

10) Framework for OBU Registration/Management

The framework below needs to be prepared for OBU registration/management, in which an OBU management center is operated by a unified organization for many different road owners and banks.

Figure 31 Framework for OBU Registration/Management

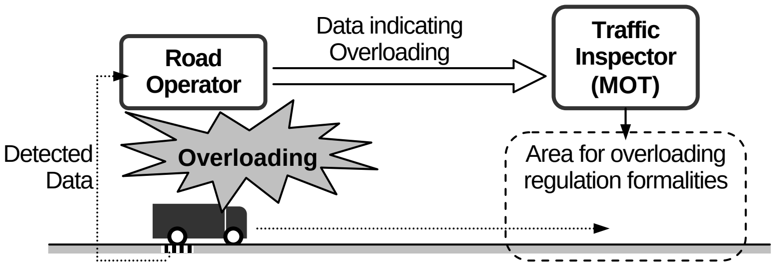


Source: ITS Standards & Operation Plan Study Team

11) Framework for Overloading Regulation

The procedure for overloading regulation is shown in the figure below. The role of road operator is to handover the inspector the information on the overloaded vehicle and the data from vehicle weighing system which indicates the fact of overloading.

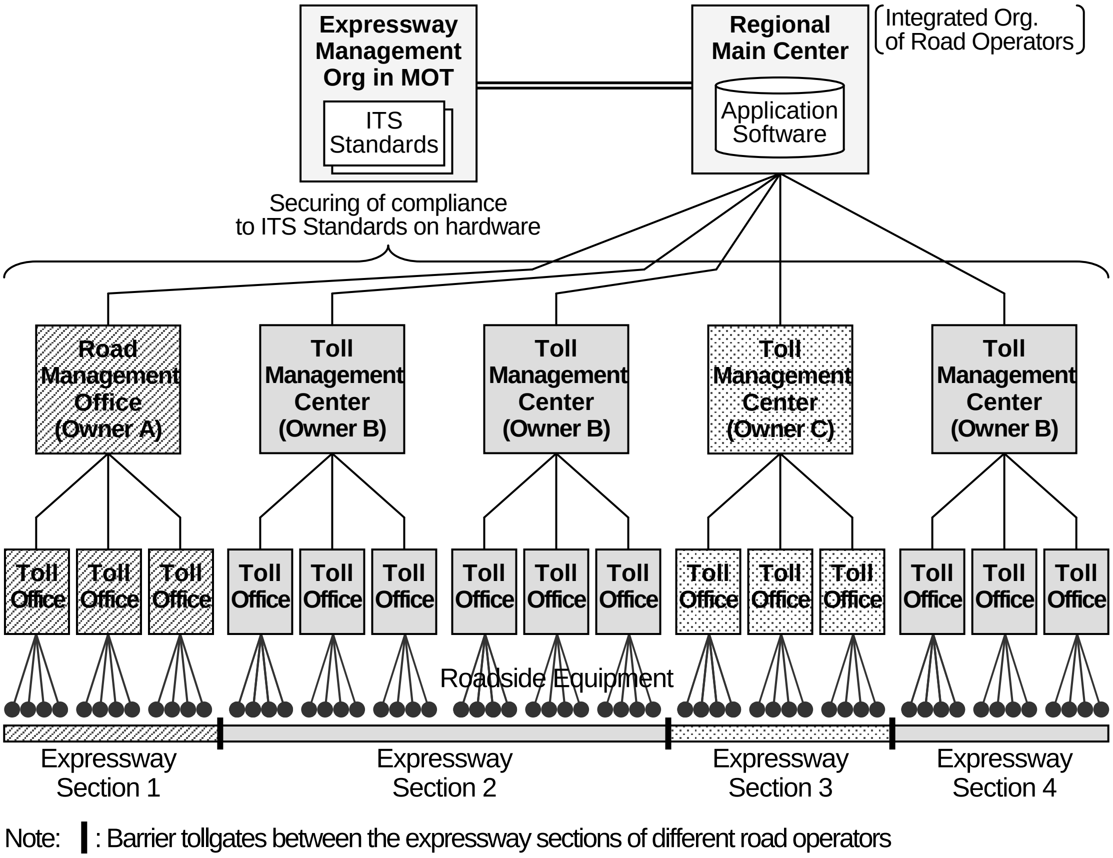
Figure 32 Procedure for Overloading Regulation



Source: ITS Standards & Operation Plan Study Team

The framework for overloading regulation shown in the following figure includes many different road owners, who own the expressway section and the vehicle weighing system, and the Regional Main Center. The Standards on hardware is to be managed by the Expressway Management Organization in MOT. The application software is to be managed in the Regional Main Center and the part for roadside operation is to be distributed under license to each road owner.

Figure 33 Framework for Overloading Regulation

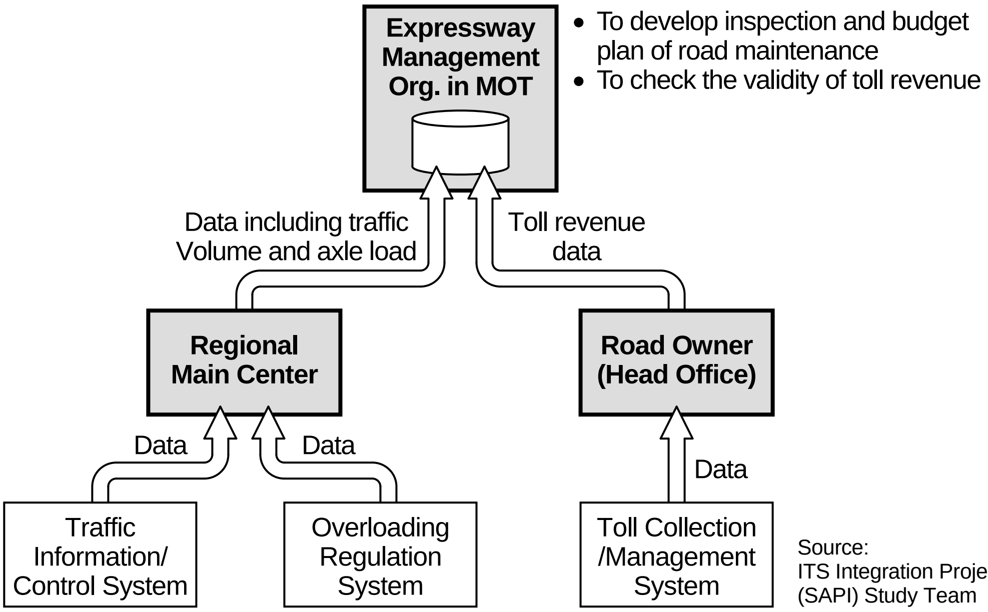


Source: ITS Integration Project (SAPI) Study Team

12) Framework for Integrated Data Management

In the framework below, traffic data, axle load data and toll revenue data are to be acquired and stored at the same place, and to be utilized for developing plans of inspection and budget for road maintenance and checking the validity of required toll revenue.

Figure 34 Framework for Integrated Data Management

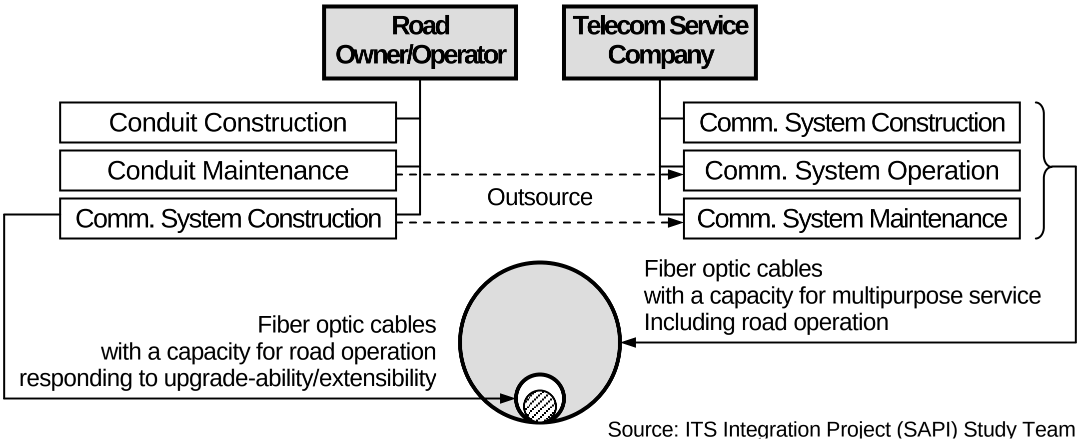


Source:
ITS Integration Project (SAPI) Study Team

13) Framework for Communication Network Management

It is recommended for road owners/operators to outsource the communication network management to a telecom service company, because telecom service companies have higher skills. Introduction of communication system/equipment also is to be outsourced to the telecom service companies in the future, as proposed in the Decision No.3569/VPCP- KTN VNPT, because they can select appropriate system, which will not be the hindrance of the operation and maintenance.

Figure 35 Framework for Communication Network Management



Source: ITS Integration Project (SAPI) Study Team

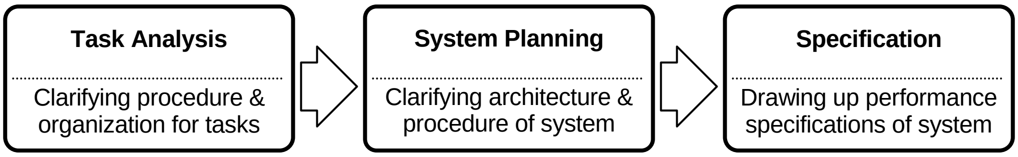
➢10 System Operation/Management Plan

Operation and management of the system was discussed in this chapter and the following results were reasoned out from the discussion:

- Frameworks and role sharing for expressway operation
- Event trace diagrams of tasks for expressway operation
- Screen transition diagram.
- Operation/management plan for the traffic information/control system, the autometed toll collection system, the vehicle weighing system and the communication system
- Basic policy on training system operation/management
- Equipment operation manual lists.

Procedures and organizations for expressway operation were clarified by using task analysis, and based on its results, an appropriate architecture and procedure for implementing tasks were defined and performance specifications of the system were to be drawn up as outputs.

Figure 36 Procedure of Discussion based on Task Analysis

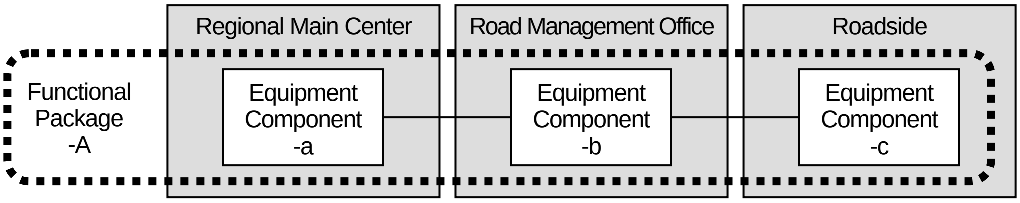


Source: ITS Integration Project (SAPI) Study Team

1) Role Sharing

ITS cosists of many functional packages and each functional package consists of several equipment components which can be installed separately in different locations as shown in the figure below. However, the centers and roadside are operated respectively by the different organizations. Accordingly, for discussing the sytem operation, the roles are to be detailed responding to the functional packages and the offices where equipment packages are installed.

Figure 37 Functional Package Consists of Equipment Components in Different Locations



Source: ITS Integration Project (SAPI) Study Team

The roles of exressway operation for the major organizations: the expressway management organization in MOT, the road owner, the road operator, the telecommunication service company, the OBU management center and the bank are shown in the form of matrix, in the Study, which corresponds to the functional packages and the locations.

2) Event Trace Diagrams

The tasks for expressway operation are listed in the table below. In the Study, the discussion results on these tasks are shown by using the event trace diagrams.

Table 10 Task List of Event Trace Diagrams

Name of System	No.	Task Procedures
Traffic Information/Control System	4.2	Routine Patrol
	4.3	Traffic Condition Monitoring
	4.4	Incident Reporting by Mobile Phone (113 Call)
	4.5	Incident Reporting by Mobile Phone (115 Call)
	4.6	Incident Reporting by Mobile Phone (to Private Hospital)
	4.7	Incident Reporting by Mobile Phone (to Regional Main Center)
	4.8	Incident Reporting from Patrol
	4.9	Incident Identification by Camera
	4.10	Ascertainment of Incident Situation
	4.11	Heavy Rain Identification
	4.12	High Wind Identification
	4.13	Dense Fog Identification
	4.14	High Temperature Identification
	4.15	Flood Identification
	4.16	Stopped Vehicle Identification
	4.17	Reverse Driving Identification
	4.18	Left Obstacle Reporting
	4.19	Vandalism Identification
	4.20	Road Damage Identification
	4.21	Construction Work Information Handling
	4.22	Road Traffic Supervision
	4.23	Decision of Traffic Restriction
	4.24	Entrance Closure
	4.25	Closure
	4.26	Exit Closure
	4.27	Lane Closure
	4.28	Speed Restriction
	4.29	Incident Handling
	4.30	Incident Clearance Reporting
	4.31	Restriction Removal
	4.32	Restriction Removal Reporting
	4.33	Traffic Event Management in Regional Main Center
	4.34	Traffic Event Management in Road Management Office
	4.35	Traffic Event Management by Patrol Crew
	4.36	Traffic Information by VMS
	4.37	Traffic Information by Internet
	4.38	Traffic Information by Broadcast
	4.39	Traffic Information Cancellation
	4.40	Traffic Data Management
	4.41	Integrated Data Management
	4.42	Routine Data Check in Regional Main Centre

Source: ITS Integration Project (SAPI) Study Team

Table 11 Task List of Event Trace Diagrams (2)

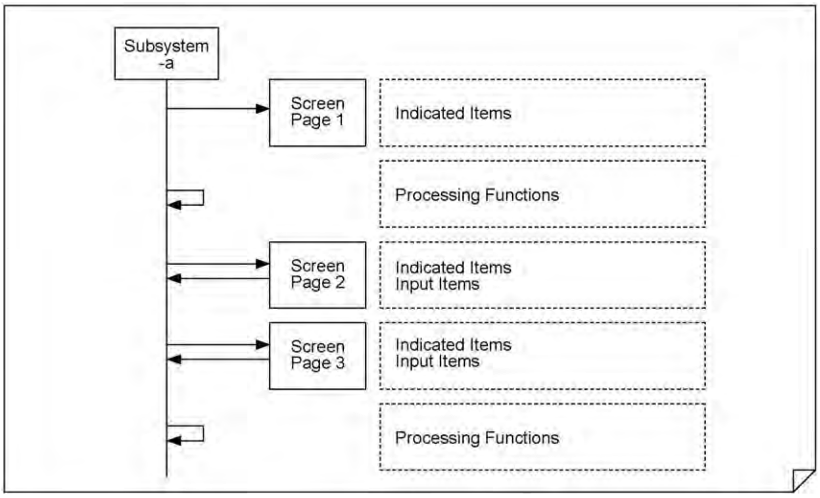
Name of System	No.	Task Procedures
Automated Toll Collection /Management System	4.43	Toll Collection by Manual
	4.44	Toll Collection by Touch & Go
	4.45	Toll Collection by ETC
	4.46	Handling of Balance Shortage Vehicle
	4.47	Toll Data Management
	4.48	Toll Settlement
	4.49	IC-card Issuance/Management
	4.50	Recharge of Prepaid Balance
	4.51	IC-card Data Management
	4.52	IC-card Negative List Management
	4.53	OBU Registration/Management
	4.54	OBU Negative List Management
	4.55	Toll Enforcement Assistance
Vehicle Weighing System	4.56	Axle Load Measurement
	4.57	Axle Load Data Management
	4.58	Overloading Regulation

Source: ITS Integration Project (SAPI) Study Team

3) Screen Transition Diagram

The screen transition diagram shows required function of processing and input/output in the form of time series as below. In this study, the screen transition diagrams shall be prepared and software components are to be discussed based on them.

Figure 38 Screen Transition Diagrams



Note: This diagram shows function of processing and input/output required for the software component in the form of time series. This need to be consistent with event tracing diagrams and message sequence diagrams.

Source: ITS Integration Project (SAPI) Study Team

➢11 Key System Policies

In the Study, the key policies, as premises for structuring ITS, were discussed from an objective and neutral stand point free from the intentions of individual organizations/firms who have relations with the expressway construction in Vietnam. The discussion is conducted in such a manner as to involve the policies/candidates in on-going expressway construction projects and the following reasoned conclusions are reached.

(1) Arrangement of CCTV Camera for Monitoring
→At 2km intervals continuously along the expressway

(2) Arrangement of CCTV Camera for Event Detection
→On the through lanes and the ramps on trial

(3) Vehicle Detector Arrangement →Midway between a pair of interchanges

(4) Type of Vehicle Detector →Image recognition type

(5) Upgrading to Next-generation System based on CCTV Camera for Multi-purpose

(6) Road-to-Vehicle Communication Method for ETC
→Active-DSRC
Note: Passive-DSRC can be competitive in trial use and RF-Tag is to be followed up.

(7) Tollgate Lane Operation →Combined use with Touch&Go

(8) Upgrading to Next-generation ETC based on GPS/GSM/DSRC

(9) Checking of Prepaid Balance →By prepaid-balance-in-card

(10) Contact-less IC-Card Type
→TYPE-A and Felica as the candidates for conclusive selection through field trial

(11) Axle Load Scale Arrangement → Closely in front of entrance tollgates

(12) Integration of Roadside Equipment Control
→Combination of NVR introduction and technological disclosure obligation to suppliers

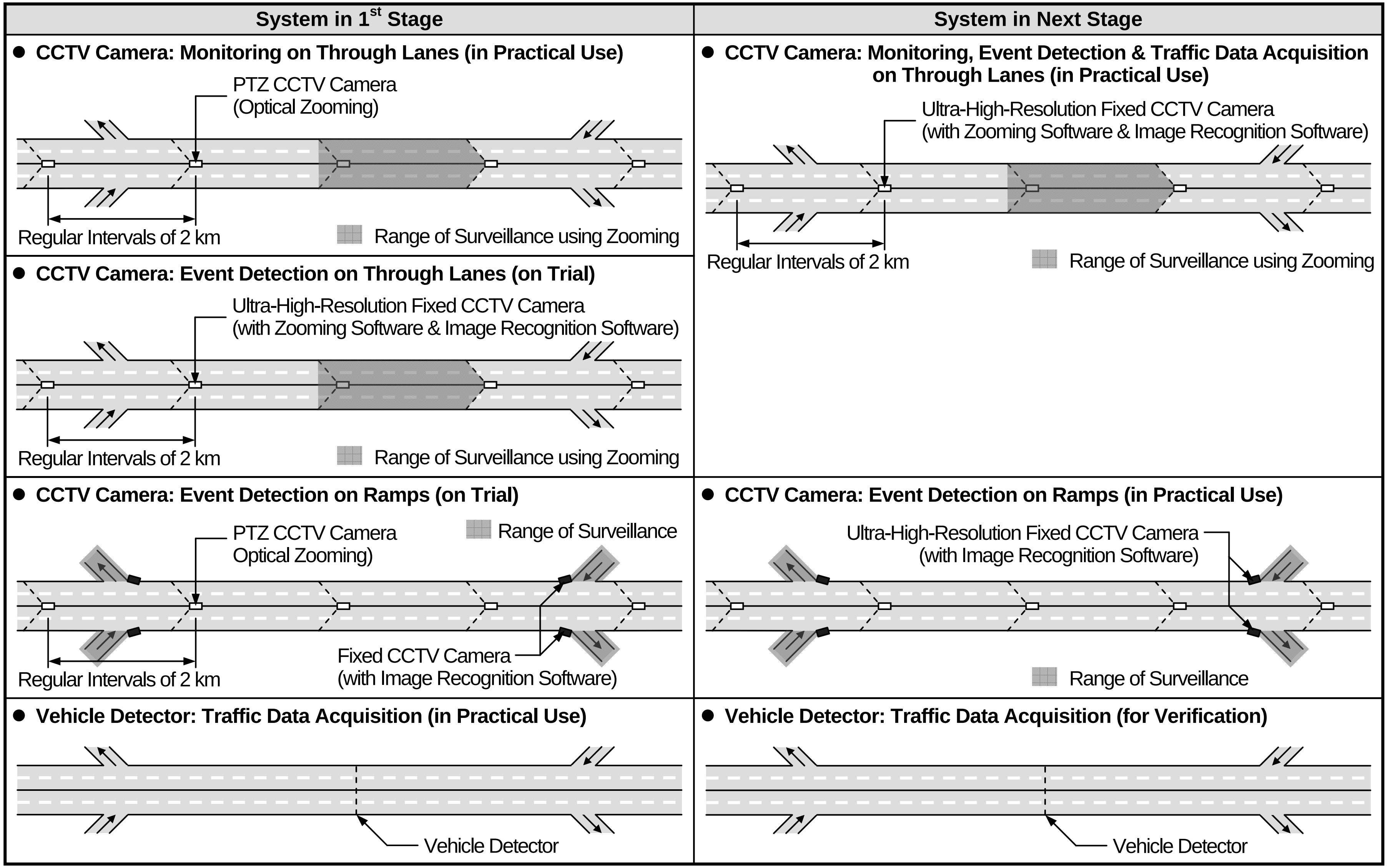
(13) Transmission Method →G-Ethernet

The major items below are shown in figures and tables in the following pages.

- Arrangement policy of CCTV camera
- Comparison of alternative road-to-vehicle communication methods for ETC
- Comparison on alternatives of axle load scale arrangement
- Integration of CCTV camera control using NVR
- Comparison on transmission methods

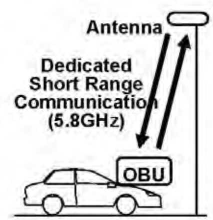
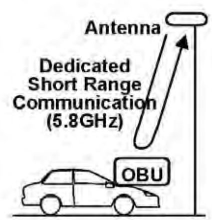
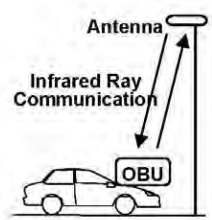
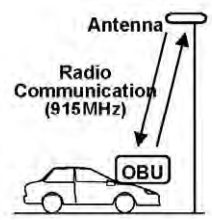
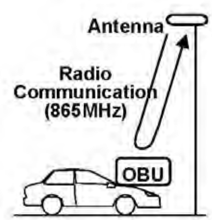
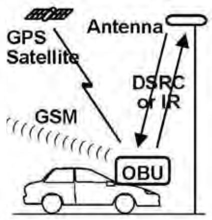
It is necessary, additionally, to finalize the selected results and verify them in ITS integration project as the first stage of system implementation to be compliant with the Draft ITS Standards.

Figure 39 Arrangement Policy of CCTV Camera



Source: ITS Integration Project (SAPI) Study Team

Table 12 Comparison of Alternative Road-to-Vehicle Communication Methods for ETC

	Active-DSRC	Passive-DSRC	DSRC/IR	IR	RF-Tag (Active)	RF-Tag (Passive)	GPS/GSM
Outline							
Actual Use in Toll Collection	Many experiences	Many experiences	Many experiences	Many experiences	Many experiences	A few experiences	No experience
Shared Use of System among Different Operators	Many experiences	Many experiences	A few experiences	No experience	No experience	Few experience	No experience
Shared Suppliers in Actual Road Operation	12 (in Japan)	3 (in France)	7 (in Korea)	No experience	No experience	No experiences	No experience
Application to Distance Proportional Tariff	Many experiences	A few experiences	Many experiences	Many experiences	A few experiences	Not applicable under international std.	No experience
Applicability to ERP	Applicable	Applicable	Not applicable	Not applicable	Applicable	Applicable	Applicable
Recommendation in On-going Project in Vietnam	HCMC–Long Thanh –Dau Giay	HCMC–Trung Luong, Can Tho Bridge	None	None	Not Applicable (Conflict with GSM)	Cau Gie–Ninh Binh	None
Accuracy of Data Communication	High (99.9999%)	No regulation	Lowering by Sunlight	Lowering by Sunlight	Relatively low Fear of double charge	Relatively low Fear of double charge	No regulation
Vehicle Deceleration	Not necessary	Not necessary	Not necessary	Necessary	Not necessary	Not necessary	Not necessary
2-pice Type OBU (IC-card Business)	Many experiences	For trial	Many experiences	Many experiences	Not capable	Not capable	No experience
Required Cost of OBU	Average	Low (1-piece type)	Average	Average	Low (1-piece type)	Very low (1-piece type)	High (1-piece type)
Combined Use with Touch&Go	Capable	For trial	Capable	Capable	Capable	Capable	Not capable
Required Cost of Roadside Equipment	Low	Average	High	Average	Average	Average	Very low
International Standard	Established	Established	Established	Patented	Established	Established	None
Grading (The Number of Advantages)	Recommended (12)	Competitive (8)	Not suitable (7)	Not suitable (4)	Not suitable (6)	To be followed up (6)	Not suitable (3)

Note: ERP: ERP by multi-lane free-flow, OBU: OBU includes Tag, Underlined words: Fatal disadvantage

Source: ITS Standards & Operation Plan Study Team

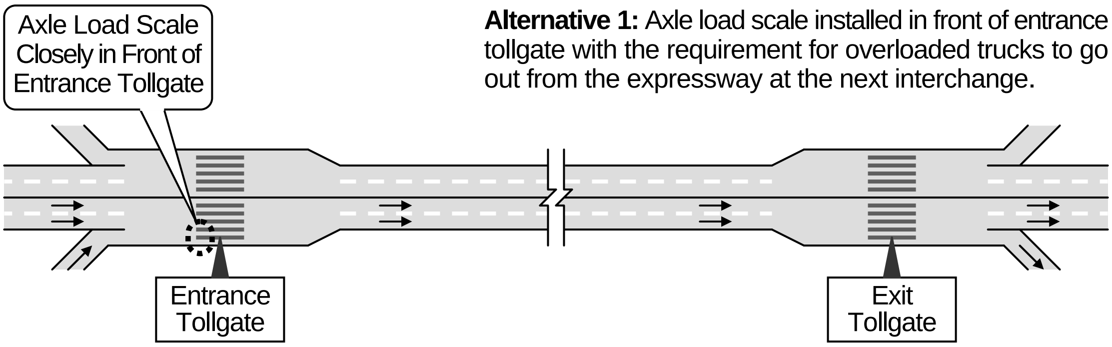
Table 13 Comparison on Alternatives of Axle Load Scale Arrangement

	Alternative 1	Alternative 2	Alternative 3
Intended Level of Penalty for Overloaded Trucks	Average Penalty	Avarege Penalty	High Penalty
Installation of Axle load Scale in to All Tollgates to Prevent Avoidance	Possible	Possible	Possible
Control/Stop of Overloaded Trucks	Easy	Not Easy	Easy
Accuracy of Measurement	Enough (within Tollgate Lane)	Enough (within Tollgate Lane)	Enough (within Tollgate Lane)
Additional Installation of Weigh-bridges to Impose a Penaly	Necessary	Necessary	Not Necessary
Preparation of Additional Legal Framework	Necessary	Necessary	Necessary and Difficult
Grading	Recommended	Comparable	Comparable

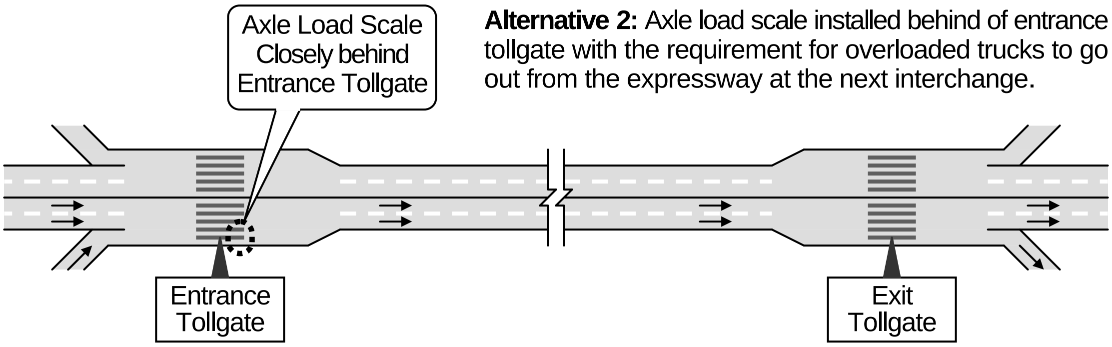
Source: ITS Integration Project (SAPI) Study Team

Figure 40 Alternatives of Axle Load Scale Arrangement

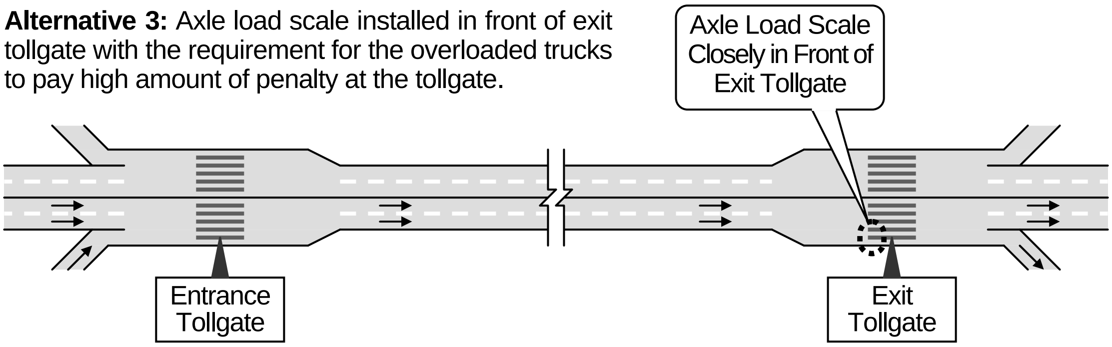
Alternative 1: Axle load scale installed in front of entrance tollgate with the requirement for overloaded trucks to go out from the expressway at the next interchange.



Alternative 2: Axle load scale installed behind of entrance tollgate with the requirement for overloaded trucks to go out from the expressway at the next interchange.

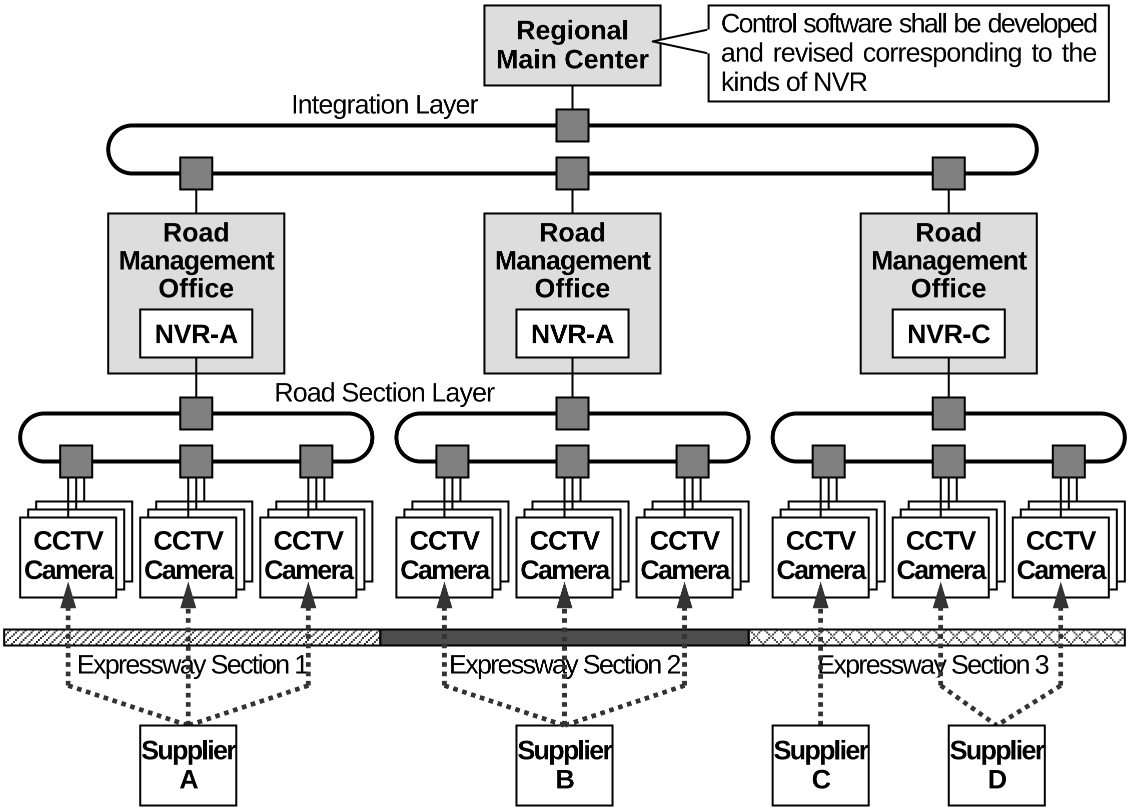


Alternative 3: Axle load scale installed in front of exit tollgate with the requirement for the overloaded trucks to pay high amount of penalty at the tollgate.



Source: ITS Integration Project (SAPI) Study Team

Figure 41 Integration of CCTV Camera Control using NVR (Network Video Recorder)



Note: NVR can be installed at communication nodes or in road management offices.

Source: ITS Standards & Operation Plan Study Team

Table 14 Comparison on Transmission Methods

	IP over ATM	IP over G-Ethernet	IP over SDH	IP over ATM/DWDM	IP ovrer SDH/DWDM
Communication Node	ATM	Media Converter	SDH	DWDM	DWDM
Interface of Ethernet	Available	Available	Available	Available	Available
Maximum Capacity	0.6 Gbps (Concept-2)	40 Gbps (Concept-3)	40 Gbps (Concept-3)	1 Tbps (Concept-3)	1 Tbps (Concept-3)
Capacity for ** Additional Service	Not Sufficient	Not Sufficient	Not Sufficient	Sufficient	Sufficient
Bandwidth Guarantee	Capable	Capable	Capable	Capable	Capable
Network Management	Capable	Capable	Capable	Capable	Capable
Compatibility	Low	High	High	High	High
Implementation Cost	Low	Average	Average	High	High
Track Records in Telecom Service	--	--	--	--	Adopted by Viettel
Grading	Not Suitable	Recommended	Comparable	Not Suitable	Not Suitable

Note: **: Leasing of lines as a simple additional services using the remaining capacity of communication network.

Source: ITS Standards & Operation Plan Study Team

➢12 Feasibility Study of Project

The economic analysis of the Project is made for the following two effects:

- Estimation of some of individual effects of ITS implementation which are separable from that of road construction and possible to quantification, which includes traffic monitoring, Traffic accident information dissemination, Traffic congestion information dissemination, Weather information dissemination, Non-stop toll collection, Vehicle weighing
- Cost reduction effects by system integration compared to without integration.

In the Study the financial analysis is made on the basis of estimation of cost ratio in terms of cost per unit of road length between ITS implementation and road development itself, and financial reasonability for the investment of ITS implementation is examined.

1) Alternative Cases

Base Case

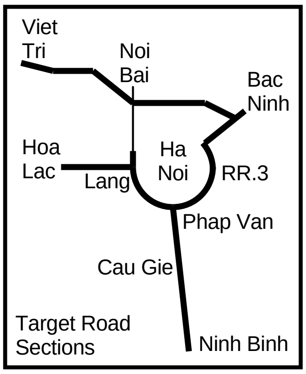
Ha Noi Metropolitan Area is to be defined as the study area. The target road network of the Project is to be formed by selections of the road sections below, which are shown in the official letter 2584/VEC-DA from VEC to MOT, evaluating effects of the project implementation.

(1) Base Case for the target road sections of the Project: Expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section, and connections to candidate locations of the Regional Main Center and the road management offices

(2) Expressway sections to be integrated under the Northern Regional Main Center other than (1).

Total length of the expressway network in the northern area, which is composed of (1) and (2), can be assumed to be around 1000 km.

Figure 42 Road Sections of Base Case



Target Road Sections of the Project (Base Case)	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Phap Van–Cau Gie	30 km
Cau Gie–Ninh Binh	50 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Noi Bai–Viet Tri	80 km
Total	268 km

Source: ITS Integration Project (SAPI) Study Team

Comparison Case 1

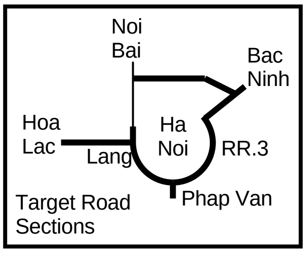
The road network of the comparison case 1 is to be formed consisting of the road sections selected from the followings:

(1) Comparison case for target road sections of the Project: Expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section

(2) Expressway sections to be integrated under the Northern Regional Main Center other than (1).

Total length of the expressway network in the northern area, which is composed of (1) and (2), can be assumed to be around 1000 km.

Figure 43 Road Sections of Comparison Case 1



Road Sections of Comparison Case 1	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Total	108 km

Source: ITS Integration Project (SAPI) Study Team

Comparison Case 2

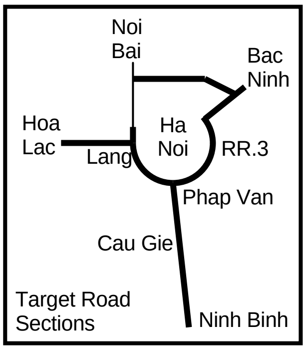
The road network of the comparison case 2 is to be formed consisting of the road sections selected from the followings:

(1) Comparison case for the target road sections of the Project: Expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section, and connections to candidate locations of the Regional Main Center and the road management offices

(2) Expressway sections to be integrated under the Northern Regional Main Center other than (1).

Total length of the expressway network in the northern area, which is composed of (1) and (2), can be assumed to be around 1000 km.

Figure 44 Road Sections of Comparison Case 2



Road Sections of Comparison Case 2	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Phap Van–Cau Gie	30 km
Cau Gie–Ninh Binh	50 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Total	188 km

Source: ITS Integration Project (SAPI) Study Team

2) Study Results

The quantified ITS implementation effects and the cost ratio of ITS implementation to road construction for the alternative cases are shown using the indicators -1 to -5 in the table. The followings can be observed:

- Regarding Indicator-1: estimated number of accidents to be identified by CCTV Camera, the Base Case with the largest scope of integration shows the highest value. This indicator represents that ITS implementation covering larger operation length of expressway network provides larger effect in identifying the occurrences of traffic accidents.

Table 15 Quantified Effect by Alternative Case

	Without ITS	With ITS		
		Base Case	Case 1	Case 2
Operation Length km	Zero	268	108	188
Indicator-1: Estimated Number of Accidents to be Identified by CCTV Camera for Operation Length in km	Zero	265	106	186
Indicator-2: Estimated Reduction of Fatalities in Accidents on Expressway for Unit Length in the Case Assumed Rate of Number of Accidents per 10^9 Vehicle-km = 600 (Unit : fatalities/year/km)				
(Number of Fatalities in Base Case in 2015)	986	493		
(Number of Fatalities in Base Case in 2020)	1,508	754		
(Number of Fatalities in Case 1 in 2015)	457		229	
(Number of Fatalities in Case 1 in 2020)	581		291	
(Number of Fatalities in Case 2 in 2015)	900			450
(Number of Fatalities in Case 2 in 2020)	1,343			672
Reduction per Unit Length in Year 2015	--	1.84	2.11	2.39
Reduction per Unit Length in Year 2020	--	2.81	2.69	3.57
Indicator-3: Effect of Reduction of Passing Time at Tollgates for Operation Length in km (Unit : hours/day)				
(Base Case in 2015)	3,494	2,102		
(Base Case in 2020)	5.344	3,215		
(Case 1 in 2015)	1,786		1,075	
(Case 1 in 2020)	2,271		1,367	
(Case 2 in 2015)	3,028			1,822
(Case 2 in 2020)	4,523			2,721
Reduction in Year 2015	--	1,392	711	1,206
Reduction in Year 2020	--	2,129	905	1,802
Indicator-4: Effect of CO2 Emission Reduction for Operation Length in km (Unit : ton-CO2 per day)				
(Base Case in 2015)	2,832	2,824		
(Base Case in 2020)	4,197	4,184		
(Case 1 in 2015)	1,271		1,267	
(Case 1 in 2020)	1,572		1,567	
(Case 2 in 2015)	2,686			2,678
(Case 2 in 2020)	3,912			3,901
Reduction in Year 2015	--	8.3	3.8	7.8
Reduction in Year 2020	--	12.3	4.8	11.4
Indicator-5: Effect of Fuel Consumption Reduction for Operation Length in km (Unit : Kilo Litter per day)				
(Base Case in 2015)	1,001	998		
(Base Case in 2020)	1,487	1,482		
(Case 1 in 2015)	452		450	
(Case 1 in 2020)	560		558	
(Case 2 in 2015)	947			944
(Case 2 in 2020)	1,381			1377
Reduction in Year 2015	--	3.1	1.4	2.9
Reduction in Year 2020	--	4.6	1.8	4.2
Indicator-6: Cost Ratio of ITS Implementation to Road Construction	--	3.66%	3.87%	3.65%

Source: Estimated by ITS Integration Project (SAPI) Study Team

Note: The effects in terms of "per original distance km" have been estimated by multiplying the effects per one km by the total distance km in each case.

The objective expressway sections are:

Base Case: Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Viet Tri, Phap Van – Cau Gie and Cau Gie – Ninh Binh

Case 1: Four (4) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh

Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

- Regarding Indicator-2: The estimated reduction of fatalities for the unit length showed the highest value in the Case 2 and fell within the range of 1.8 to 3.6 fatalities/year/km depending on the average traffic volume for each road network of alternative case.
- Regarding indicators -3 to -5: The estimated effect of reduction of passing time at tollgates, effect of CO2 emission reduction, and effect of fuel consumption reduction showed the highest value in the Base Case with the largest scope of integration.
- Regarding Indicator-6: The estimated cost ratio of ITS implementation to the road construction each alternative case fell within the range of 3% to 4%. These ratios are considered not so high as a level of the investment amount in ITS compared with the road construction cost and can be determined financially reasonable.

Cost Reduction Effect by System Integration:

The effect of cost reduction by system integration is estimated as approximately million 10,300 Yen for the total distance of expressway of 1,000 km in length, which is equivalent to the difference in implementation cost of the Main Center between the cases “with system integration” and “without system integration”.

At the present stage in Vietnam where expressway usage has been just begun, ITS implementation is premised on stepwise approach responding to user’s needs or budgetary constraints. It is critically important to involve as many expressway section as possible in early stage in order to ensure the achievement of cost reduction effect by system integration.

Additionally, it should be noted that most part of the effects by system integration is provided by center software based on the technology of traffic event data management: the mainstay of traffic information/control and by ETC based on prepaid IC-card. These technologies are highly advanced through actual application to traffic information/control over the expressway network more than 5,000 km in Japan and include the equipment components for traffic analysis, traffic event data management, traffic supervision, VMS indication, traffic information, integrated data management, lane control, road to vehicle communication, OBU management and toll data management.

Conclusion

Typical effects of the ITS introduction are shown by the indicators foregoing from economic and financial aspects. It has been examined that the Base Case and the Case 2 with larger scopes of integration show higher values of effects. Additionally to the results, it is requested to exclude the Noi Bai – Viet Tri section from the Project Scope by the Official Letter 400/VEC-DA from VEC to JICA. Considering these conditions, it is concluded that the Case 2 is to be the Project Scope.

Project Scope (Case 2)	• Mai Dich–Thanh Tri (Ring Road 3) • Lang–Hoa Lac • Phap Van–Cau Gie • Cau Gie–Ninh Binh • Ha Noi–Bac Ninh • Noi Bai–Bac Ninh

➢13 Location of Northern Regional Main Center

1) Assumed Candidate Site

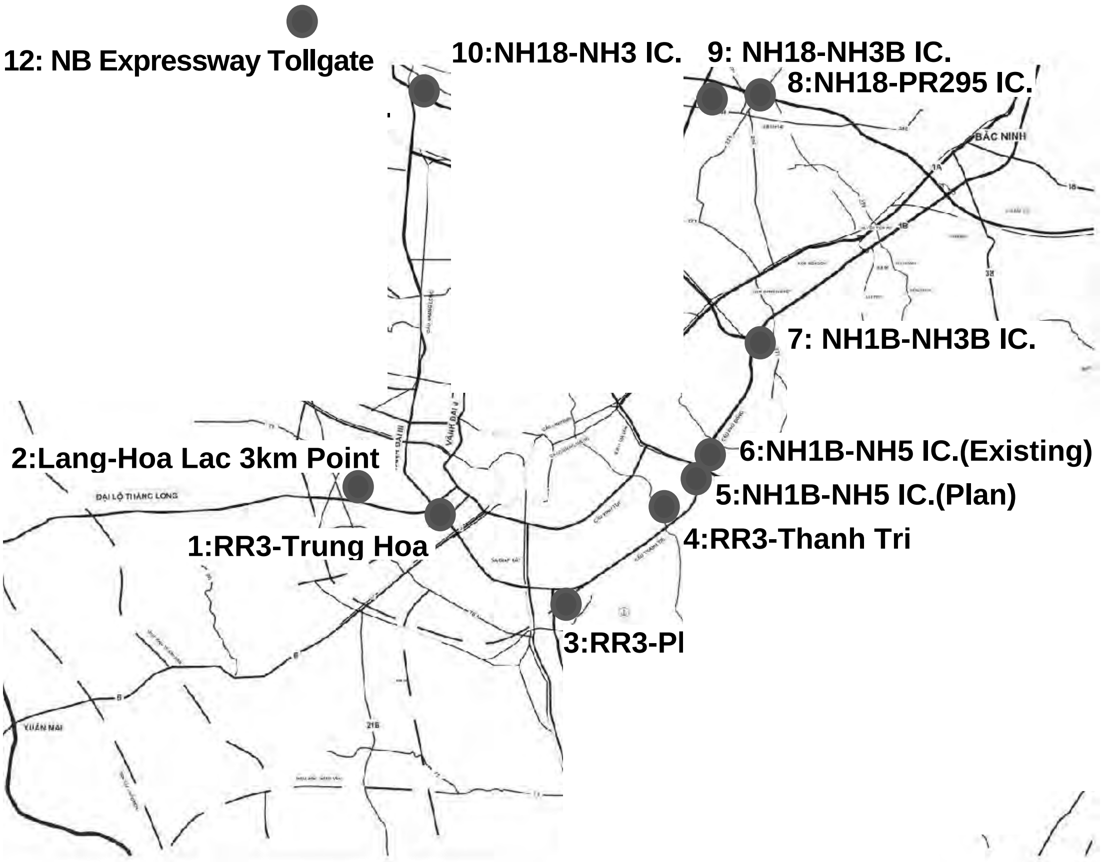
In the Study, the following twelve (12) candidate sites have been assumed.

Basically all of twelve (12) candidate sites have consistency with broader plans and programs or already constructed/under way of road construction projects.

Most of security against natural disaster or power failure such as folding and blackout problems is free or manageable issues. Most of selected sites area regarding an accessibility of optical fiber cable for ITS installed along the expressways, it is advantageous location for the Northern Regional Main Center within interchange/junction areas or nearby these areas. For easiness on commutes for staffs of the center and accessibility for related organization, most of candidate sites are located either within Hanoi city area or metropolitan area and rather easy access from the major trunk roads. Regarding Easiness of land acquisition of site (or building) for the center, most of them are within the road right of way or some adjacent area of which require land acquisition.

For space requirement of the Regional Main Center is totally 3,000 m^2 of which 800 m^2 for building lot area, 1,500 m^2 for car parking/passage area and 700 m^2 for green area; however, when road maintenance/management related facility site is in associated with the Regional Main Center, space for the green area is to be much reduce the area. The following figure shows location map of candidate sites for the Northern Regional Main Center.

Figure 45 Location Map of Candidate Sites for Northern Regional Main Center



Source: ITS Integration Project (SAPI) Study Team

2) Evaluation of Candidate Site

Candidates of the location of the Northern Regional Main Center were evaluated, as the prerequisite for discussing the communication network for ITS and the cooperation among relevant organizations, focusing on the following criteria:

- Land use suitable on surroundings and easiness of land acquisition: total required area 5,000 m^2 includes 700 m^2 for building, 2,000m^2 for car park and 2,300 m^2 for green area for extension responding to the expressway construction in the future
- Connectivity to optical fiber cable network installed along the expressways
- Easiness on commutes for staffs and accessibility to other organizations
- Security against natural disaster and stableness on power supply
- Pollution related impacts.

Table 16 Evaluation Matrix of Candidate Sites

	Site location	Sufficiency of land area	Easiness of land acquisition of sufficient area	Good accessibility and easiness on commutes	Connectivity to optical fiber cable network in the Project	Security against natural disaster and stableness on power supply	Pollution related impacts	Evaluation advantage of positive side	Remarks
1	RR3 – Trung Hoa	+++	-	++	++	++	-	9	
2	Lang – Hoa Lac 3km Point	+++	++	++	++	++	-	11	Second recommended
3	RR3 – Phap Van IC.	+++	-	+	++	++	-	8	
4	RR3 – Thanh Tri	-	-	++	++	++	+	7	
5	NH1B – NH5 IC.(Plan)	+++	-	-	++	++	-	7	
6	NH1B – NH5 IC.(Existing)	++	-	++	++	++	-	8	
7	NH1B – NH3B IC.	+++	++	-	++	++	+	10	
8	NH18 – PR295 IC.	+++	+++	+	++	++	+	12	Most recommended
9	NH18 – NH3B IC.	+++	-	+	++	++	+	9	
10	NH18 – NH3 IC.	+++	++	+	++	++	+	11	Second recommended
11	Thang Long – NH18 IC.	+++	+++	-	++	++	-	10	
12	Noi Bai Expressway Tollgate	++	+++	+	-	++	-	8	

Note: +, ++, +++ : shown prioritized advantage, - : shown disadvantage weight

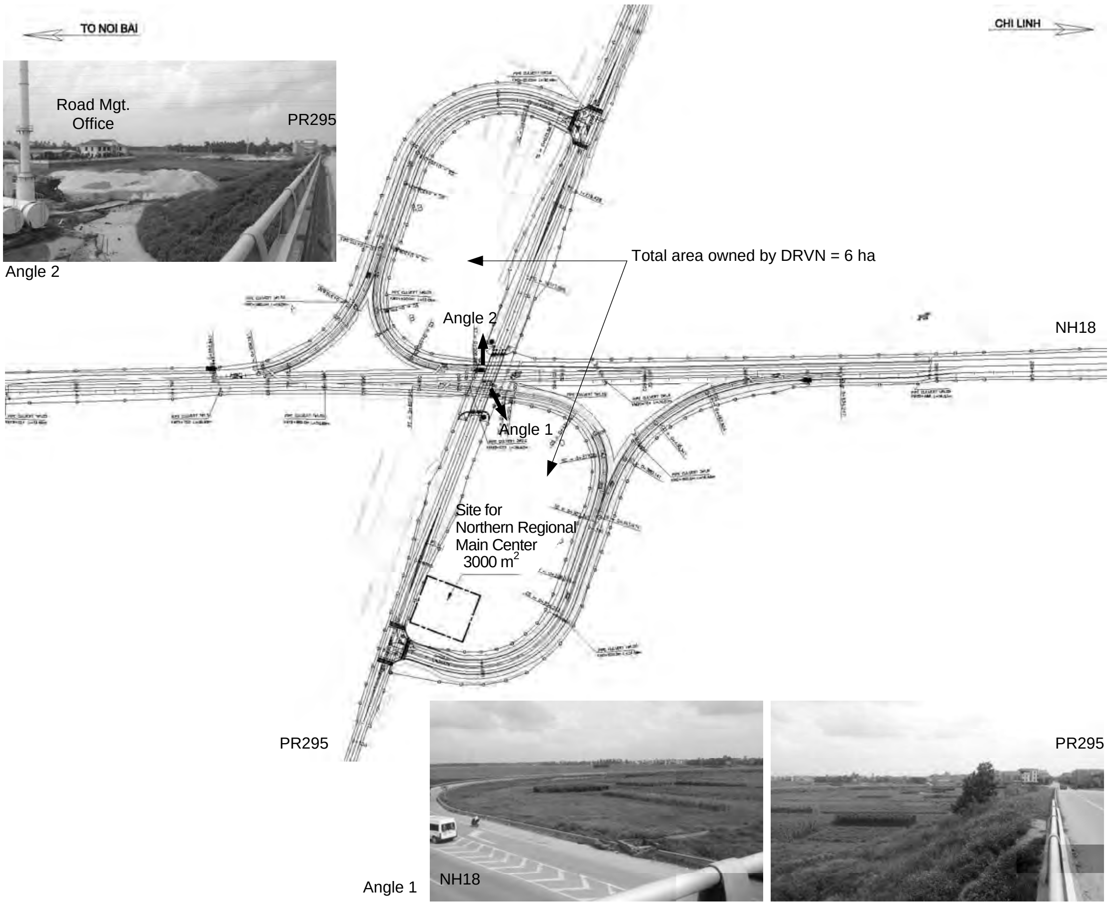
Source: ITS Integration Project (SAPI) Study Team

3) Conclusion:

Based on the evaluation results above, the NH18–PR295 Interchange is to be concluded for site location of the Northern Regional Main Center.

The Northern Regional Center, which requires the site of 3000 m^2, is to be constructed in the area surrounded by the ramps in the interchange between Noi Bai – Bac Ninh and the Provincial Road 295 in the Project as shown in the following figure.

Figure 46 Location of Northern regional Main Center



Source: ITS Integration Project (SAPI) Study Team

➢14 Environmental Social Consideration Study of Project

The discussion on environmental and social consideration for the ITS Integration Project was proceeded based on Vietnamese environmental regulation and new JICA guideline.

1) Project overview

Scope of the ITS project

The ITS project is located on the Northern Delta Region. The project site is within right of way and interchange areas. The major project components are as follows:

- Total length of optical fiber cable network installation, setup underground of the expressway, is 84.62 km excluding 11.38 km of viaduct cable that be integrated with other facilities of other project
- Construction of conduit system with the length appropriate to the length of fiber cable network constructed inside the right of way
- Power of transmission less than 100 W
- Construction of Regional Main Center and Road Management Office (at Lang – Hoa Lac section) with land area of 3,000 m^2 for each

Natural Environment

Locating in the greater Hanoi, the project area bears the common topographic characteristics of the Red River Delta, which is relatively flat plain. The terrain gently inclines in the direction from North to South and from West to East.

The project area is belonged to the tropical monsoon climate with two major seasons, a cold dry season (October - March) and a hot rainy season (April - September). The average annual temperature is 24℃. The project is located in the North-Eastern Tropical Monsoon region. The climate differs according to the four seasons, whereby winter is cold, summer is hot with high humidity, and spring and fall relatively cool. The average annual temperature is 23 to 25℃.

The biodiversity of the project area is poor due to strong impacts of urbanization and development of agricultural land rural area; and there is not of any specific vegetation or inhabited area of endangered or rare species enlisted in the Red Data Book.

Socio-economic condition

The project area's population is over 7 million in 2010. Population density is very high in Hanoi, over 10,000 person/km^2 in urban areas, followed by 1,257 person/ km^2 in Bac Ninh, 914 person/km^2 in Ha Nam, and 648 person/ km^2 in Ninh Binh.

In the past decade during 2001 - 2010, there were rapid economic growth in Hanoi, and the economic structure has been modernized, and efficient. The GDP of Hanoi City during 2000 to 2005, grew at a level of annual 10.7%, and 6.72% during 2007 to 2010. The real GDP of Hanoi city in 2010 reached to 246 trillion 723 billion Vietnam Dong, with share of 13.0% of the real GDP nationwide.

2) Legal framework of Environmental and Social Considerations

Law, regulations and National Technical Regulations related to environmental and social issues

- Law on Environmental Protection, July 2006
- Government Decree No.29/2011/ND-CP, July 2011.

Government, regarding “Providing strategic environmental assessment, environmental impact assessment, and environmental protection commitment”; and pursuant to the Letter No.214/MT dated 01 June, 2012 issued by Department of Environment, Ministry of Transportation regarding “Comments on environmental legal procedure for the ITS project” showing that the project with less than 100 km of total length of optical cable or smaller than 5 ha area of Regional Main Center or less than 2kW capacity of power for transmission will need to prepare only an Environmental Protection Commitment but not Environmental Impact Assessment report.

3) Provisional Scoping

The study showed that no household resides in the project site and land acquisition is not required for construction of conduit system. Regarding the location of Regional Main Center, interchange of NH18–PR295 is the best location with favorable conditions such as sufficiency of land size, no land acquisition, good connectivity to cable network, good accessibility to public transportation, no flood and inundation, and unexpected environmental impacts.

The provisional scoping revealed that all of the environmental impacts associated with the construction office building and conduit system, and installation of fiber cable are minimal. Air pollution, noise and vibration occurring during the construction could be minimized through an adequate implementation of mitigation measures.

Roads and transport vehicles shall be properly maintained and repaired, as required. Installation of speed limits and road signage will minimize traffic and reduce road-related accidents.

A construction camp worker management plan shall be implemented by the contractor to deal with issues such as resource conflicts, drugs, disease etc., especially sexually transmitted diseases and HIV/AIDS.

During operation phase, the addition of operational staffs will lead to over exploitation of resources in the project area. There will be an increase in demand for resources and community and health services which could result in social conflicts. Co-management of existing resources between communes and operational staff shall be encouraged in order to maintain the integrity of natural and social resources in the project area.

All of the impacts could be minimized by applying appropriate mitigation measures proposed in the Environmental and Social Considerations report.

4) Conclusion

It is concluded that the ITS Integration Project will not give serious environmental impact, but the project will give many beneficial effects to the region wide socio-economic condition as well as peoples in the region. The Project is concluded to be feasible.

The Environmental Commitment will be prepared in advance of the Project Implementation and the Project will be implemented based on the environmental management/monitoring program.

➢15 Basic Design of Project

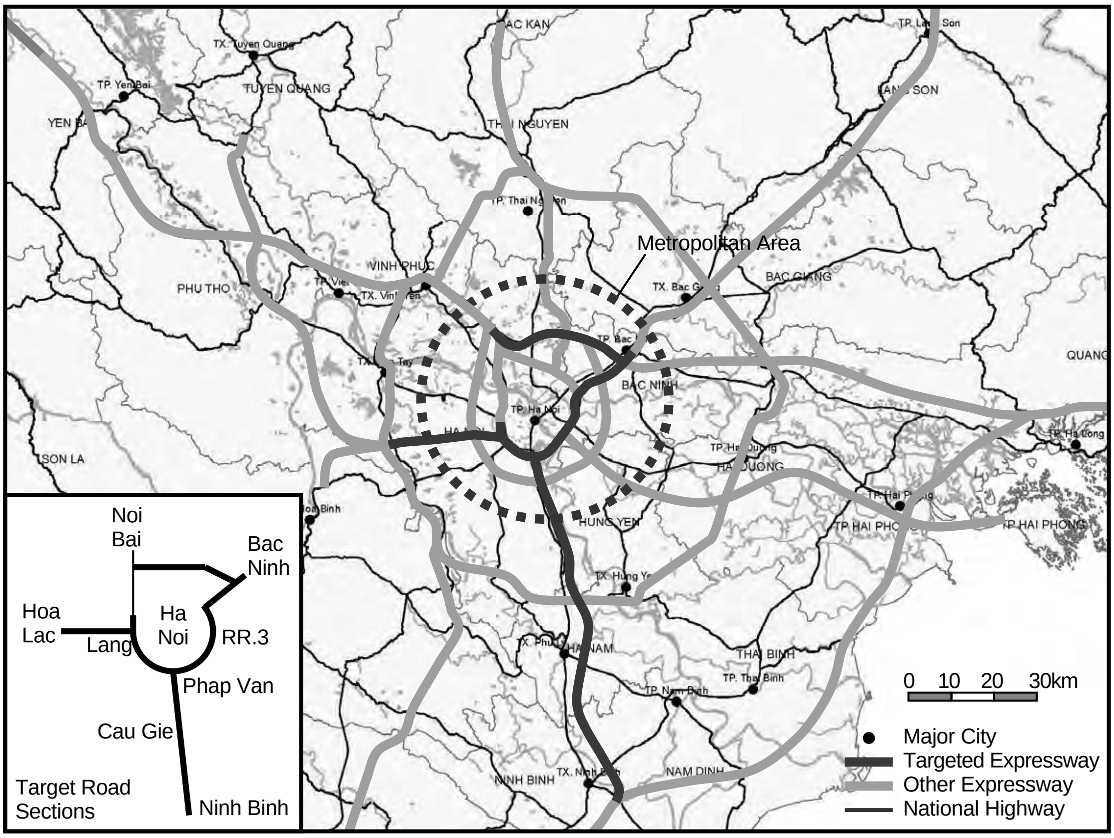
1) Project Scope

Based on the study results foregoing, the target road network of the ITS Integration Project is formed as follows:

The expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section, and connections to candidate locations of the Regional Main Center and the road management offices

Total length of the expressway network in the northern area including other expressways to be integrated under the Northern Regional Main Center can be assumed around 1000 km.

Figure 47 Road Sections of Project Area



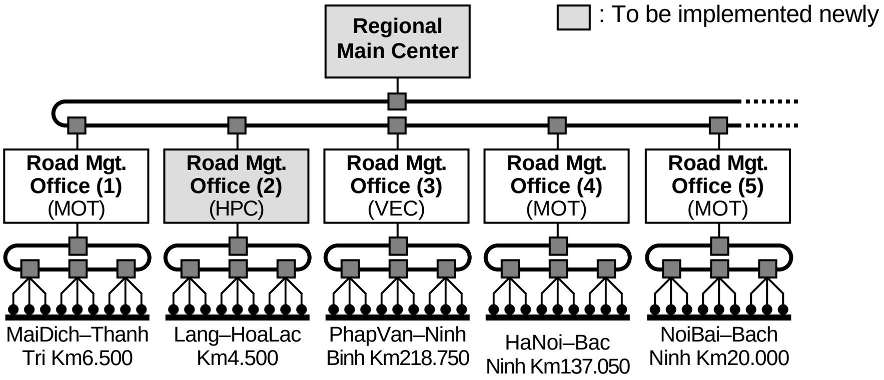
Road Sections of Comparison Case 2	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Phap Van–Cau Gie	30 km
Cau Gie–Ninh Binh	50 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Total	188 km

Source: ITS Integration Project (SAPI) Study Team

2) Center Equipment

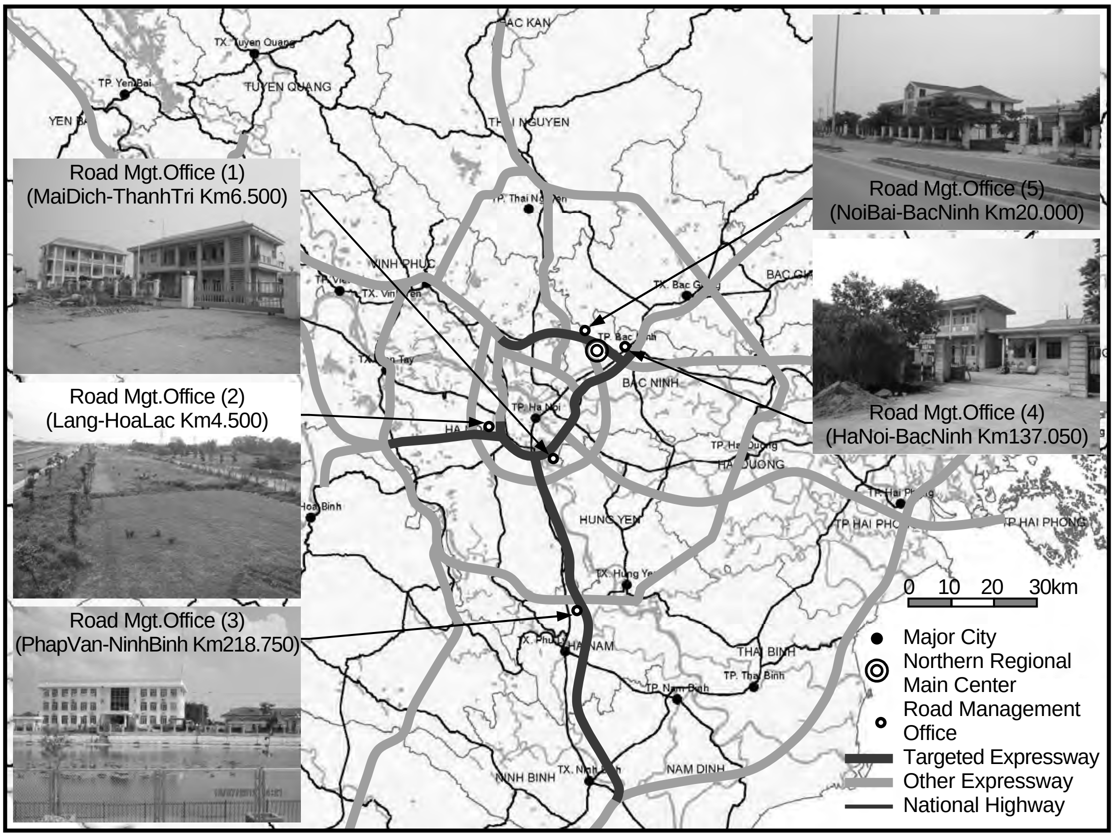
The structure and location of the Northern Regional Main Center and the road management offices are shown in the figures below. The center equipment for all of the Northern Regional Main Center and the road management offices needs to be implemented in the Project. The building construction only for the Northern Regional Main Center and the road management office of the Lang – Hoa Lac section is necessary in the Project.

Figure 48 Northern Regional Main Center and Road Management Offices



Source: ITS Integration Project (SAPI) Study Team

Figure 49 Location of Northern Regional Main Center and Road Management Offices



Source: ITS Integration Project (SAPI) Study Team

System architectures and the functional packages required for the Northern Regional Main Center and the road management offices are to be mentioned in the following.

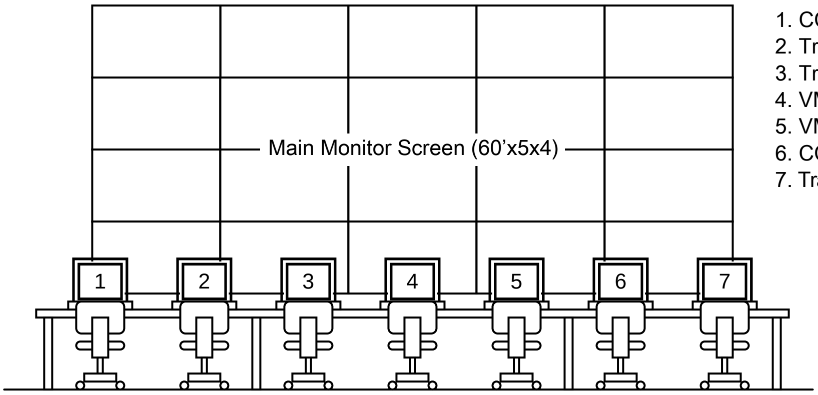
Northern Regional Main Center:

Traffic information/control is to be conducted totally from the Regional Main Center using the following functional packages:

(a) CCTV Monitoring
(b) Event Detection (by Image)
(c) Vehicle Detection
(d) Traffic Analysis
(e) Weather Monitoring
(f) Traffic Event Data Management
(g) Traffic Supervision
(h) VMS Indication
(i) Traffic Information

Vehicle detectors, weather sensors and VMSs need to be controlled directly from the Regional Main Center for integrating traffic information dissemination. The center equipment for actualising these functions is to be installed in the Regional Main Center.

Figure 50 Equipment Overview in Regional Main Center



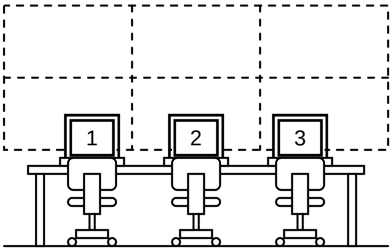
1. CCTV Center Controller Console
2. Traffic Event Data Input Device
3. Traffic Event Data Input Device
4. VMS Center Controller Console
5. VMS Center Controller Console
6. CCTV Center Controller Console
7. Traffic Supervising/Control Console

Source: ITS Integration Project (SAPI) Study Team

Road Management Office:

A part of center equipment is to be installed in the road management offices for expressway operation. CCTV cameras are to be controlled and the traffic event data are to be input from the road management office as well for handling and clearing incidents. The traffic event data can be input from the road management office; however, prioritisation of the traffic event data is to be done in the Regional Main Center and the result is to be sent directly to the VMS or CSS.

Figure 51 Equipment Overview in Road Management Office



1. Traffic Event Data Input Device
2. CCTV MonitoringConsole**
3. CCTV MonitoringConsole

**: A CCTV monitoring console can be replaced with the traffic supervising/control console in the case the main monitor screen is installed in the road management office.

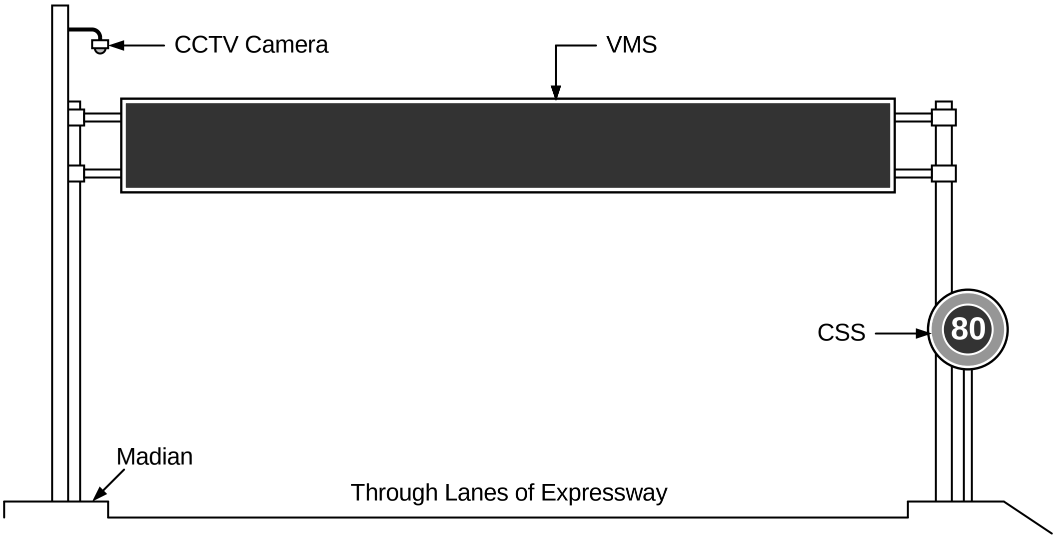
Source: ITS Integration Project (SAPI) Study Team

3) Roadside Equipment

In the Project, roadside equipment components below are to be installed for the 1st stage of stepwise implementation. The arrangement of these components is shown in the following tables.

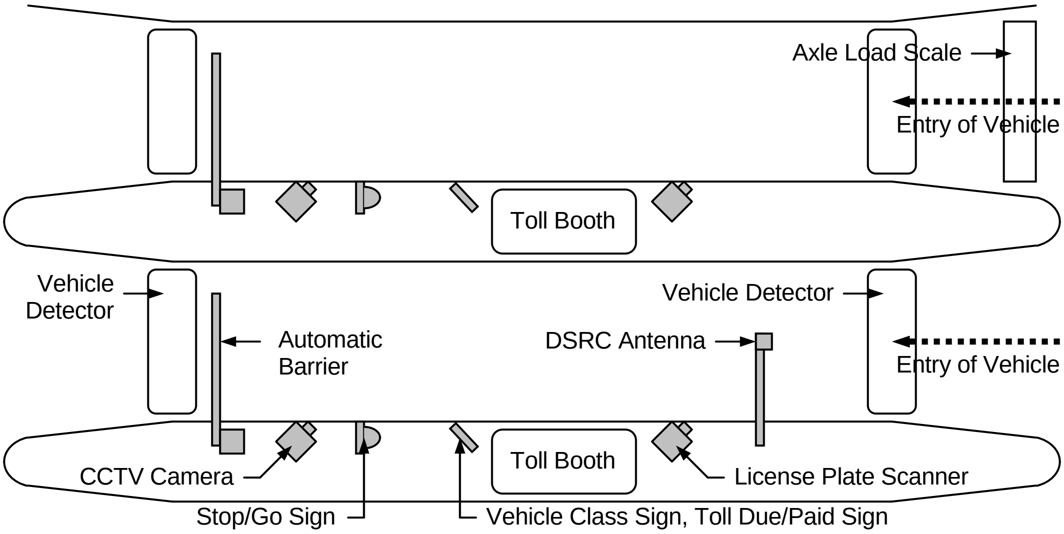
- CCTV camera (for monitoring and for event detection)
- Vehicle detector
- VMS (Variable Message Sign)
- CSS (Changeable Speed Limit Sign)
- ETC (Electronic Toll Collection)
- Touch&Go/manual
- Axle load scale

Figure 52 Installation of VMS/CSS



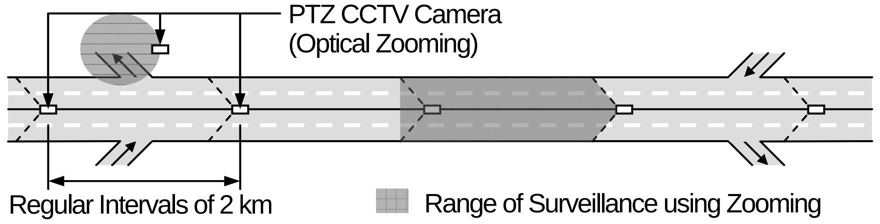
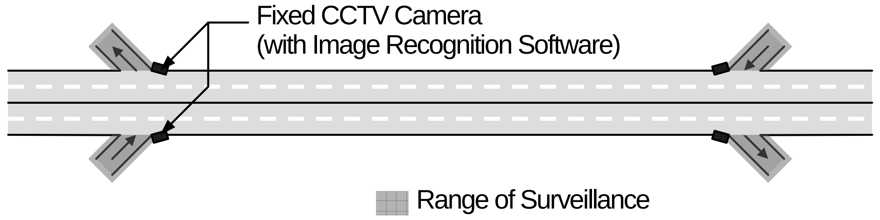
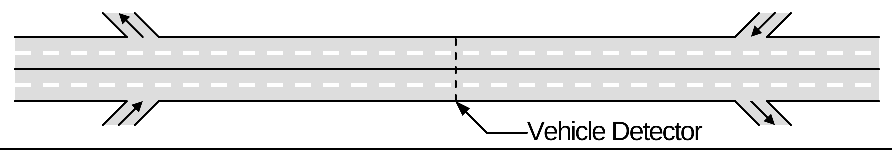
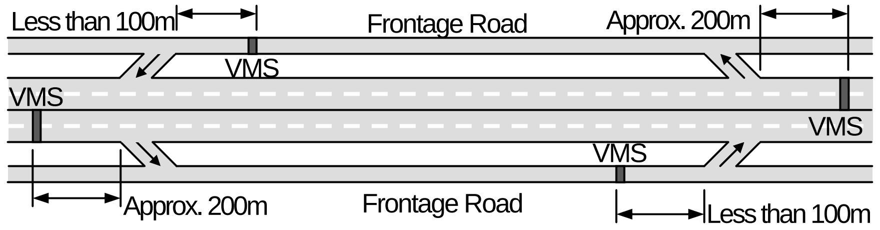
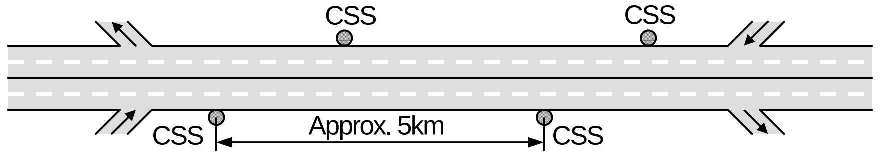
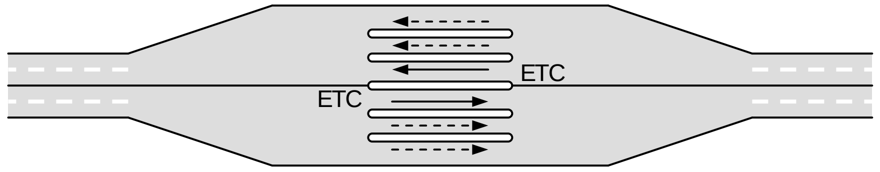
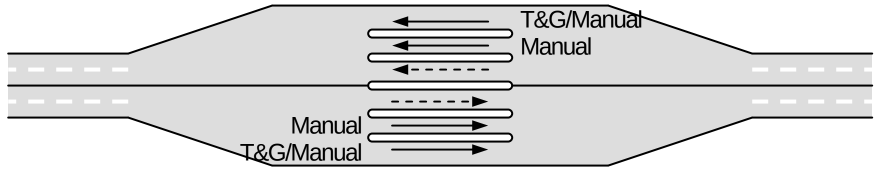
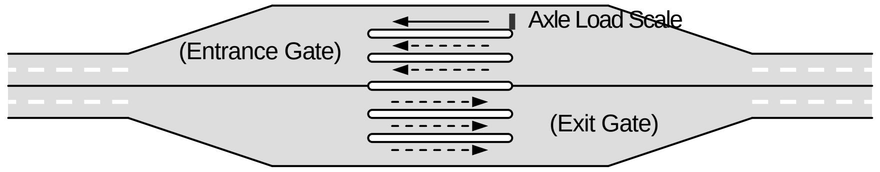
Source: ITS Integration Project (SAPI) Study Team

Figure 53 Installation of Roadside Equipment of Toll Collection and Vehicle Weighing



Source: ITS Integration Project (SAPI) Study Team

Table 17 Arrangement of Roadside Equipment in the Project

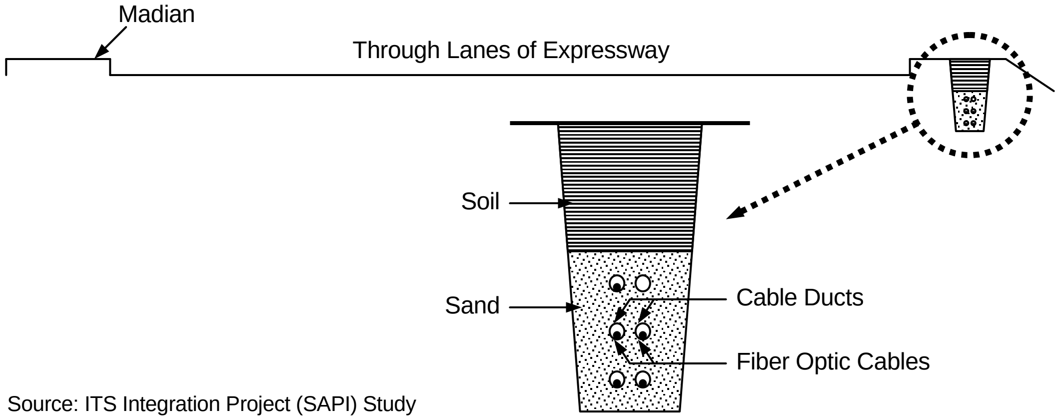
Arrangement of Roadside Equipment			Mai Dich–Thanh Tri Section	Lang–Hoa Lac Section	Phap Van–Cau Gie –Ninh Binh Section	Ha Noi–Bac Ninh Section	Noi Bai–Bac Ninh Section
1. PTZ Camera: for Monitoring		At regular intervals of 2 km (in practical use)	24 sets	38 sets	16 sets Excluding items to be installed by Grant and by 1st Stage ITS (design by Cadpro)	31 sets	48 sets
2. Fixed Camera: for Event Detection		At all ramps (in trial use)	10 sets Fully equipped with image recognition	20 sets	0 sets Excluding items to be installed by Grant and by 1st Stage ITS (designed by Cadpro)	27 sets	12 sets
3. Vehicle Detector:		At middle point between a pair of interchanges (in practical use)	14 sets	8 sets	12 sets	10 sets	6 sets
4. VMS: for Traffic Information		At 100 m back from the diverge to entrance gate and at 200 m back from the diverge to exit gate (in practical use)	18 sets	16 sets	18 sets Excluding items to be installed by Grant	18 sets	14 sets
5. CSS: for Speed Limitation		At regular intervals of 5 km (in practical use)	14 sets	9 sets	37 sets	10 sets	17 sets
6. ETC: for Toll Collection		At a median-side lane of the tollgate which has lanes more than two (in practical use)	2 sets	--	12 sets Excluding items to be installed by 1st Stage ITS (designed by Cadpro)	2 sets	2 sets
7. Touch&Go/Manual: for Toll Collection		At a roadside lane of all toll gates (in practical use)	8 sets	--	60 sets	8 sets	8 sets
8. Axle Load Scale: Overloading Regulation		At a roadside lane of entrance toll gates (in practical use)	2 sets	--	6 sets Excluding items to be installed by 1st Stage ITS (designed by Cadpro)	2 sets	2 sets

Source: ITS Integration Project (SAPI) Study Team

4) Communication Network

Communication network is to be performed by fiber optic cables installed in the ducts along the expressway network as shown in the figure below.

Figure 54 Installation of Communication Network



Source: ITS Integration Project (SAPI) Study

5) Policy of Basic Design Specification

In the Study, wide selectivity on technologies is to be ensured for realizing the services of ITS by performance specifications. The specifications are defined onto equipment components through their attributes that can be verified externally such as functions, performance and interfaces. That is named as the Basic Design Specifications. In compliance with the results of the Basic Design, the detailed design specifications shall be prepared by the Contractor of the Project Implementation.

6) Requirements for Specification of Functional Packages and Other Items

The requirements for specification corresponding to the functional packages and other items below are listed in the tables as shown in the following page.

- Voice communication
- CCTV monitoring
- Event detection (by Image)
- Vehicle detection
- Traffic analysis
- Weather monitoring
- Traffic event data management
- Traffic supervision
- VMS indication
- Mobile radio communication
- Traffic information
- Integrated data management
- Tollgate lane monitoring
- Vehicle/class identification
- Lane control
- Road-to-vehicle communication
- IC-card recording
- Toll data management
- OBU management
- Axle load measurement
- Measurement lane monitoring
- Communication system
- Communication ducts
- Base structures

The basic design specifications of the functional packages and other items are shown in Appendix-5 and the specifications of electric power supply are shown respectively in that of the functional packages and other items. The specifications of buildings shall be prepared in the detailed design to be conducted complementarily after the Study.

Table 18 Requirements for Specification of Functional Package and Other Items (Excerpt)

Traffic Information/Control System	
(1) Voice Communication	
Requirements	Major Equipment Component
• To receive notification of incident occurrence promptly from road user and to identify the user's location on the expressway. • To receive report of current traffic conditions on the expressways and of incident occurrence promptly from the operators in the toll office. • To switch and connect the interactive voice and emergency directives among Regional Main Center, Road Management Offices and toll offices. • To send directives to the units concerned simultaneously and with top-priority at any time for clearing incidents and enforcing traffic regulations. • To receive notification of incident occurrence generally within 20 minutes, and to send road operation vehicles to the incident site generally within 1 hour. • To function 24 hours a day, 365 days a year.	Regional Main Center Directive Communication Console Administrative Telephone Road Management Office Directive Telephone Administrative Telephone Toll Office Directive Telephone Administrative Telephone
(2) CCTV Monitoring	
Requirements	Major Equipment Component
• To recognize incident occurrences on the road and their type, such as traffic accidents, breakdown vehicles, left obstacles, driving in the reverse direction, vandalism and natural disaster, by remote monitoring at the Main Center and road management office. • To recognize the severity of incidents through identifying types of vehicles involved (such as trucks, buses and sedans) by appearance. • To control roadside equipment remotely from the Main Center in real time and from road management office at a occurrence of incident. • To minimize load caused by data transmission including video image on the communication system. • To store the needed video images. • To print out the needed results. • To save implementation cost by utilizing internet technologies.	Roadside CCTV Camera Road Management Office CCTV Center Controller CCTV Monitoring Console Regional Main Center CCTV Center Controller CCTV Monitoring Console
(3) Event Detection (by Image)	
Requirements	Major Equipment Component
• Automatically and promptly to detect incident occurrences and their types, such as traffic accidents, breakdown vehicles, left obstacles, reverse driving, vandalism and natural disaster, by analyzing video image captured at roadside. • To measure number of vehicles and vehicle speed at a specific point on the road. • To notify the detected results automatically and promptly to the Main Center road and management office. • To monitor original video image remotely at the Main Center and road management office. • To identify the time and place of incident occurrence at the Main Center and road management office. • To minimize load caused by data transmission including video image on the communication system.	Roadside CCTV Camera Road Management Office Image Recognition Processor
(4) Vehicle Detection	
Requirements	Major Equipment Component

Source: ITS Integration Project (SAPI) Study Team

➢16 Project Implementation Plan

The following items are to be discussed for the Project Implementation Plan in this chapter:

- Organization analysis (on project implementation and system operation)
- Packages for Implementing Project
- Project Implementation Schedule
- Important points for implementation
- Training program
- Financial Schedule.

1) Project Implementation Organizations

(1) MOT (Ministry of Transport)

MOT is to be the organization for for budget execution. The Ministry of Transport has the responsibility for the implementation of tasks and powers as stipulated in Decree No. 178/2007/ND-CP dated 3rd December 2007 by the Government on functions, powers, duties, and organizational structure of ministries and ministerial level agencies.

MOT has much experience in the budget execution for the expressway construction projects and the projects for implementation of other infrastructure.

The Departments of Transport Infrastructure and Planning & Investment are responsible for expressway O&M in MOT, and the Departments of Science & Technology, Transport Infrastructure and Information Technology Center are responsible for ITS.

In addition, the Expressway Management Office which is responsible for both expressway O&M and ITS is set up in MOT in 1st April 2011 and is transferred to DRVN in 26th April 2012.

(2) VEC (Vietnamese Expressway Corporation)

VEC is to be the organization for the project implementation. VEC is established on 1st September, 2004, the Prime Minister issued the document No.1245/ CP-DMDN on approving the establishment of VEC with major business of investment, development and management, maintenance of national expressway system.

VEC has experiences in the expressway construction including ITS implementation for the expressway of Phap Van – Cau Gie – Ninh Binh, Long Thanh – Dau Giay and Noi Bai – Lao Cai.

2) System Operation Organizations

(1) Expressway Management Organization in MOT

MOT has experience in the management of expressway operation for the following sections:

- HCMC – Trung Luong Expressway (based on the Decision No.195/QD-BGTVT)
- Cau Gie – Ninh Binh Expressway (based on the Decision No. 2451/QD-BGTVT).

MOT has experience in the management of overloading regulation based on the Circular No.07/2010/TT-BGTVT. The roles below are to be fulfilled by the Expressway Management Organization in MOT for system operation.

- Ownership/funding/management of the Regional Main Center
- Regulation on hardware/software in compliance with the ITS Standards
- Issue of permission for enforcing serious traffic restrictions such as road closure
- Exchange monitored information/data of traffic conditions/events
- Integrated management on the data from toll collection/management, traffic information/ control and heavy truck control (including overloading regulation)
- Development of inspection and budget plan of road improvement/maintenance
- Check of the validity of toll revenue in comparison with the data of traffic
- Evaluation of road operator’s achievement in the expressway operation.

(2) VEC

VEC has the following experiences in the expressway operation in the section of Cau Gie – Ninh Binh based on the Decision No. No. 2451/QD-BGTVT:

- Expressway operation preparing the special telephone number 19001838
- Cooperation with expressway police and ambulance for incident clearance
- Toll collection by manual
- Overloading regulation.

They established a road management office for expressway operation at Vuc Vong. The roles below are to be fulfilled by VEC for system operation.

Road Owner:

- Ownership/funding/maintenance of road structure/facilities of an expressway section other than ITS
- Ownership/funding of facilities of ITS of an expressway section
- Submission of the application for utilization of radio frequency
- Toll collection/management of an expressway section
- Charge for toll fare
- Transfer of transaction data/status and assistance for toll enforcement.

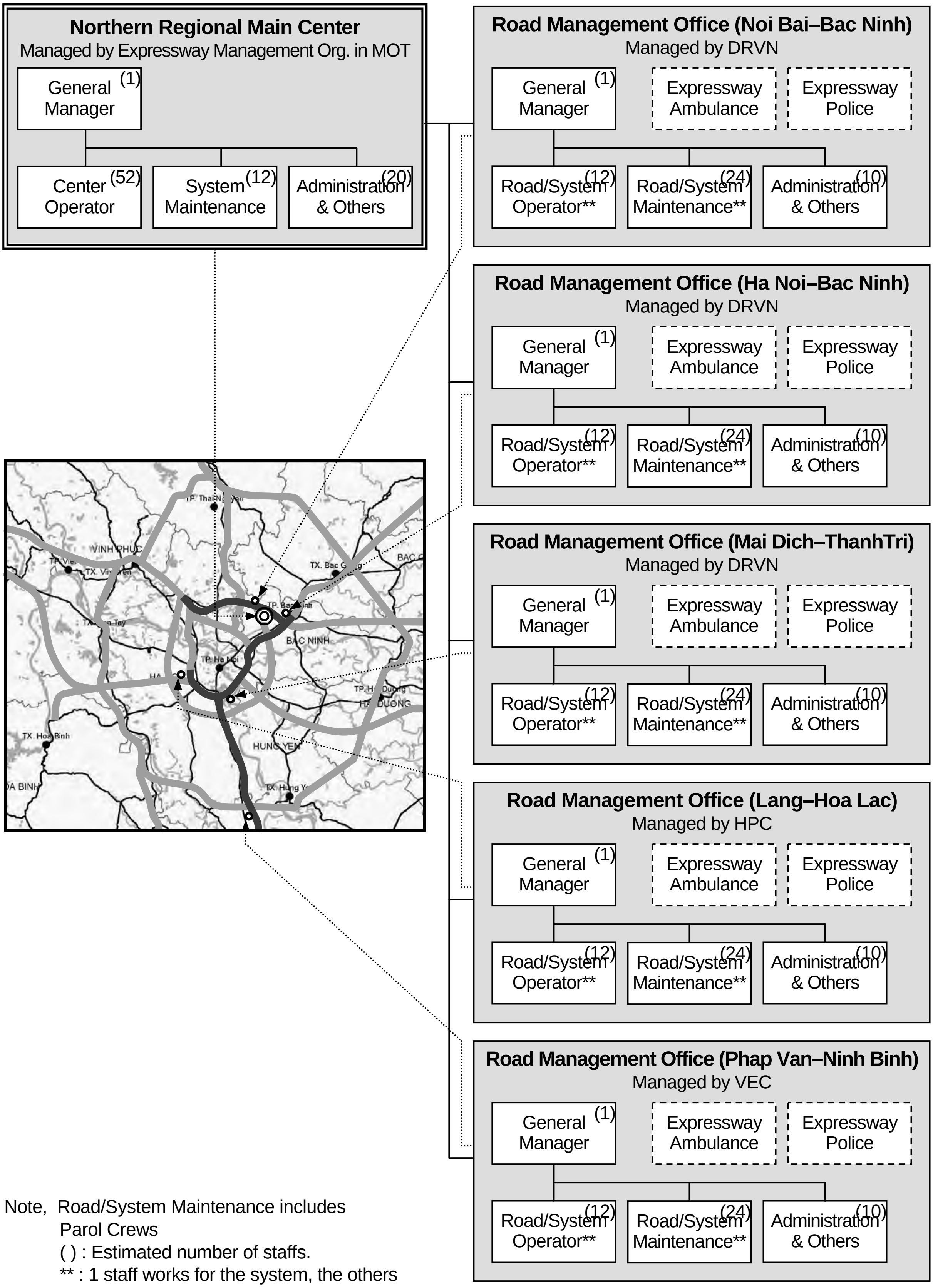
Road Operator (in Regional Main Center):

- Member dispatch for operation of the Regional Main Center
- Acquisition of information through the special call number or sensors of ITS
- Maintenance of hardware/software of ITS.

Road Operator (in Each Expressway Section):

- Traffic information/control of an expressway section
- Dispatch of a patrol crew to the incident site
- Judgement on the gravity of incident and enforcement of the traffic restrictions
- Input a traffic event data at the road management office or roadside and checking of them
- Assistance of toll collection of an expressway section
- Operation of mobile radio communication for patrol and road-to-vehicle communication for ETC
- Overloading regulation of an expressway section
- Operation/maintenance of hardware/software of ITS.

Figure 55 Organizations of Northern Regional Main Center and Road Management Offices



Note, Road/System Maintenance includes
Parol Crews
( ) : Estimated number of staffs.
** : 1 staff works for the system, the others
work for road and traffic using ITS

Source: ITS Integration Project (SAPI) Study Team

Organizations of Northern Regional Main Center and Road Management Offices

The offices for expressway operation need to be integrated and cooperated. The organization of the offices for operation of the expressway sections in the Project Area is illustrated before, which includes the Northern Regional Main Center and five road management offices.

(3) Bank

Toll settlement among different road owners is to be operated a bank or an organization permitted by the State Bank (as the case of Decision No.5190/NHNN-TT). The banks have experiences in the toll collection for several sections of the arterial road as well. For example, Vietin Bank provide toll collection service using ETC at many tollgates including the followings:

- Can Tho Bridge Tollgate (Can Tho City)
- Luong Met Tollgate (Lang Son Province)
- South of Gie Bridge Tollgate (Ha Nam Province)
- Phu My Bridge Tollgate (HCM City)
- Tan Son Nhat Airport Tollgate (HCM City)
- Da Nang Airport Tollgate (Da Nang City)
- Dong Xoai Tollgate (Binh Phuoc Province).

The roles below are to be fulfilled by the Bank for system operation.

- IC-card issue/recharge/management service
- Reception of claim for invalidation of an IC-card from a user
- Generation/distribution of IC-card validation list and assistance for toll enforcement.

(4) OBU Management Center

It is recommended to set up the OBU Management Center in the Vietnam Register, which is in charge of vehicle registration. The roles below are to be fulfilled by the OBU Management Center for system operation.

- OBU registration/management service
- Generation/distribution of OBU registration/invalidation list and assistance for toll enforcement.

3) Packages for Implementing Project

The Project is to be implemented in the following three packages:

Package-1: The systems for traffic information/control and electric power supply, which are located mainly in the Northern Regional Main Center, the road management offices and roadside, and in addition communication system and communication ducts.

Package-2: The systems for toll collection/management and vehicle weighing, which are located mainly in the toll offices, the tollgates, offices relevant to the operation framework and in-vehicle, and in addition the system for integrated data management and electric power supply.

Package-3: Buildings and the system for electric power supply for the Northern Regional Main Center and the road management office of Lang – Hoa Lac.

Table 19 Functional Packages and Other Items in Package for Implementing Project

Functional Packages and Other Items		Package-1	Package-2	Package-3
Traffic Information /Control	(1) Voice Communication	XX		
	(2) CCTV Monitoring	XX		
	(3) Event Detection (by Image)	XX		
	(4) Vehicle Detection	XX		
	(5) Traffic Analysis	XX		
	(6) Weather Monitoring	XX		
	(7) Traffic Event Data Management	XX		
	(8) Traffic Supervision	XX		
	(9) VMS Indication	XX		
	(10) Mobile Radio Communication	XX		
	(11) Traffic Information	XX		
	(12) Integrated Data Management		XX	
Toll Collection /Management	(13) Tollgate Lane Monitoring		XX	
	(14) Vehicle/Class Identification		XX	
	(15) Lane Control		XX	
	(16) Road-to-Vehicle Communication		XX	
	(17) IC-card Recording		XX	
	(18) Toll Data Management		XX	
	(19) OBU Management		XX	
Vehicle Weighing	(20) Axle Load Measurement		XX	
	(21) Measurement Lane Monitoring		XX	
Other Items	Communication System	XX		
	Communication Ducts	XX		
	Buildings			XX
	Power Supply	XX	XX	XX

Source: ITS Integration Project (SAPI) Study Team

4) Project Implementation Schedule

The following implementation items are to be performed in “the Study for Assistance of ITS Integration Project implementation over National Highway No.3 and Hanoi Metropolitan Area”.

- Feasibility Study
- EIA Study
- Basic Design

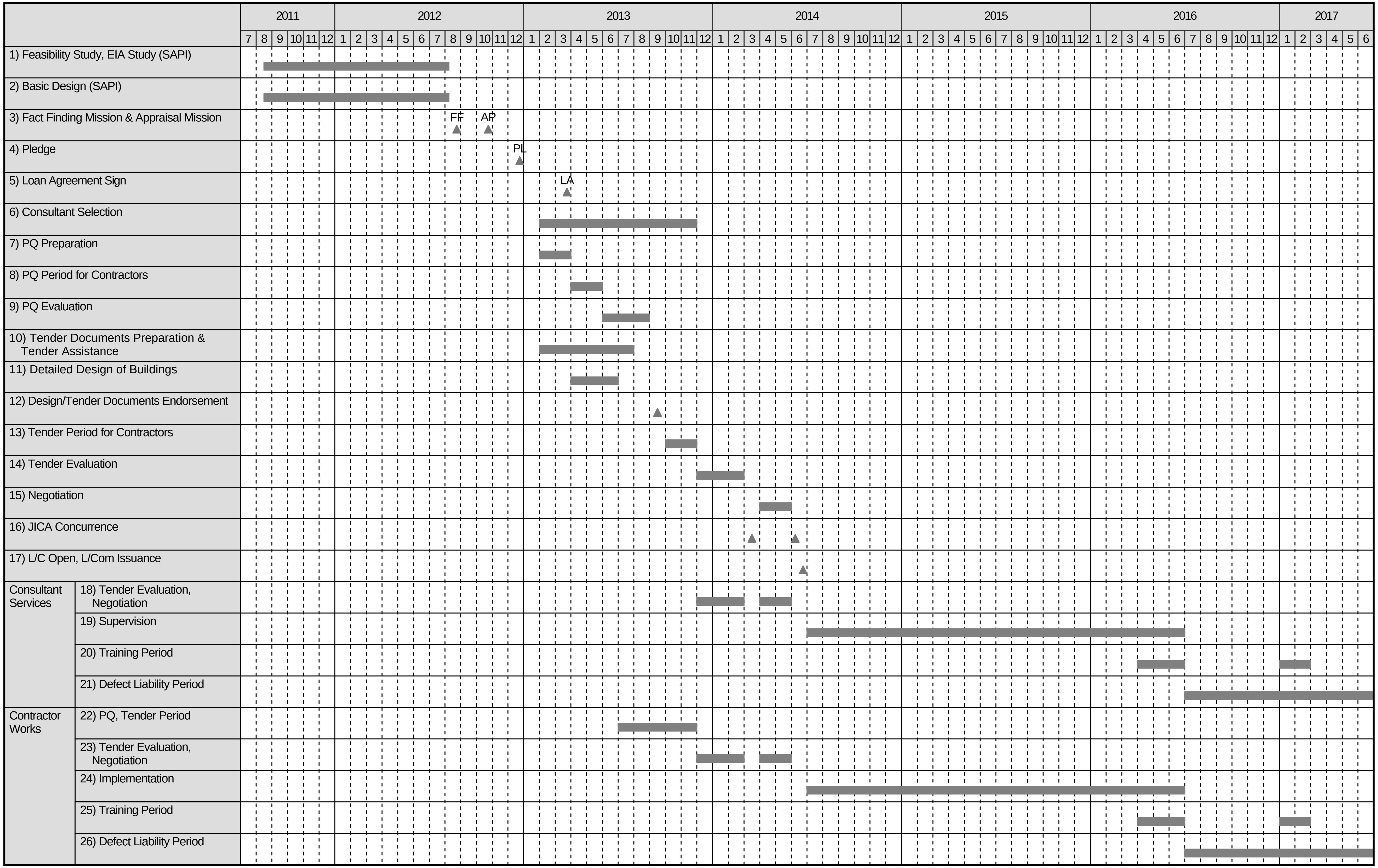
Additionally, the items below are to be completed in advance of the project implementation.

- Appraisal mission
- Loan agreement sign
- Tender documents preparation
- Consultant TOR preparation and tender assistance
- Consultant selection
- Design and tender documents endorsement
- PQ for Contractors
- Tender process for Contractors

The tender period for the Contractors is to be 2 months from October in 2013 and the Project Implementation Period is to be 2 years from July in 2014. Additionally, the Defect Liability Period is to be secured for a year after the Implementation Period.

The project implementation schedule is shown in the figure in the following page.

Figure 56 Project Implementation Schedule



Source: ITS Integration Project (SAPI) Study Team

5) Training Program

The objectives of the training are shown below.

Training on Traffic Control of Expressway

The objective of this training is basic knowledge transfer for the operator of traffic information/ control system responding to the occurrences of incidents for first stage, and enhancement of capability of traffic control for second stage through the process of obtaining advice from traffic control expert during actual traffic control operation in rainy season.

Training on System Operation/Maintenance

The objective of this training is basic knowledge transfer for the responsible staff of system operation and maintenance. The targets are the traffic information/control system, the automated toll collection system and the vehicle weighing system.

Training on Lane Operation

The objective of this training is basic knowledge transfer for the responsible staff on the lane operation for toll collection and vehicle weighing. The target includes the drivers who are not familiar to pass the toll gate and how to prevent the passage of fraudulence driver.

Table 20 Training Items

- Proper monitoring and judging gravity of incident using roadside equipment of Traffic Information/ Control System
- Proper operation of data management and exchange among expressway operators using Traffic Information/Control System
- Proper operation of incident clearance in cooperation with related organizations using Traffic Information/ Control System
- Proper operation of information dissemination in cooperation with related expressway sections using Traffic Information/Control System
- Proper tollgate lane operation for toll collection under usage of ETC and Touch&Go System
- Proper operation of handling the vehicle with balance shortage or without OBU under usage of ETC System
- Proper operation of IC-card issuance/ invalidation and toll settlement in cooperation with a bank
- Proper operation of OBU registration/ invalidation in cooperation with related organizations
- Proper lane operation for overloading regulation under usage of Axle Load Scale
- Proper integrated management on data from Traffic Information/Control, Toll Collection and Vehicle Weighing
- Proper/prompt recovery work of the system by identifying fault location on the communication network of ITS

6) Financial Schedule

(1) Basic Assumptions for Project Cost including Contingencies

The investment is scheduled from year 2014 to 2015, and the commencement of operation is year 2016. The share percentages of investment cost disbursement are 30% and 70% for the year 2014 and 2015, respectively.

The price contingency rate is:

- Foreign currency portion: 1.6%
- Local currency portion 6.9%
- The rate physical contingency is 10%.

No contingencies are assumed for the cost item of project administration cost. Except the cost item of project administration cost, the costs are assumed to include the tax portion of 10% as VAT.

(2) Financing Scheme

The assumed financing sources are JICA's Loan (STEP), and JICA's Loan for Consulting Services, and the government counterpart fund. Regarding JICA Loans, no re-lending scheme is assumed.

JICA's Loan (STEP):

- Interest rate: 0.20%
- Total repayment 40 years (Grace period: 10 years and net repayment of 30 years)
- Commitment charge: 0.10% on un-disbursed balance.

JICA's Loan for Consulting Services:

- Interest rate: 0.01%
- Total repayment 40 years (Grace period: 10 years and net repayment of 30 years)
- Commitment charge: 0.10% on un-disbursed balance.

(3) Assumption on Operation and Maintenance Costs for ITS

Based on the engineering study results, the unit value of operation and maintenance (O&M) costs (except replacement cost of equipment) for ITS per kilometer is estimated to be 2.33 million yen per annum.

The distance kilometer of the target road network is 188 km, and the annual total O&M costs for ITS are estimated to be 438 million yen. The O&M costs for ITS are assumed to increase in line with the escalation rate of 2.66% per annum, which is the assumed weighted average rate with the escalation rate of 6.9% in local currency portion (at 20% in assumed share) and escalation rate of 1.6% in foreign currency portion (at 80% in assumed share).

(4) Assumption on Replacement Cost of Equipment

The replacement cost of equipment is assumed to be required cost during operation period other than the above O&M costs for ITS. The unit value of replacement cost of equipment of ITS per kilometer is estimated to be 1.64 million yen per annum, and the annual total costs are estimated to be 309 million yen. Regarding the replacement cost of equipment, it is assumed that the unit price escalation will be compensated by the cost reduction through technological innovation.

(5) Tabulation on Cash Flow

Cash flow is to be considered for years during the loan repayment period. The item of required fund after operation is assumed to compensate the amounts of out-flow items of loan repayment, loan interest payment, O&M costs for ITS and replacement cost of equipment.

As a result, the amount required as a fund after operation is examined, which is equivalent to be, for example, approximately 808 million yen in the year 2016.

(6) Assumption on Operation and Maintenance Costs for Road

Based on the engineering study results, the unit value of operation and maintenance (O/M) costs (except replacement cost of equipment) for the road per kilometer is estimated to be 4.0 million yen per annum.

(7) Balance of Toll Revenue and O&M Costs

The balance of toll revenue and O&M costs is to be considered for years 2020 and 2025. Toll revenue in 2025 is estimated adding the same increase as that from 2015 to 2020 to the value in 2020. According to the estimated results, the total O&M costs for road and ITS can be covered by 40% of the toll revenue, which is to be shared for the operator.

➢17 Review of ITS Basic Plan for New National Highway No.3

The ITS basic plan for New National Highway No.3 was reviewed and the cost for the ITS package of the New NH3 was estimated based on the harmonized conditions with the ITS Integration Project. The cost will be updated during detailed design stage of ITS.

1) Outline of New National Highway No.3 (Ha Noi – Thai Nguyen Expressway)

The outlines of the New National Highway No.3 (Ha Noi – Thai Nguyen Expressway) are as shown below.

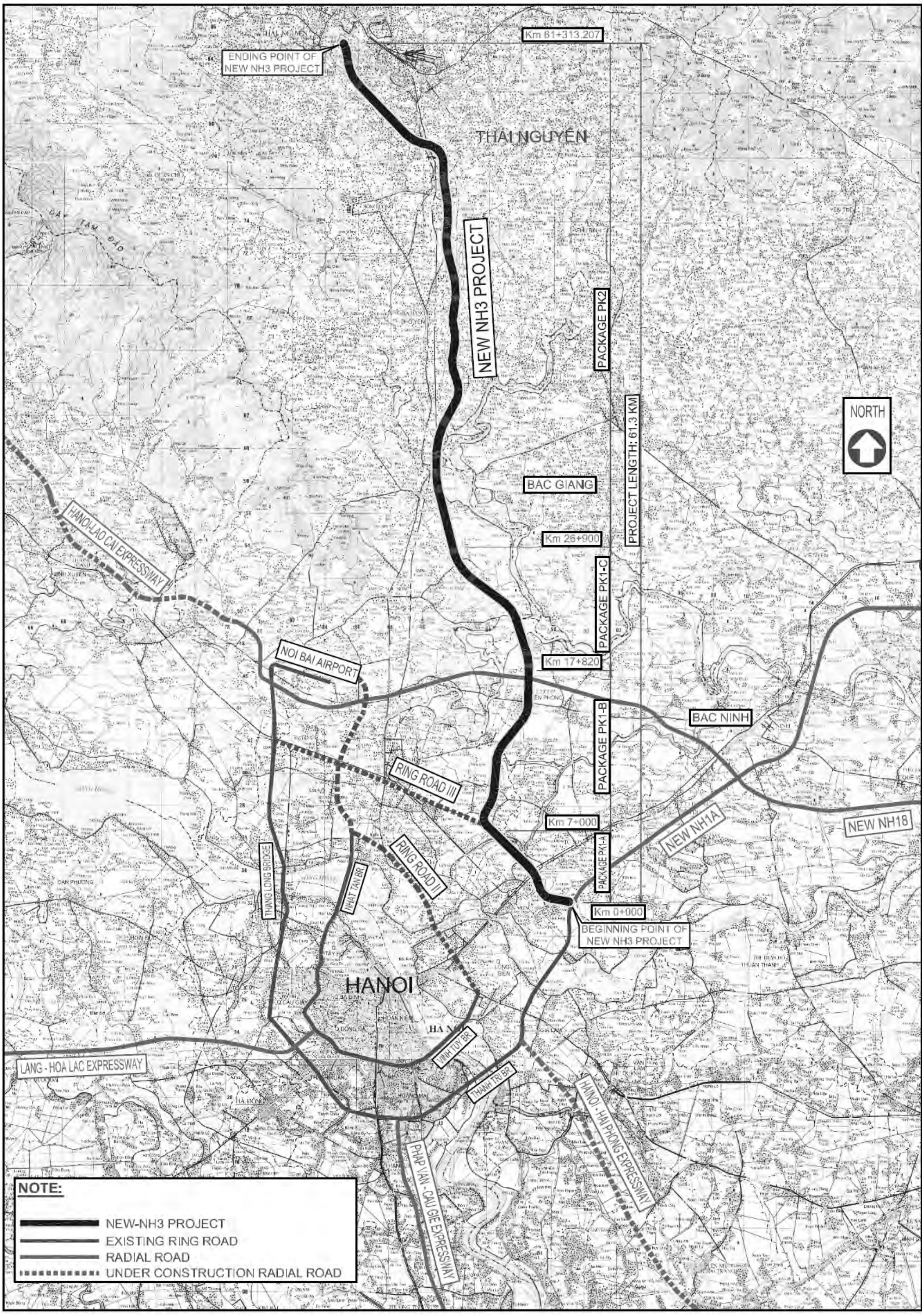
- Executing Agency: Project Management Unit No.2 (PMU2)
- Road Operator: Directorate for Roads of Vietnam (DRVN)
- Total Length: 61.313 km
- Beginning Point: Ninh Hiep (Intersection with the new NH1A to the north of Phu Dong Bridge), Gia Lam district, Hanoi city
- Ending Point: The point connecting to beginning of Thai Nguyen bypass, Tan Lap ward, Thai Nguyen province
- Location Map: See Figure 58
- Source of Finance: JICA loan
- Stage of Construction: Under construction
- Design Speed: 100 km/h
- Access Control: Open system

2) Discussion Items

The following items are discussed in the review of the Study:

- Comparison between Previous ITS Basic Plan for New NH3 and JICA Draft ITS Standard
- Traffic Information/Control System of New NH3 Road Management Office
- Proposed Modifications to ITS Implementation Plan on New NH3
- ITS Implementation Plan for New
- Implementation Schedule for New NH3
- Project Cost for New NH3

Figure 57 Location Map of New National Highway No.3



Source: Consultant of the New NH3 Project

➢18 Required Conditions for Project Implementation

Through the discussion in the Study, it became evident that the following conditions are required for the implementation of ITS Integration Project.

(1) The Project is to be implemented by VEC and the project budget is to be executed by MOT.

(2) Road management offices are to be integrated in a single hierarchical structure under the Northern Regional Main Center by decision of MOT.

(3) The Northern Regional Main Center is to be located at NH18 – PR295 Interchange.

(4) A team consists of the expressway police, the expressway ambulance and the road operator is to be assigned to each road management office.

(5) The road management office of Lang-Hoa Lac section is to be constructed on the north side at around KM4+500 of the section.

(6) The space for ITS operation is to be secured in all road management offices.

(7) The Banks for IC-card issuance/operation is to be selected by decision of the State Bank.

(8) The OBU Management Center for OBU Registration/Management is to be set up under Vietnam Register by decision of MOT.

(9) Axle load scale installation in the Project is to be defined as the 1st stage of stepwise implementation of the system for overloading regulation.

(10) The following legal systems are to be prepared:

- Setting up of the special telephone number without area code to call the Regional Main Center (by MOT and MIC)
- Definition of a specific organization responsible for enforcing traffic restriction on the expressway (by MOT and MOPC)
- Definition of specific banks responsible for IC-card issuance/operation for ETC and Touch&Go (by the State Bank)
- Definition of specific organization responsible for OBU registration/management for ETC (by MOT)
- Preparation of legal system to impose penalty against overloading by measuring axle load (by MOT)
- Preparation of legal system for unlawful drivers who ignore payment of penalty against overloading or toll (by MOPC).

➢19 Revision of Draft ITS Standards

The following documents are reviewed and revised in the Study:

- Summary of ITS Master Plan
- Draft ITS Design Standards (3 volumes for the priority ITS user services)
- Draft ITS General Specifications (24 volumes for the functional packages)
- Draft ITS Message/Data Standards
- Draft ITS Communication System Plan.

TABLE OF CONTENTS

1. Introduction

1.1 Background and Necessity

National Highway No.3 is a critical arterial road links Ha Noi the capital of Vietnam with Thai Nguyen the strategic point of industry and economy in the northern region. Its traffic volume has been growing at a 10% annual rate and further growth is expected in the future. To deal with this problem, introduction of ITS for smooth traffic control is now under discussion.

At the same time, designing and construction of expressway network is underway nationwide in Vietnam. In the Ha Noi Metropolitan Area, a high quality road network consist of in radial sections including expressways as well as National Highway No.3 and Ring Road No.3 bundles them has been constructed, and it will be completed by the end of 2013.

With the start of services of such high quality road network including the expressways, the increase in traffic accidents has become a major problem in Vietnam. On the HCMC – Trung Luong Expressway of length 40 km in the South of Vietnam, during 18 months from its commencement in February 2010, 113 coccurrences of traffic accident has been reported and accident rate has become a high value at 1.8 affairs/km/year.

It is estimated that the inexperience in high speed driving is a cause of such high rate of traffic accident and it should be expected that it decreases gradually keeping pace with ripeness in high speed driving. In either case, it is necessary to take a measure against such undesired condition. In particular, prompt response to an accident is extremely important, because the potentiality of serious injuries and fatalities is high in the traffic accidents on expressways. A significant effect is expected to be achieved by introduction of ITS for quick identification and notification of accident occurrence or its situation.

In addition, insufficiency in the development of road network in Vietnam makes it difficult to find a detour in the event of a traffic accident. For this reason, a high effect is expected in rapid notification of accident occurrence and information provision of the few detours that is to be realized by ITS.

Use of expressway has begun only recently in Vietnam, and occurrences of significant congestions have not been reported. However, it is estimated that congestion will take place around the exit gates to ordinary roads, with the increase in daily use of expressway and traffic volume on it in the future, not only at the occurrence of traffic accident but also at the commute time in the morning/evening of weekday and in the evening of holiday. It is expected to secure smooth traffic by taking advantage of ITS to support the selection of appropriate entrance/exit gate, to provide the information of traffic restriction and to collect the traffic data.

The barrier tollgates have been installed on many arterial roads in Vietnam and these are operated by a flat tariff system. On the other hand, a distance proportional tariff system is being applied to the expressways which are under construction at present and many tollgates are being built at their entrances and exits. Significant effects are expected to be provided by system introduction of ETC (Electronic Toll Collection) for non-stop processing and increase of tollgate capacity, because the tollgates are prone to be disincentive against the smooth traffic and the superior route selectivity.

However, when introducing, it becomes important requirement for it to be able to process both the flat tariff and the distance proportional tariff simultaneously. It is expected to realize the smooth and sustainable road operation in the future through harmonization among the flat tariff and the road pricing in the metropolitan areas and the distance proportional tariff for intercity traffic.

On the other hand, in Vietnam, expressway network being constructed by sections funded by different donors, it has become an important issue how operate such sectioned road network. It is required to set up cooperative management system among many different road operators. In such situation, ITS introduction is under discussion for realizing road operation in efficient and integrated form. Striving toward the development of the ITS Standards in Vietnam, the issues on inter-operability of data, compatibility of equipment components and connectability of communication network are to be resolved.

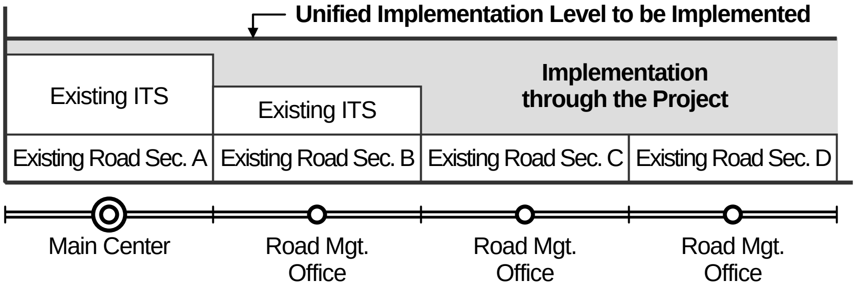
In the “Study for Supporting ITS Standards & Operation Plan Development in Vietnam”, which was conducted following VITRANSS2, ITS operation framework, key policies on system and the Draft ITS Standards are shown as the results. However, these results have not been formulated and integration on ITS has not been established. Consequently, it has become critically important:

- To establish a procedure to integrate ITS implementation over different road sections
- To show the way to utilize ITS for expressway operation and addressing traffic problems.

Necessity of ITS Integration Project

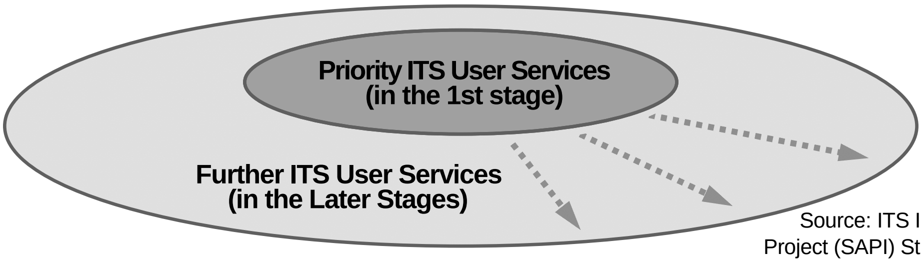
The Project aims to unify the ITS implementation levels covering the whole road network including a number of expressway sections, to verify/establish a procedure for integrating systems, to build up the Northern Regional Main Center, to initiate expressway operation/ maintenance (O&M) using ITS and to show the way to utilize ITS for solving traffic problems in the metropolitan areas.

Figure 1.1 Unification of Implementation Levels through the ITS Integration Project



Source: ITS Standards & Operation Plan Study Team

Figure 11.2 Initiation of ITS User Services



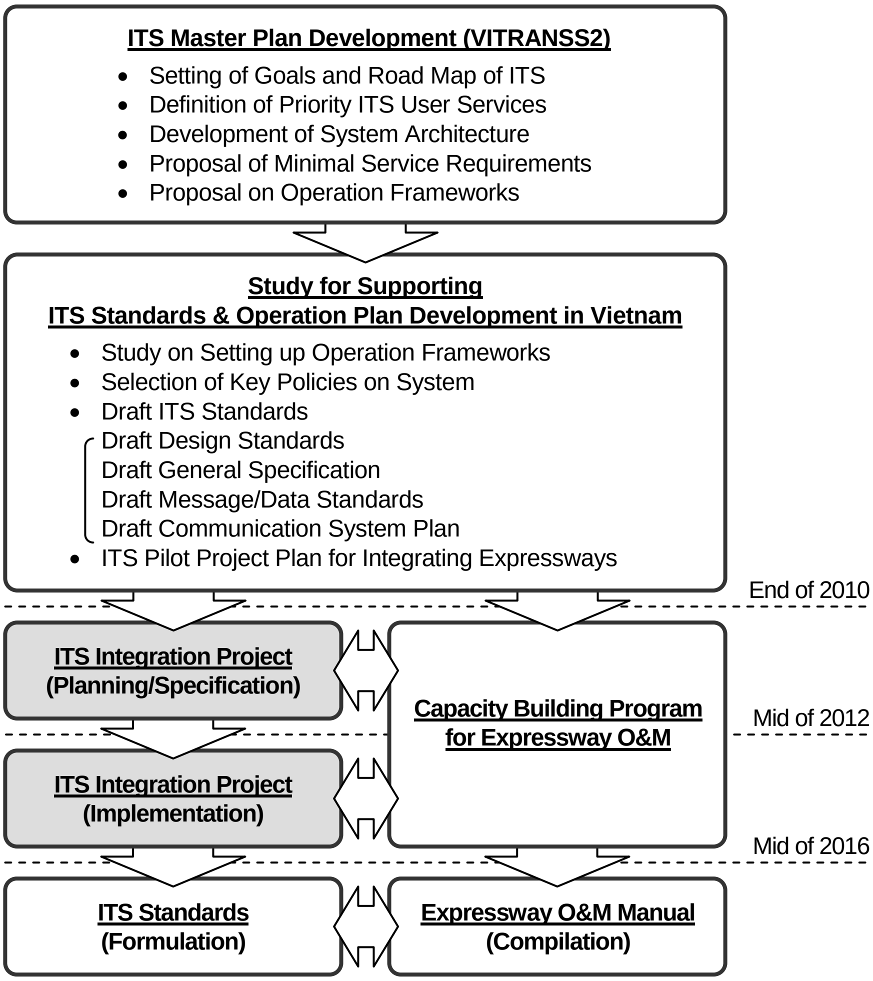
Source: ITS Integration Project (SAPI) Study Team

The Project is to initiates the priority ITS user service focusing on the road operation aiming at extension to the further ITS user services in the later stages based on the ITS Master Plan.

Position of ITS Integration Project

The flowchart from the development of the ITS Master Plan to the formulation of the ITS Standards in Vietnam is shown in the following figure. The ITS Integration Project is positioned as a step for verifying the practicality of the Draft ITS Standards and leading it to formulation.

Figure 1.3 Position of ITS Integration Project



Source: ITS Integration Project (SAPI) Study Team

1.2 Objective of Study

Objective of the Study is to integrate and secure compatibility of ITS over the whole Ha Noi Metropolitan Area achieving the following items:

- Evaluation of the ITS Integration Project and development of a specific plan for project implementation
- Consensus building on the specific plan with parties concerned in Vietnam
- Conforming ITS of National Highway No.3 to previous study results and the developed specific plan.

1.3 Study Scope

1) Study Area

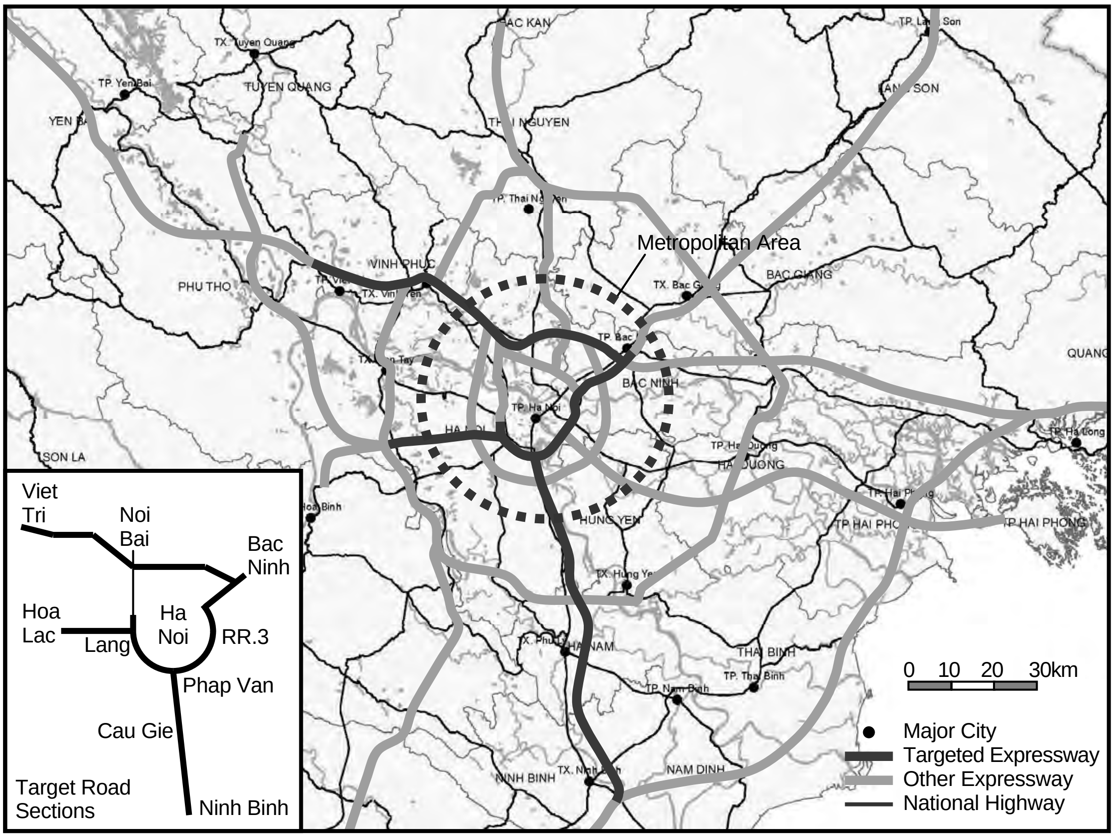
Ha Noi Metropolitan Area is to be defined as the study area. The target road network of the Project is to be formed by selections of the road sections below, which are shown in the official letter 2584/VEC-DA from VEC to MOT, evaluating effects of the project implementation.

(1) Base case for the target road sections of the Project: Expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section, and all connections to candidate locations of the Regional Main Center and the road management offices

(2) Expressway sections to be integrated under the Northern Regional Main Center other than (1).

Total length of the expressway network in the northern area, which is composed of (1) and (2), can be assumed to be around 1000 km.

Figure 1.4 Road Sections in Study Area



Target Road Sections of the Project (Base Case)	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Phap Van–Cau Gie	30 km
Cau Gie–Ninh Binh	50 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Noi Bai–Viet Tri	80 km
Total	268 km

Source: ITS Integration Project (SAPI) Study Team

2) Systems to be Discussed

The scope of the Study embraces to discuss and evaluate the ITS Integration Project focused on the following four systems:

- System for road traffic information/control
- System for non-stop toll collection
- System for heavy truck control
- Communication system.

These are based on the ITS user services shown in the ITS Master Plan.

Table 1.1 Definition of Three Priority ITS User Services

Traffic Information/Control

Service descriptions:

This service provides accurate surveillance of traffic conditions on expressway and adjacent arterial roads. This service assists prompt action of the road operator and the emergency vehicles by notifying occurrence of traffic accidents, broken-down vehicles and other obstacles. This service allows drivers en route and in advance to avoid the influence of the incidents by providing accurately updated information. This service also allows appropriate interchange/route selection by providing drivers en route with information; such as crowdedness and travel-time. This service makes it possible to measure actual traffic volume continuously for developing rational road construction/improvement plan.

Functional packages to be included in the system:

(1) Voice communication
(2) CCTV monitoring
(3) Event detection (by image)
(4) Vehicle detection
(5) Traffic analysis
(6) Weather monitoring
(7) Traffic event data management
(8) Traffic supervision
(9) VMS indication
(10) Mobile radio communication
(11) Traffic information
(12) Integrated data management

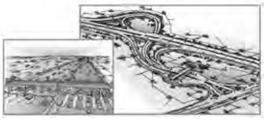
Non-stop Toll Collection

Service descriptions:

This service enables toll collection without stopping vehicles: ETC (Electronic Toll Collection). This service relieves bottlenecks at the tollgates and allows smooth incoming and outgoing at the interchanges. This service reduces the number of tollbooths and solves the problem of land acquisition for the tollgates in suburban areas where traffic congestion will become an issue in near future. This service realizes simple vehicle inspection at the border crossings, and provides road or vehicle operators with the time of vehicle passage at the tollgates. Computerized toll management can vastly reduce uncollected toll revenue due to the failure in counting/classifying vehicles and can realize appropriate sharing of the toll revenue among different road operators.

Functional packages to be included in the system:

(13) Lane monitoring
(14) Vehicle/class identification
(15) Lane control
(16) Road-to-vehicle communication
(17) IC-card recording
(18) Toll data management
(19) OBU management



Heavy Truck Control

Service descriptions:

This service eliminates overloading of heavy trucks by automatic execution of vehicle weighing at interchanges. It restrains damage to the road structure and extends its durable lifetime. This service restrains congestion caused by heavy trucks and allows freight trans-port to improve safety by eliminating overloading. This service allows prompt action of the road operator at the occurrence of serious accidents caused by heavy trucks and hazardous-material trucks and appropriate vehicle operation by keeping track of the trucks on the expressway network.

Functional packages to be included in the system:

(20) Axle load measurement
(21) Axle load data management

Note: (22) Communication System, (23) Communication Ducts and (24) Base Structures are to be discussed additionally to the functional packages above.

Source: ITS Integration Project (SAPI) Study Team

3) Study Outputs

The following items are to be developed in the Study:

- Feasibility Study Report
- Basic Design Report
- Project Implementation Plan
- System Operation Management Plan
- Revision of Draft ITS Standards.

1.4 Related National Plans/Strategies and International Standards

The followings are enumerated as the related national plans/strategies for the Study:

- No.1327/QD-TTg (Decision): The Master Plan on Development of Road Transportation in Vietnam up to 2020 with a Vision towards 3030
- No.1734/QĐ-TTg (Decision): The Vietnam Expressway Network Development Master Plan toward 2020 and a vision beyond 2020
- No.140/QD-TTg (Decision): Detailed Planning on the Eastern North-South Expressway
- ITS Master Plan in “the Comprehensive Study on the Sustainable Development of Transportation System in Vietnam (VITRANSS2)”
- No.05/2011/QD-TTg (Decision): The Master Plan on Transport Development in the Northern Region up to 2020 with a Vision towards 3030
- No.1259/QD-TTg (Decision): General Planning on Construction of Hanoi up to 2030 with a Vision toward 2050.
- No.3569/VPCP-KTN (Decision): Coordination in Construction of Fiber Optic Cable Network for Expressway System
- ISO/CD 14813: Reference model architecture for the ITS sector
- ISO/IEC 11179: Information technology – specification and standardization of data elements
- ISO/DIS 14817: Transport information and control systems – requirements for an ITS/TICS central data registry and ITS/TICS data dictionaries
- ISO 14443: Contact-less IC-Card
- ISO/IEC 18092: Information technology – telecommunications and information exchange between systems – near field communication – interface and protocol (NFCIP-1)
- ITU-R M.1453: DSRC at 5.8GHz (physical layer)
- ISO 15628: DSRC application layer
- ISO 14906: Application interface definition for DSRC.

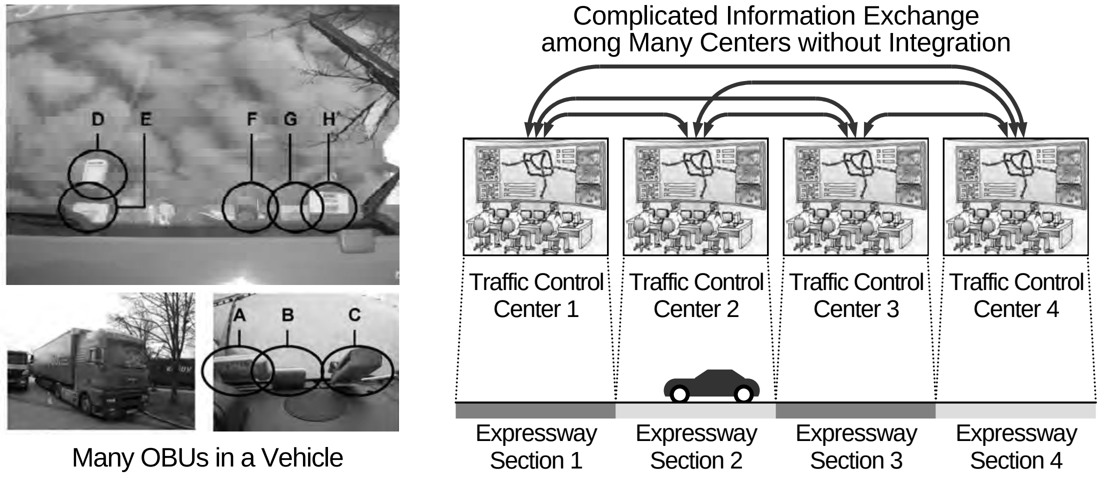
1.5 Concepts of Project

1) Integration of ITS on Target Road Network

ITS is actualized by data exchange among various centers and devices on the communication network, but an unhappy situation can occurs as shown in the figure below. Standardization and integration based on the following three concepts are necessary for reducing cost of ITS implementation accordingly:

- Connectability: to secure connection of the communication network between expressway sections constructed respectively by different owners
- Interoperability: to share the data and the data center for expressway operation among different operators
- Compatibility: to secure the way to prepare interchangeable devices through the market supported by different suppliers.

Figure 1.5 Unhappy Situation of ITS without Standard or Integration



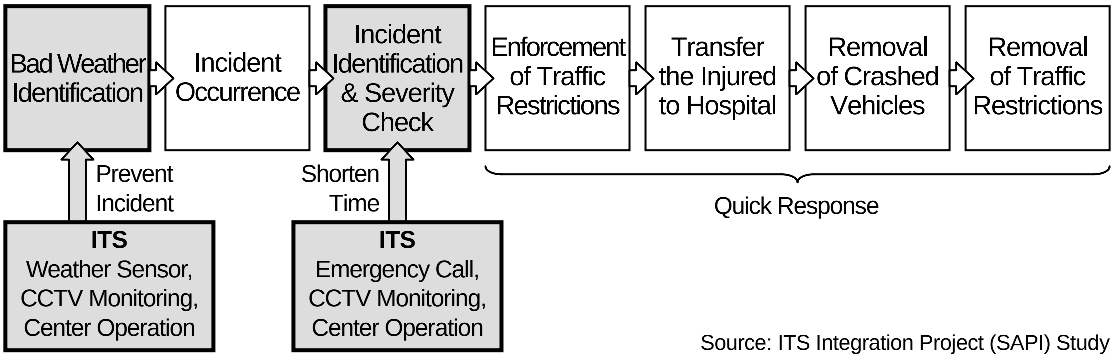
Many OBUs in a Vehicle

Source: ITS Integration Project (SAPI) Study

2) Improvement in Quick Response to Incident Occurrence

A serious incident carries off a number of human lives and paralyzes the functions of the expressway network for several hours. It is a keen issue for expressway operation to realize the quick response to incident occurrence. The project will establish measures for the quick response using ITS.

Figure 1.6 Quick Response to Incident Occurrence using ITS

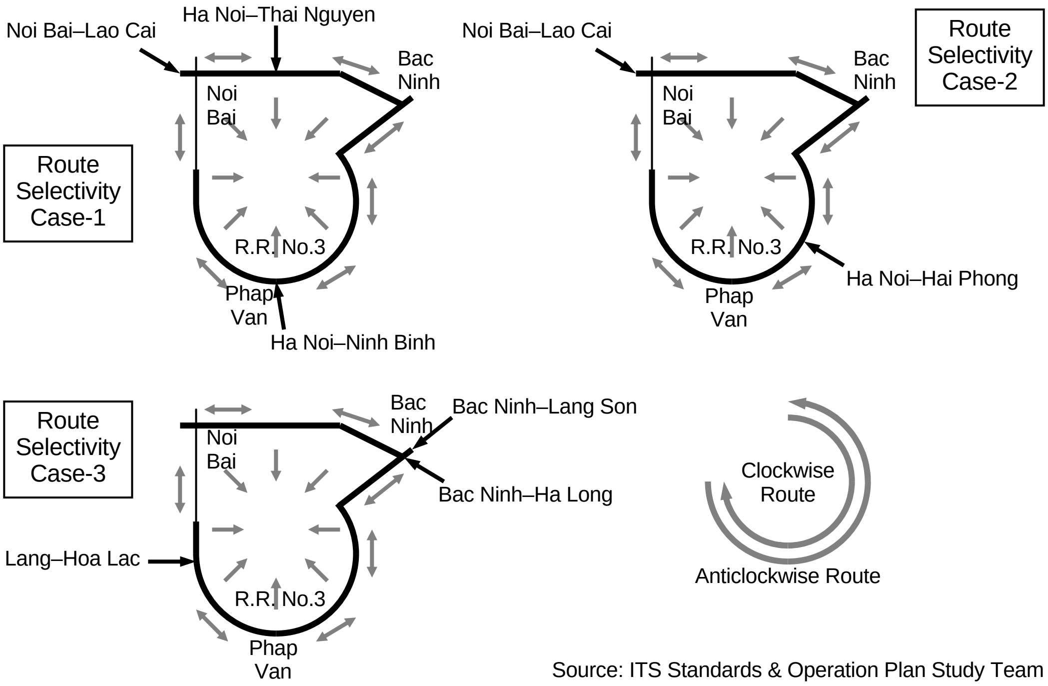


Source: ITS Integration Project (SAPI) Study

3) Increase in Route Selectivity by Introducing ITS

It is useful for traffic information/control and smooth traffic to install roadside equipment along the ring-shaped road network shown in the figures below. The installed equipment allows to disseminate information on incident occurrences or traffic congestion to the through traffic and the traffic flows into Ha Noi City from the radial roads. By this means, it becomes possible for drivers to select a clockwise or anticlockwise driving route or an exit interchange appropriately and to avoid obstructions.

Figure 1.7 Route Selectivity on Ring-shaped Road Network Equipped by ITS



Source: ITS Standards & Operation Plan Study Team

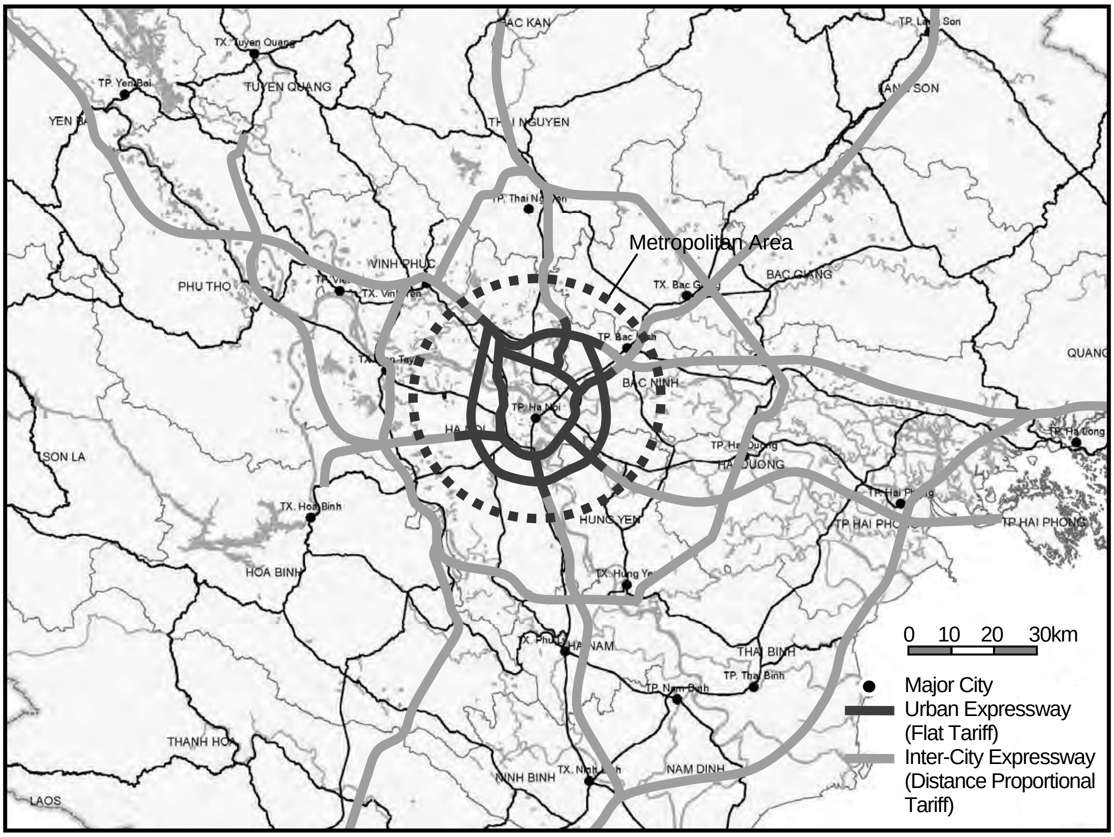
Furthermore, by introducing ETC into the tollgates located on the ramps of entrance/exit interchanges along the ring-shaped motorway and on the through lanes of radial roads, bottlenecks of the road network can be eliminated and traffic flow will get smooth.

4) Increase in Route Selectivity by Combined Toll Rate System

Application of a closed system to the expressways is defined by TCVN 5729/2007: Expressway Standard for Design in Vietnam, and introduction of a distance proportional tariff system is under consideration. The distance proportional tariff system is suitable for securing fairness among the road users corresponding to driving distances on the inter-city expressway network. However, for dispersing concentrated traffic into a reasonable volume of traffic over the wider road network in the metropolitan area, it is effective to adopt the flat tariff system.

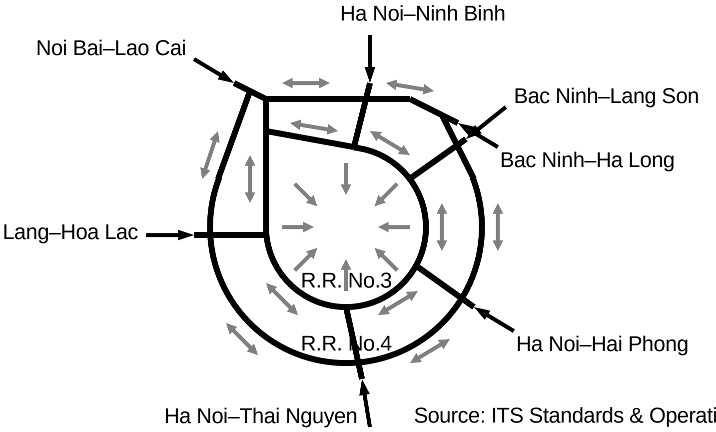
From this perspective, a combined toll rate system shown in the following figure is proposed as an ideal model for the future in Ha Noi Metropolitan Area. This system consists of the flat tariff system for the urban expressways inside of the Ring Road No.4 and the distance proportional tariff system for the inter-city expressways, and the two systems are separated by barrier tollgates located right outside of the Ring Road No.4 on the radial expressway.

Figure 1.8 Combined Toll Rate System in Northern Region



Source: ITS Standards & Operation Plan Study Team

Figure 1.9 Route Selectivity through Ring Roads No.3 and No.4



Source: ITS Standards & Operation Plan Study Team

Through installation of roadside equipment of traffic information/control system along the ring roads No.3 and No.4 and eliminating bottlenecks by introducing ETC into the tollgates at interchanges, drivers can utilize the two ring roads in combination responding to incident occurrences and traffic congestion, and the traffic volume can be dispersed.

5) Setting Up of Cooperative Management System for Road Network

The expressway network in the Northern Region mentioned in “Decision 1734/QĐ-TTg: Approving the Vietnam Expressway Network Development Master Plan toward 2020 and a vision beyond 2020” is shown with the recommended operation system in the table below.

Table 1.2 Expressway Network in Northern Region

Road Section	Length	Through lanes	Frontage Road	Parallel Road
Ring Road 3	56 km	Expressway **	Urban Artery ***	--
Ring Road 4	125 km	Expressway **	Urban Artery ***	--
Ring Road 5	320 km	Expressway **	--	--
Lang–Hoa Lac–Hoa Binh	56 km	Expressway **	Urban Artery ***	--
Phap Van–Cau Gie–Ninh Binh	83 km	Expressway **	--	NH 1 ****
Ha Noi–Hai Phong	105 km	Expressway **	--	NH 5 ****
Ha Noi–Bac Ninh–Bac Giang–Lang Son	130 km	Expressway **	--	NH 1 ****
Noi Bai–Bac Ninh–Ha Long–Mong Cai	294 km	Expressway **	--	NH 18 ****
Ha Noi–Thai Nguyen–Bac kan	90 km	Expressway **	--	NH 3 ****
Ha Noi–Viet Tri–Lao Cai	264 km	Expressway **	--	NH 2 ****
Ninh Binh–Hai Phong–Quang Ninh	160 km	Expressway **	--	NH 10 ****

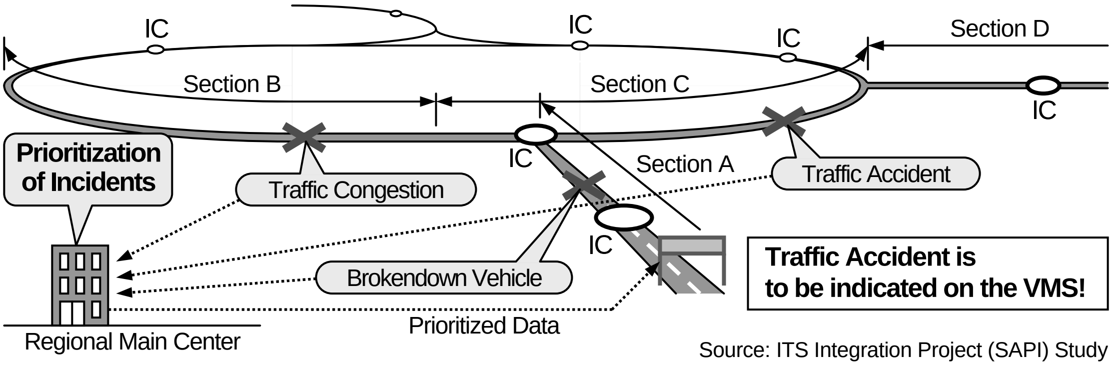
Note: **: Recommended to be operated under the Expressway Management Org. in MOT, ***: Recommended to be operated under the Ha Noi People's Committee, ****: To be operated under DRVN, NH: National highway.

Source: ITS Integration Project (SAPI) Study

Excluding Ring Road No. 5 which length remains undefined by the end of 2nd Stage of ITS Master plan, the total length of inter-city expressway network in the Northern Region of Vietnam will be around 1000 km. However, it is assumed that the expressway operation is to be shared by many different BOT investors as well as VEC. An integrated operation under a single regional main center, which covers the expressway network in the Ha Noi Metropolitan Area, is required for responding appropriately to incidents.

For example, incident information is to be provided by the regional main cener to the drivers with an total prioritization over the whole expressway network.

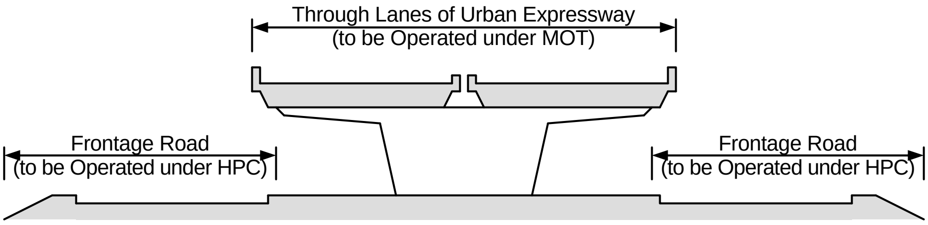
Figure 1.10 Integrated Incident Information with Prioritization



Source: ITS Integration Project (SAPI) Study

The figure below illustrates the proposal for Ring Roads No.3 and No.4 whereby the frontage roads are to be operated under Ha Noi City as urban arteries and the through lanes are to be operated under the Expressway Management Organization in MOT as urban expressways.

Figure 1.11 Cooperative Operation for Ring Roads No. 3 and No. 4



Source: ITS Integration Project (SAPI) Study

2. Approach for System Integration of ITS

2.1 General

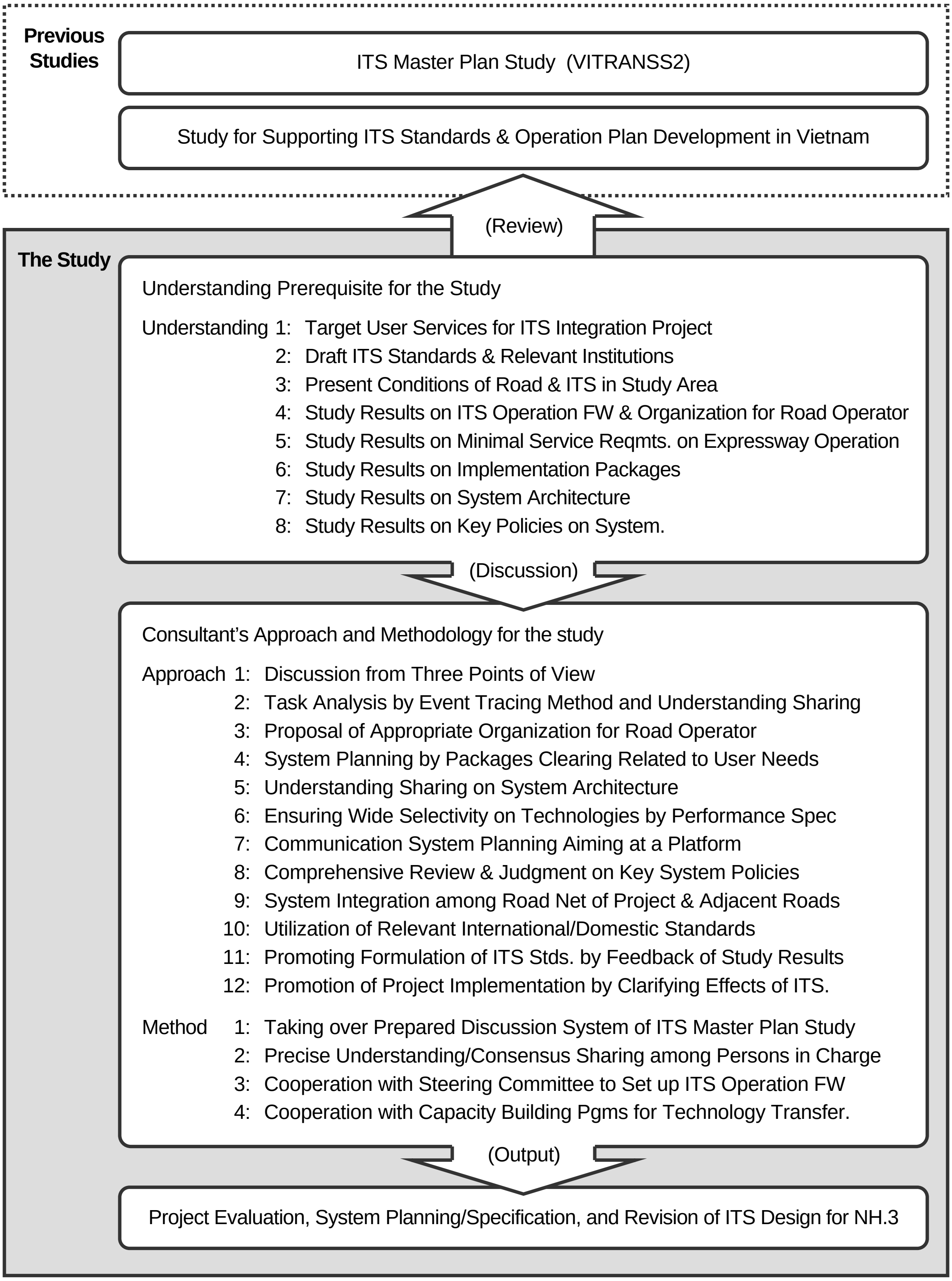
In this chapter, the following approaches are adopted for discussing the system integration of ITS in the Study:

- Three points of view for discussion
- Concept of of stepwise introduction of ITS user services
- Sharing of understanding based on system architecture
- Consideration of stepwise system implementation by package: implementation package and functional package
- Procedure for system integration among different expressway projects.

2.2 Study Procedure

The results of previous studies were reviewed first in the Study as shown in the figure below, and discussions was proceeded based on the understanding prerequisite for the Study and the consultant's approach and methodology, which were shared among the study team and parties concerned in Vietnam.

Figure 2.1 Study Procedure



ITS Master Plan Study (VITRANSS2)

Study for Supporting ITS Standards & Operation Plan Development in Vietnam

Understanding Prerequisite for the Study

Understanding 1: Target User Services for ITS Integration Project
2: Draft ITS Standards & Relevant Institutions
3: Present Conditions of Road & ITS in Study Area
4: Study Results on ITS Operation FW & Organization for Road Operator
5: Study Results on Minimal Service Reqmts. on Expressway Operation
6: Study Results on Implementation Packages
7: Study Results on System Architecture
8: Study Results on Key Policies on System.

Consultant's Approach and Methodology for the study

Approach 1: Discussion from Three Points of View
2: Task Analysis by Event Tracing Method and Understanding Sharing
3: Proposal of Appropriate Organization for Road Operator
4: System Planning by Packages Clearing Related to User Needs
5: Understanding Sharing on System Architecture
6: Ensuring Wide Selectivity on Technologies by Performance Spec
7: Communication System Planning Aiming at a Platform
8: Comprehensive Review & Judgment on Key System Policies
9: System Integration among Road Net of Project & Adjacent Roads
10: Utilization of Relevant International/Domestic Standards
11: Promoting Formulation of ITS Stds. by Feedback of Study Results
12: Promotion of Project Implementation by Clarifying Effects of ITS.

Method 1: Taking over Prepared Discussion System of ITS Master Plan Study
2: Precise Understanding/Consensus Sharing among Persons in Charge
3: Cooperation with Steering Committee to Set up ITS Operation FW
4: Cooperation with Capacity Building Pgms for Technology Transfer.

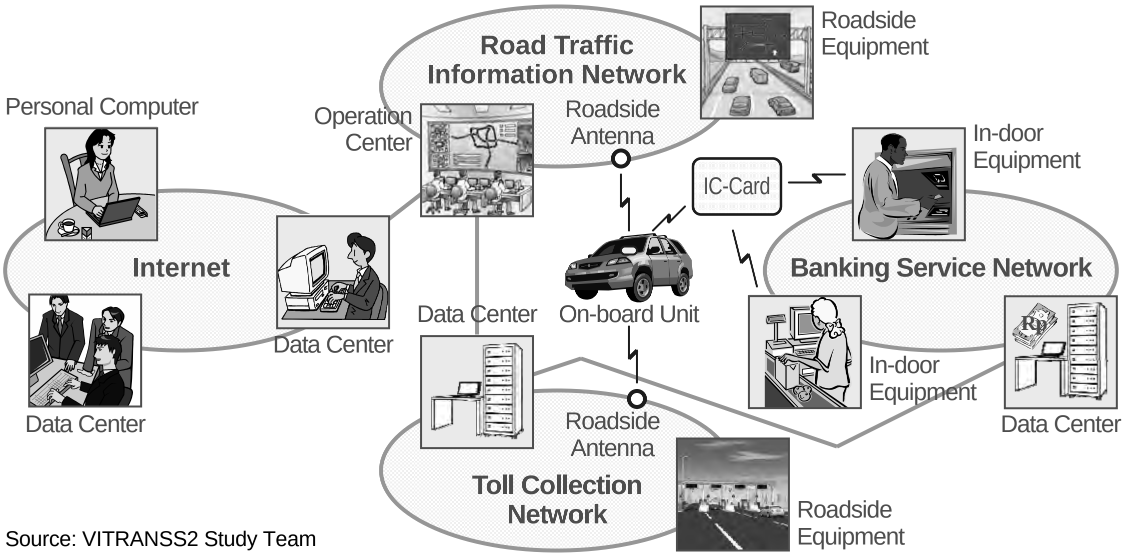
Project Evaluation, System Planning/Specification, and Revision of ITS Design for NH.3

Source: ITS Integration Project (SAPI) Study Team

2.3 Three Points of View for Discussion

ITS is realised by using communication network operated by many different organizations, as well as other information services. ITS services can be provided by exchanging required data among many pieces of equipment through the communication network.

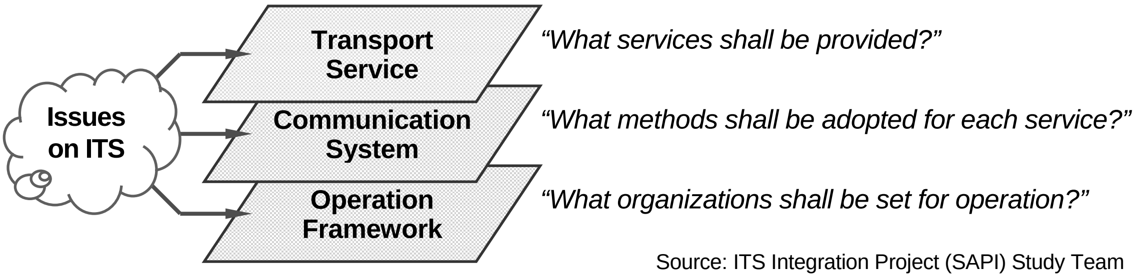
Figure 2.2 Conceptual Illustration of ITS



Source: VITRANSS2 Study Team

In the Study, issues on ITS introduction were discussed from the following three points of view: transport service, communication system and operation framework.

Figure 2.3 Viewpoints for Discussing Issues on ITS Introduction



Source: ITS Integration Project (SAPI) Study Team

Table 2.1 Discussion Items corresponding to Three Points of View

Discussion of Issues	Viewpoint of Transport Service	Viewpoint of Communication System	Viewpoint of Operation Framework
Existing Conditions of Road/Traffic/ITS	●	●	●
Basic Understanding of Total Expressway Operation	●		●
Framework of Expressway Operation using ITS			●
System Operation/Management Plan	●	●	●
Key System Policies		●	
Feasibility Study of Project	●	●	●
Location of Northern Regional Main Center		●	●
Environmental Social Consideration Study of Project	●	●	●
Basic Design of Project		●	
Project Implementation Plan	●	●	●

Source: ITS Integration Project (SAPI) Study Team

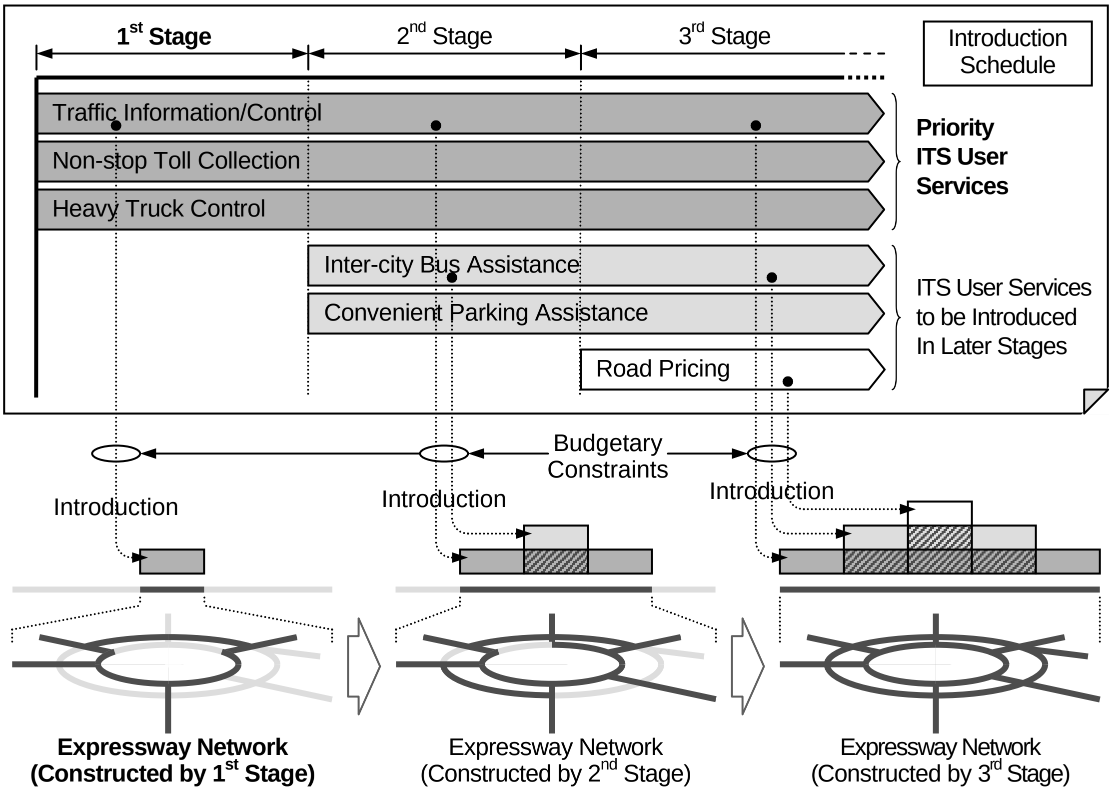
2.4 Stepwise Introduction of ITS User Services

In the ITS Master Plan, the road map has been proposed based on the time period divided into three stages (1st Stage: up to 2015, 2nd Stage: from 2015 to 2020, 3rd Stage: from 2020 to 2030).

Figure 2.4 Road Map of ITS for Inter-city Road Network

Source: VITRANSS2 Study Team

Figure 2.5 Concept of Stepwise Introduction of ITS User Services



Source: ITS Integration Project (SAPI) Study

ITS user services are to be introduced stepwise divided into three stages shown in the road map keeping pace with progress of road network construction and changes in volume/quality of road traffic and in user needs.

However, the system of ITS is to be implemented stepwise responding to smaller scale of progress and changes. For launching of stepwise implementation of ITS through the Project in the 1st stage, issues are discussed in the system planning that assuming implementation for the following reasons:

- To meet changes in needs responding to economics or traffic
- To harmonize with progress of the expressway network construction
- To meet budgetary constraints
- To respond to technological improvement

The ITS user service introduction schedule below is shown in the ITS Master Plan. The prioritised service contents to be introduced in the 1st stage are defined for the three priority ITS user services in the schedule. The ITS Integration Project is to be focused on these prioritised service contents.

Figure 2.6 ITS User Service Introduction Schedule (in ITS Master Plan)

	1st Stage 2015	2nd Stage 2020	3rd Stage 2030
Traffic Information /Control	• Incident notification assistance and information • Traffic congestion information related to incidents • Weather information • Traffic control assistance responding to occurrences of incidents • Center-to-center data exchange for traffic information and control	• Traffic congestion information • Travel-time information • Traffic control assistance	• Incident information by monitoring continuously along the roads
Non-stop Toll Collection	• Non-stop toll collection at toll island • Center-to-center data exchange for non-stop toll collection		• Non-stop toll collection on free-flow at ETC exclusive interchange
Heavy Truck Control	• Overloading regulation by automatic vehicle weighing • Center-to-center data exchange for overloading regulation	• Heavy/hazardous-material truck tracking • Center-to-center data exchange for truck tracking	
Inter-city Bus Assistance		• Bus tracking information provision • Center-to-center data exchange for bus tracking	
Convenient Parking Assistance		• Parking information provision • Center-to-center data exchange for convenient parking assistance	• Parking fee collection at highway-oasis • Integrated fee collection for park&bus-ride • Center-to-center data exchange for park& bus-ride fee collection
Road Pricing			• Cooperation with road pricing in urban areas

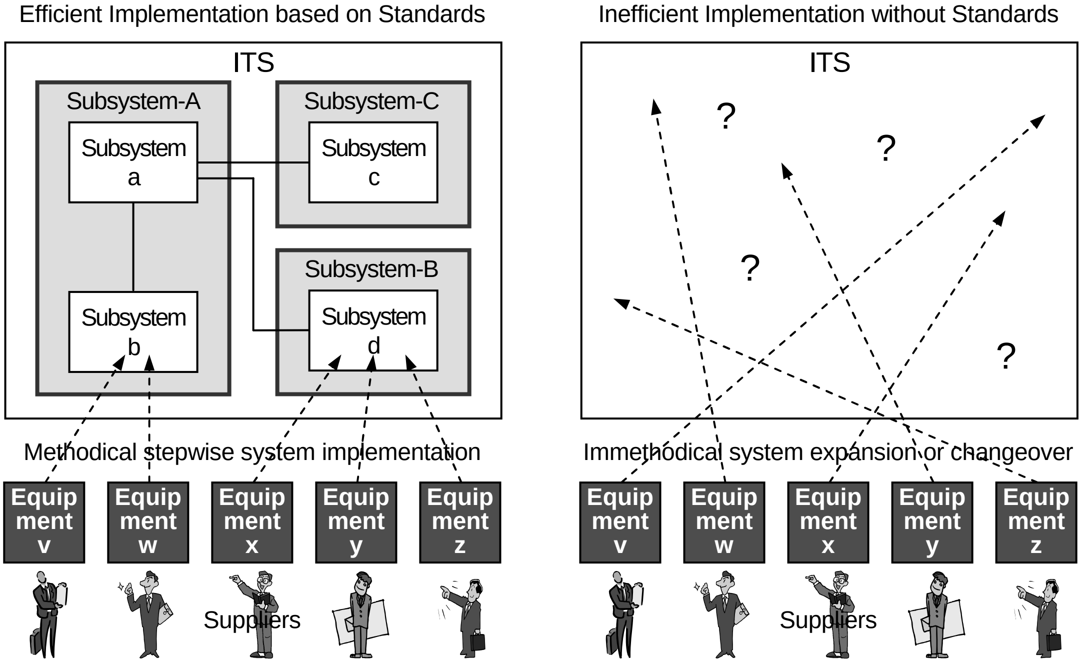
Source: ITS Integration Project (SAPI) Study Team

2.5 Understanding based on System Architecture

1) Efficiency and Outline of System Architecture

Through the ITS Master Plan Study and the Study of ITS Standards & Operation Plan, ITS has been illustrated using the system architecture consists of simple graphical symbols and texts in order to share understanding of system configuration of ITS among all persons in charge. When an unknown device is substituted for a subsystem in the system architecture by the supplier in actual implementation, appropriateness of the substitution can be verified easily and clearly in reference to the system architecture. Inheriting this method, system planning of ITS was performed in the Study aiming for what should be implemented in the Project.

Figure 2.7 Efficient ITS Implementation by Sharing Understanding



Source: ITS Integration Project (SAPI) Study Team

In the Study, the following diagrams prepared in the ITS Master Plan Study and the Study of ITS Standards & Operation Plan have been used as the system architecture. Notation of these diagrams is to conform to UML (Unified Modelling Language), which is adopted for the reference model architecture for the ITS sector shown in ISO/CD 14813.

<u>**Collaboration Diagram**</u>

This diagram indicates a system by the combination of subsystems and interfaces for sharing basic understanding of the system.

<u>**Message Sequence Diagram**</u>

This diagram indicates a sequence of exchanging messages and their data elements for making discussions on interoperability of the data.

<u>**Total System Architecture of ITS**</u>

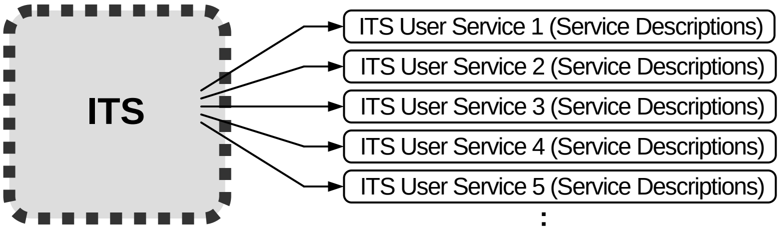
This diagram indicates an integration of collaboration diagrams for sharing understanding of the total structure of ITS and location of each subsystem in the center or on roadside.

2) Concept of Breakdown into Packages

Definition of User Needs through ITS User Services

User needs and total picture of ITS are clarified by defining and describing ITS user services.

Figure 2.8 Description of ITS User services

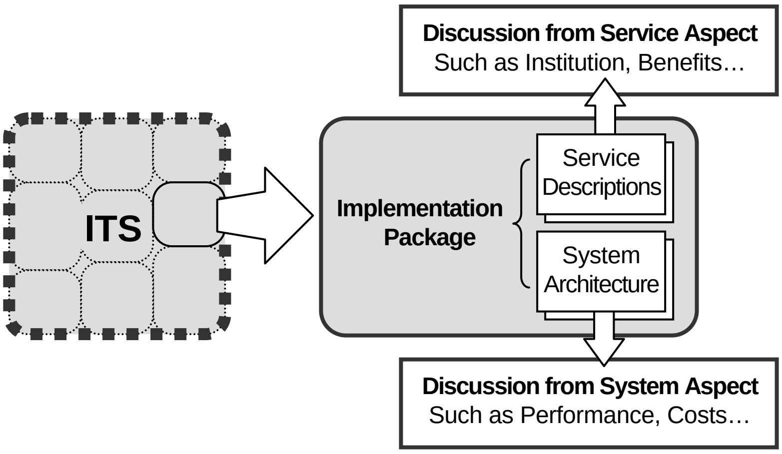


Source: ITS Integration Project (SAPI) Study Team

Definition of Implementation Package Connecting a Service to a System Architecture

Implementation packages are to be defined for stepwise implementation combining a system architecture apparently to service descriptions brokendown from the ITS user device in order to discuss ITS on a common ground from the aspects both of service and system.

Figure 2.9 Definition of Implementation Package

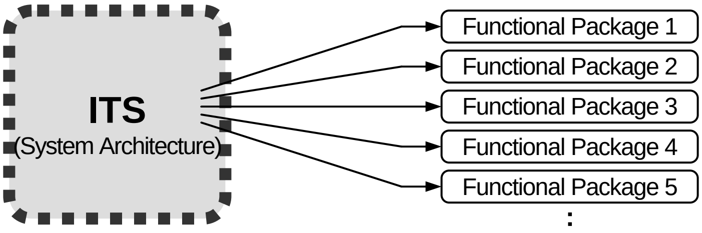


Source: ITS Integration Project (SAPI) Study Team

Detailing of a System Architecture by Implementation Packages

The system architecture is to be detailed being secgmented into packages focused on the functions of ITS.

Figure 2.10 Detailing System Architecture through Implementation Packages

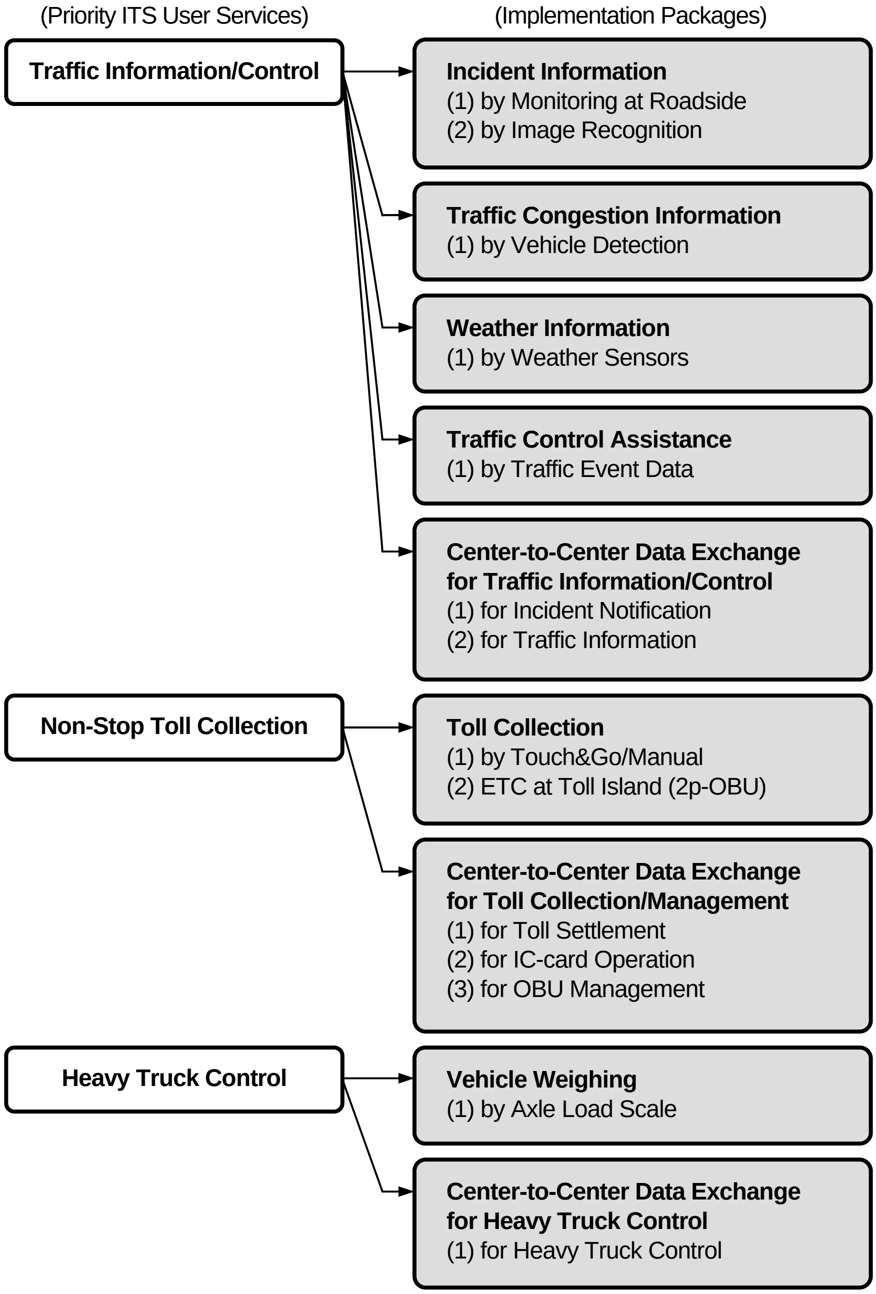


Source: ITS Integration Project (SAPI) Study Team

3) Implementation Packages

Implementation packages are to be prepared for discussing the policy of ITS introduction. In the Study, the system to be implemented in the Project is assumed to be composed of the implementation packages shown in the figure below for providing the three priority ITS user services to the road users and operators. Center-to-center data exchange is the implementation package necessary for all of the three services. Each implementation package can be actualized by one or more implementation methods.

Figure 2.11 Implementation Packages for Priority ITS User Services

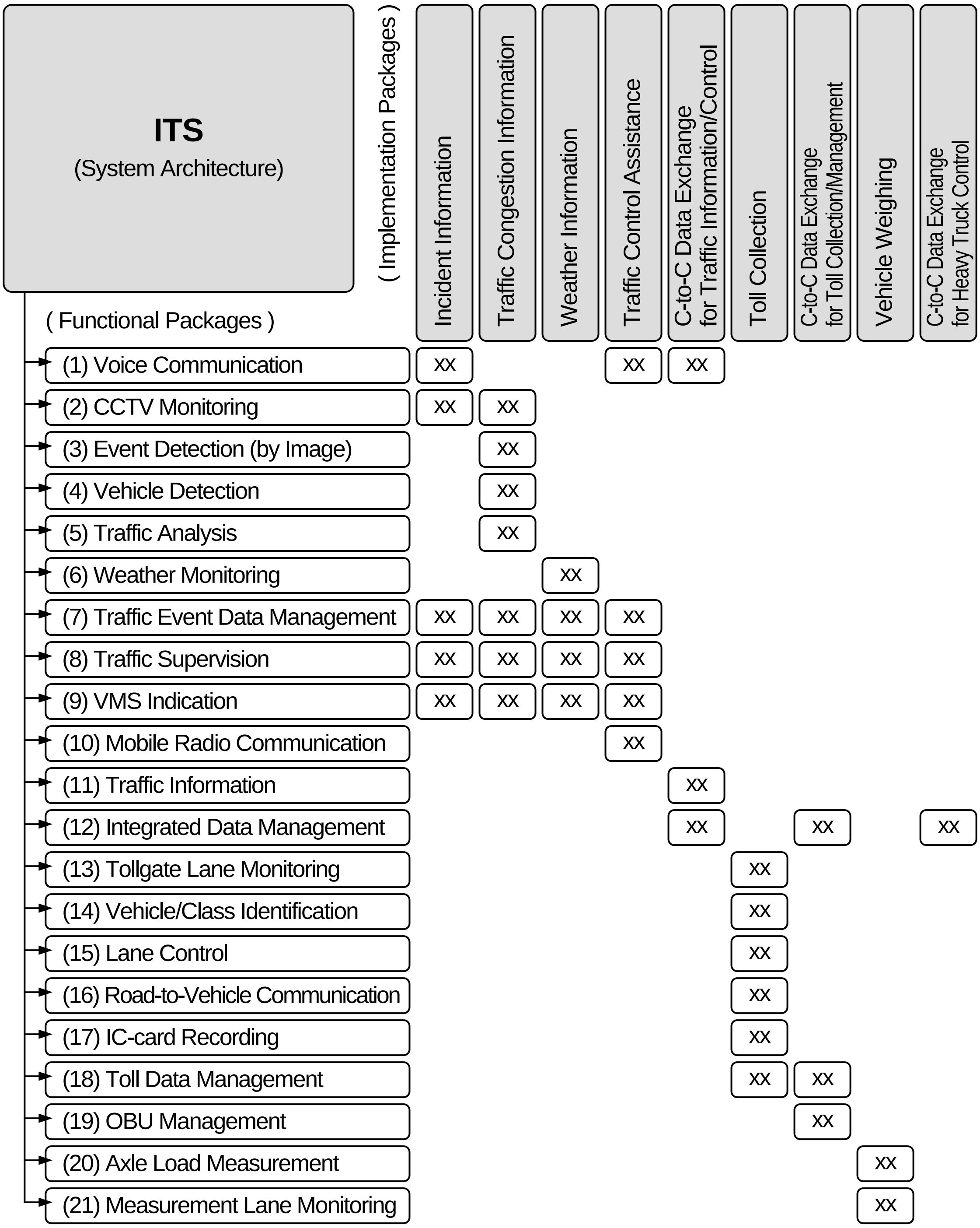


Source: ITS Integration Project (SAPI) Study Team

4) Functional Packages

As is evident from the foregoing table, the system architecture and the implementation packages of ITS are assumed to be composed of functional packages in the Study. Based on the functional packages, the roles of organizations for implementing/operating/maintaining ITS are to be discussed, the quantities required for the Project are to be calculated and the costs are to be estimated. Correspondences between the functional packages and the implementation packages aforementioned are shown in the table below.

Figure 8 Functional Packages corresponding to Implementation Packages



(Functional Packages)	Incident Information	Traffic Congestion Information	Weather Information	Traffic Control Assistance	C-to-C Data Exchange for Traffic Information/Control	Toll Collection	C-to-C Data Exchange for Toll Collection/Management	Vehicle Weighing	C-to-C Data Exchange for Heavy Truck Control
(1) Voice Communication	XX			XX	XX				
(2) CCTV Monitoring	XX	XX							
(3) Event Detection (by Image)		XX							
(4) Vehicle Detection		XX							
(5) Traffic Analysis		XX							
(6) Weather Monitoring			XX						
(7) Traffic Event Data Management	XX	XX	XX	XX					
(8) Traffic Supervision	XX	XX	XX	XX					
(9) VMS Indication	XX	XX	XX	XX					
(10) Mobile Radio Communication				XX					
(11) Traffic Information					XX				
(12) Integrated Data Management					XX		XX		XX
(13) Tollgate Lane Monitoring						XX			
(14) Vehicle/Class Identification						XX			
(15) Lane Control						XX			
(16) Road-to-Vehicle Communication						XX			
(17) IC-card Recording						XX			
(18) Toll Data Management						XX	XX		
(19) OBU Management							XX		
(20) Axle Load Measurement								XX	
(21) Measurement Lane Monitoring								XX	

Source: ITS Integration Project (SAPI) Study Team

Design specifications are to be developed corresponding to the 21 functional packages and communication system, which are outlined in the following.

(1) Voice Communication

This functional package that allows to send an emergency call and a request for help to the Main Centers and road management offices at an incident occurrence using telephones installed at roadsides, rest areas and tunnel sections and by administrative telephones installed at the toll management offices. It also allows instantly sending instructions to the units concerned for clearing incidents and enforcing traffic regulations.

(2) CCTV Monitoring

This functional package allows road operators to capture the current situation of traffic accidents, broken-down vehicles, left obstacles, driving in the reverse direction, vandalism, natural disaster and traffic conditions on the expressways and to monitor the video image at the Main Centers and road management offices by using cameras installed at road sections where traffic can get stuck easily by incidents and at long tunnel sections.

(3) Event Detection (by Image)

This functional package allows road operators to automatically recognize occurrence of traffic accidents, broken-down vehicles and left obstacles on the expressways and to send notifications to the Main Centers and road management offices by nalysing video images from cameras installed at bottleneck spots where traffic can be easily stuck and at long tunnel sections.

(4) Vehicle Detection

This functional package allows road operators to measure actual traffic volume, heavy vehicle ratio and vehicle velocity on the expressways for developing road operation/improvement plans by using vehicle detectors installed at important points on the through lanes and at the tollgates.

(5) Traffic Analysis

This functional package allows road operators to track traffic conditions on the expressways, such as crowdedness and vehicle velocity, by processing and nalysing the data captured by vehicle detectors.

(6) Weather Monitoring

This functional package allows road operators to estimate dangerous conditions for road traffic on the expressways by using data acquired by the sensors installed at the interchanges and at the road sections where undesired weather conditions frequently affect traffic safety.

(7) Traffic Event Data Management

This functional package allows road operators to conduct traffic control, regulation and information dissemination on the expressway, in a unified/integrated form, by categorizing the results (acquired through emergency telephones, mobile radio communication, event detection, traffic analysis and weather monitoring) and by organizing them as the data of traffic events specified by the place/time of occurrence and the priority.

(8) Traffic Supervision

This functional package allows road operators at the Main Center and road management office to totally supervise, visually monitor the current traffic conditions on the expressways and have the information organized as traffic events.

(9) VMS Indication

This functional package allows road operators to provide road users on the expressways with the information organized as traffic events by using VMS (Variable Message Sign) installed at locations short of entrances, exits, tollgates, junctions and tunnels.

(10) Mobile Radio Communication

This functional package allows road operators to exchange information between road operation vehicles/workers on the expressway and the road management office by using radio communication.

(11) Traffic Information

This functional package allows road operators to provide other organizations with the information organized as traffic events on the expressways through the Internet.

(12) Integrated Data Management

This functional package allows road operators to utilize acquired data such as traffic events, traffic volume, large vehicle ratio and measured axle loads of heavy trucks for developing inspection and budget plan of road maintenance and to check validity of toll revenue in comparison with traffic data.

(13) Tollgate Lane Monitoring

This functional package allows road operators to monitor current conditions of vehicle passage and operations by workers by using cameras installed in a separated lane such as a tollgate lane of the expressway.

(14) Vehicle/Class Identification

This functional package allows road operators to identify an individual vehicle by using a license plate scanner and other equipment installed in a separated lane such as a tollgate lane of the expressway.

(15) Lane Control

This functional package allows road operators to block vehicle passage without adequate toll collection by using a computer, vehicle detectors, signs and a barrier installed in a separated tollgate lane of the expressway.

(16) Road-to-Vehicle Communication

This functional package allows road operators to exchange data for toll collection and other services on the expressways by radio communication between antennas installed at roadside and on-board units installed in the vehicles.

(17) IC-Card Recording

This functional package allows road operators to deduct from prepaid balance of IC-cards for collecting toll by using equipment installed at tollgates on the expressways.

(18) Toll Management

This functional package allows road operators to maintain all data of toll collection, to manage the invalidation list on the usage of on-board units and IC-cards, and to manage toll revenue of the expressways with a high reliability by using computers and software installed in the road management office.

(19) OBU Management

This functional package allows registering of on-board units by using equipment installed in OBU issue offices, and allows to generate/manage the registration list and the invalidation list of on-board units by using computers and software installed in the OBU registration center.

(20) Axle Load Measurement

This functional package allows road operators to detect/regulate overloaded heavy trucks on the expressways by using axle load scale installed in the exit tollgate lane exclusively for large-size vehicles.

(21) Measurement Lane Monitoring

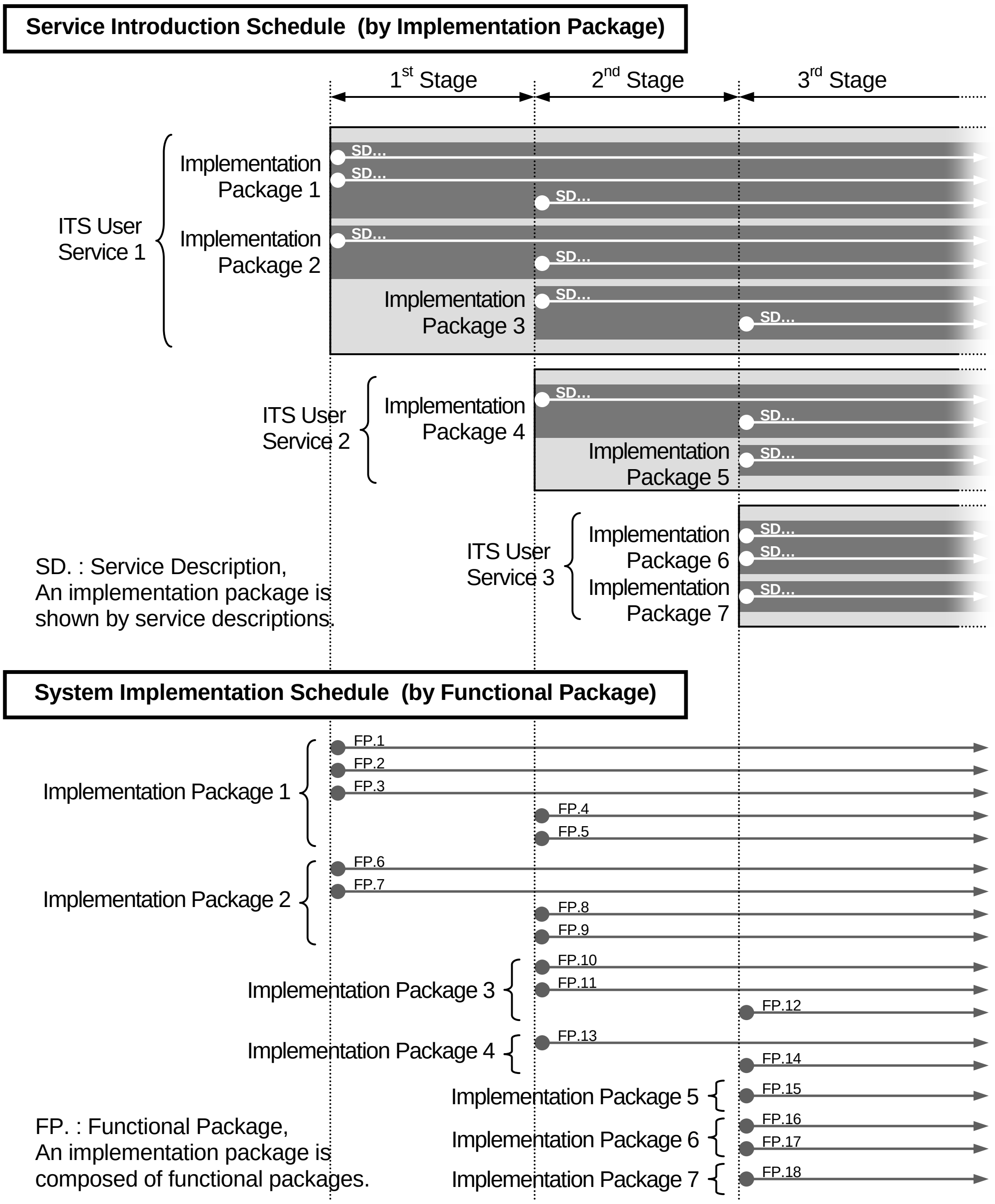
This functional package allows the road operators to monitor current conditions of vehicle passage and operations by workers by using cameras installed in a separated lane for axle load measurement of the expressway.

2.6 Stepwise System Implementation by Package

It is to be proposed in the Study to implement ITS by package for responding to the smaller scale of progress road network construction and changes in user needs. The implementation packages aforementioned are defined for this purpose. A part of ITS user service can be realized by an implementation package and the implementation package is to be composed a set of functional packages. The system of ITS is to be implemented by functional package.

Consequently, the ITS user service introduction schedule is actualized through the stepwise implementation by functional package as shown in the figure below.

Figure 2.13 Stepwise Implementation by Package



Source: ITS Integration Project (SAPI) Study Team

(1) Traffic Information/Control System

In the Study, it is assumed that stepwise system implementation for traffic information/control is to be launched in the Project based on the functional packages as shown in the figure below.

Figure 2.14 Stepwise System Implementation Schedule for Traffic Information/Control

Functional Package	1st Stage		2nd – 3rd Stage
	In the Project		
(1) Voice Communication	• Terminal installation in the Regional Main Center, road management offices and toll offices		
(2) CCTV Monitoring	• Camera installation at 2km intervals continuously along through lanes		• Camera installation at shorter intervals continuously along through lanes • Concurrent use of camera with event detection and vehicle detection
(3) Event Detection (by Image)	• Camera installation on several ramps for trial use	• Camera installation on ramps for practical use	• Camera installation around incident-prone sections on through lanes for practical use
(4) Vehicle Detection	• Detector installation at midway between a pair of interchanges on the through lanes		• Detector installation at shorter intervals continuously along through lanes • Detector installation at small intervals around congestion-prone sections on through lanes
(5) Traffic Analysis	• Estimation of traffic volume, occupancy and average travel speed		• Estimation of queue length and travel time including utilization of probe vehicles
(6) Weather Monitoring	• Sensor installation in all road management office and toll office at intervals of 20 to 40 km		• Sensor installation at shorter intervals
(7) Traffic Event Management	• Traffic control assistance based on traffic event data responding to occurrence of incidents		• Traffic control assistance based on traffic event data responding to occurrence of incidents and traffic congestion
(8) Traffic Supervision	• Traffic supervision using multi purpose large monitor screens in the Regional Main Center		
(9) VMS Indication	• VMS installation in front of entrance/exit gates and at barrier tollgates • CSS installation at 5km intervals along through lanes		• VMS installation midway between a pair of interchanges on the through lanes • CSS installation at shorter intervals along through lanes • SGM installation in front of junctions
(10) Mobile Radio Communication	• Installation for voice communication between patrol crews and road management office		
(11) Traffic Information	• Installation for providing traffic information to radio broadcasting, the Internet and mobile phones		
(12) Integrated Data Management	• System installation in in the Regional Main Center		

Source: ITS Integration Project (SAPI) Study Team

(2) Automated Toll Collection/Management System

It is assumed that stepwise system implementation for toll collection/management is to be launched in the Project based on the functional packages as shown in the figure below.

Figure 2.15 Stepwise System Implementation Schedule for Toll Collection/Management

Functional Package	1st Stage		2nd – 3rd Stage
	In the Project		
(13) Tollgate Lane Monitoring	• Camera installation on all tollgate lanes for ETC, Touch&Go and manual		
(14) Vehicle/Class Identification	• System installation for post facto toll enforcement based on current vehicle classification		• System installation for immediate toll enforcement based on revised vehicle classification
(15) Lane Control	• System installation on all tollgate lanes for ETC, Touch&Go and manual		
(16) Road-to-Vehicle Communication	• DSRC system installation at toll islands for trial use	• DSRC system installation at toll islands for practical use	• GPS/DSRC/SGM system installation for toll collection on free flow
(17) IC-card Recording	• System installation at tollgate for Touch&Go • System installation in toll offices, road management offices and a bank for prepayment		• System installation in banks and other places for prepayment
(18) Toll Data Management	• System installation in toll offices and road owner's offices		
(19) OBU Management	• System installation in the OBU management center		

Source: ITS Integration Project (SAPI) Study Team

(3) Vehicle Weighing System

It is assumed that stepwise system implementation for vehicle weighing is to be launched in the Project based on the functional packages as shown in the table below.

Figure 2.16 Stepwise System Implementation Schedule for Vehicle Weighing

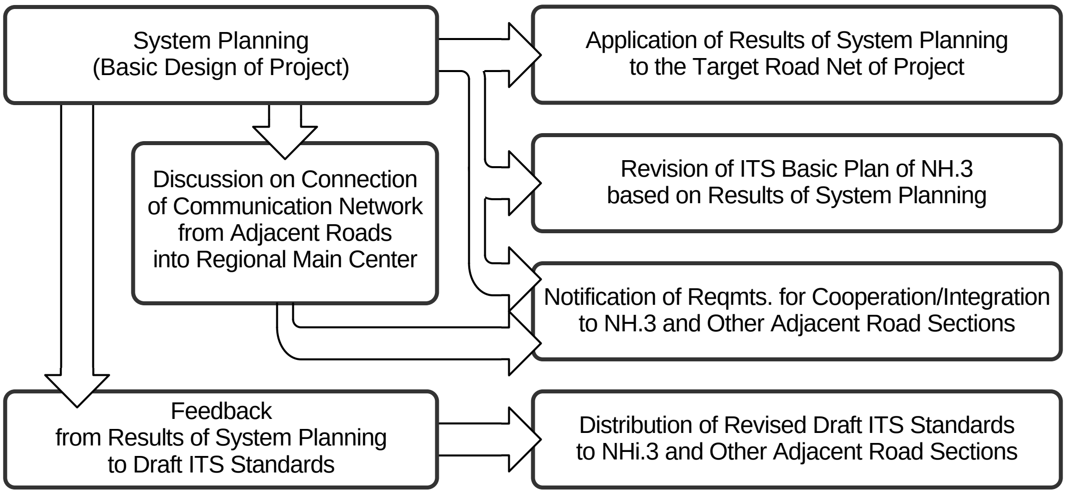
Functional Package	1st Stage		2nd – 3rd Stage
	In the Project		
(20) Axle Load Measurement	• Axle load scale installation on a Touch&Go/Manual lanes at each entrance tollgates	• Axle load scale installation on more lanes at each entrance tollgates	• Weigh bridge installation at appropriate place on through lanes
(21) Measurement Lane Monitoring	• System installation at entrance tollgates		

Source: ITS Integration Project (SAPI) Study Team

2.7 System Integration among Different Expressway Projects

In the Study, cooperation and integration of the system has been promoted by discussing harmonization among the target road network of the Project and adjacent road sections in system planning. The Draft ITS Standards has been revised by feedback from the study results and will be distributed to the National Highway No.3 and other adjacent road sections.

Figure 2.17 Procedure for System Integration among Target Road Network of Project and Adjacent Roads



Source: ITS Integration Project (SAPI) Study Team

(1) Outputs from the Basic Design in the Study are:

- To show the equipment components by showing the system architecture
- To show the specifications of equipment components and communication system
- To show the specifications of protocols, messages and data dictionary for the interfaces between equipment components.

(2) Activities in the Project Supervision are:

- To find the equipment components in the system proposed by the Contractor by making reference to the system architecture of the Basic Design
- To check the compliance of the equipment components and communication system proposed by the Contractor to the specifications of the Basic Design
- To check the compliance of the protocols, messages and data dictionary proposed by the Contractor to the specifications of the Basic Design.

(3) Outputs from the Project Implementation are:

- To revise/detail the system architecture based on the equipment components implemented
- To revise/detail the specifications based on the equipment components and communication system implemented
- To revise/detail the protocols, messages and data dictionary based on the equipment components implemented.

The ITS Standards are to be formulated based on the outputs of (3) after the Project Implementation.

3. Existing Conditions of Road/Traffic/ITS

3.1 General

The following items are surveyed as the existing conditions of the study area and the social system in Vietnam:

- Road network
- Road traffic
- Communication network and power supply
- ITS implementation and pre-existing study results
- Legal affairs relevant to ITS

Espacially road traffic data are acquired focusing on the effectiveness of traffic information for route selection on the ring shaped road of the target road network of the Project. Detailed data are shown in Appendix-1.

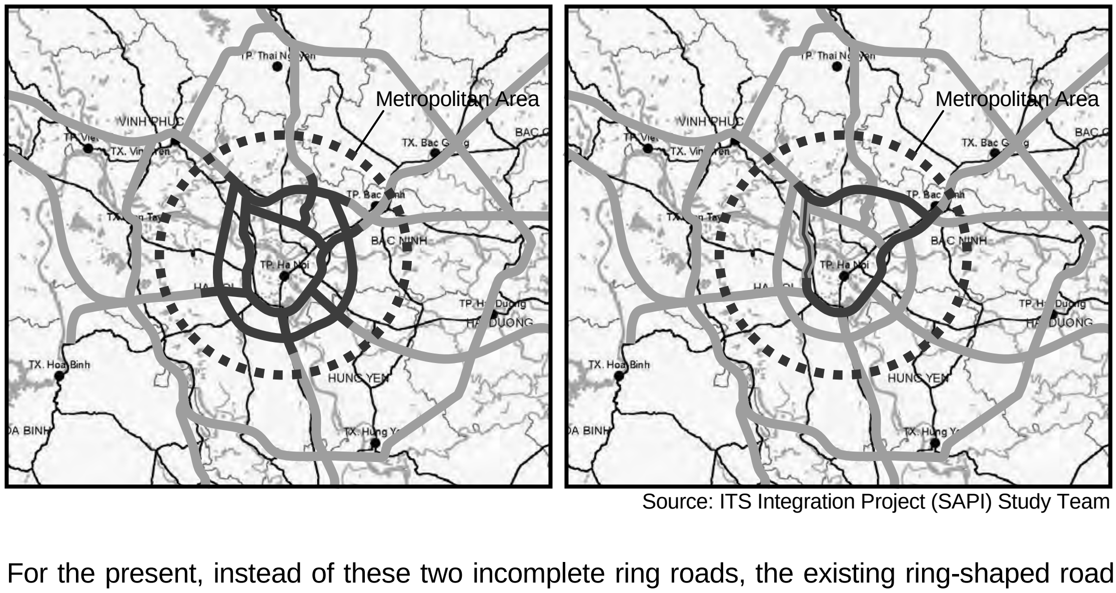
3.2 Road Network

1) Road Network and Interchanges

As mentioned in the concept of the Project in Section 1.5, combined use of the Ring Roads No.3 and No.4 is useful for securing route selectivity in case of incident occurrence or traffic congestion and dispersing concentrated traffic. That will bring the effectiveness of traffic information/control using ITS into clear view in the future.

Figure 3.1 Ring Roads around Ha Noi

(Planned Ring Roads No.3 and No.4) (Existing Ring-shaped Road Network)



Source: ITS Integration Project (SAPI) Study Team

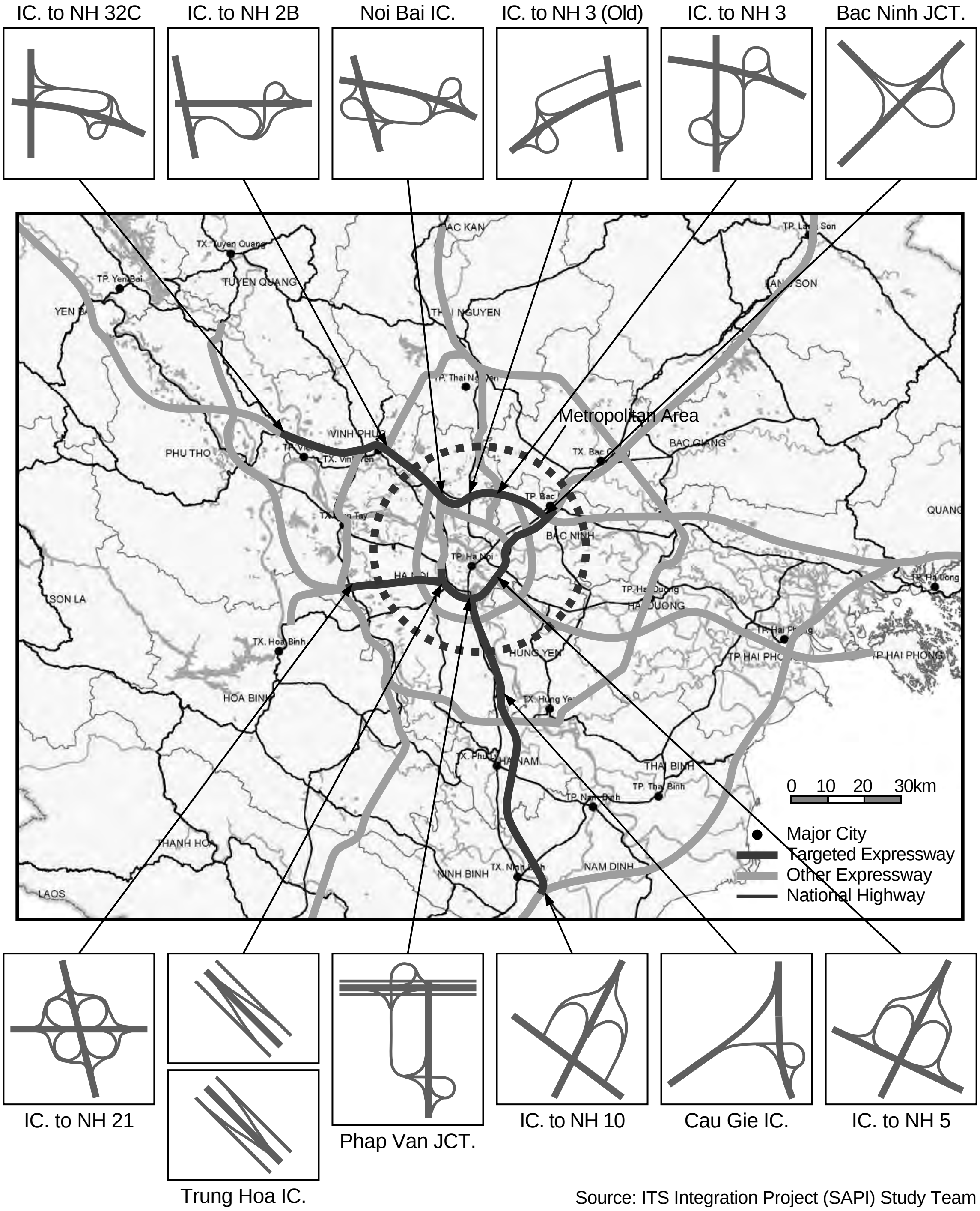
For the present, instead of these two incomplete ring roads, the existing ring-shaped road network shown in the right-hand part of figure above provides the route selectivity and as the central part of road network around Ha Noi. And the following radial expressways will be constructed and bundled by the ring-shaped road network in the immediate future.

- Lang – Hoa Lac Expressway

- Pahp Van – Cau Gie – Ninh Binh Expressway
- Ha Noi – Hai Phong Expressway
- Ha Noi – Thai Nguyen Expressway
- Noi Bai – Viet Tri – Lao Cai Expressway

The major interchanges and junctions on the target road network of the Project is shown in the figure below. The junction name is defined using the name of a major place and the interchange name is defined using the name of a major place or a connected road.

Figure 3.2 Road Network and Interchanges



Source: ITS Integration Project (SAPI) Study Team

2) Outline of Road Sections

In this section, outline of the target expressays surveyed in the Study are shown in the table.

The outline has suggested that the characteristics of expressway (especially, number of lane and road structure type) are much reflected to the scale of construction cost per kilometer, which can be said especially for the case of expressways of Mai Dich – Thanh Tri and Lang – Hoa Lac.

Table 3.1 Outline of Road Sections (1)

Expressway	**Mai Dich - Thanh Tri (Ring Road 3)**	**Lang - Hoa Lac**
Length	27 km	28 km
Design Speed	100 (km/h)	120 (km/h)
Number of Lane	-Number of Through Lanes: 4 -Number of Emergency Stop Lanes: 2	- Number of Through Lanes: 6 (with median strip) - Number of Emergency Stop Lanes: 2 - Frontage Road Lanes: 6
Major River to Pass	- Dau Bridge (To Lich River) - Thanh Tri Bridge (Red River) - Phu Dong Bridge (Duong River)	- Phu Do Bridge (Nhue River) - Day River Bridge (Day River) - Tich River Bridge (Tich River)
Characteristics of Road Structure	- Section: Mai Dich - Linh Dam: Elevated - Section: Linh Dam - Thanh Tri Bridge: Embankment	Embankment
Access Control	Full Access Control	Full Access Control
Expected Function	Expected to alleviate the existing traffic congestion and to support the future urban development outside the built-up area.	Linking Hanoi area to Hoa Lac area, where regional development related to High-tech Park, Industry Park and National University is expected in future.
Expressway	**Phap Van – Cau Gie**	**Cau Gie – Ninh Binh**
Length	30 km	50 km
Design Speed	from 60-100 upgrade to 120 km/h	120 km/h
Number of Lane	- Number of Through Lanes: 4 (or 6)	- Number of Through Lanes: 4 (or 6)
Major River to Pass	- Van Dien Bridge (To Lich River) - Tu Khoai Bridge (To Lich River) - Ha Thai Bridge (To Lich River)	About 14 bridges in total: - Duy Tien River - Chau Giang River; Day River)
Characteristics of Road Structure	Embankment	Embankment
Access Control	Full Access Control	Full Access Control
Expected Function	Expected to reduce transport cost and travel times for the movement of passengers and cargo between North to South (share traffic volume with the arterial NH.1A)	Expected to reduce transport cost and travel times for the movement of passengers and cargo between North to South (share traffic volume with the arterial NH.1A)

Source: Compiled by ITS Integration Project (SAPI) Study Team

Table 3.2 Outline of Road Sections (2)

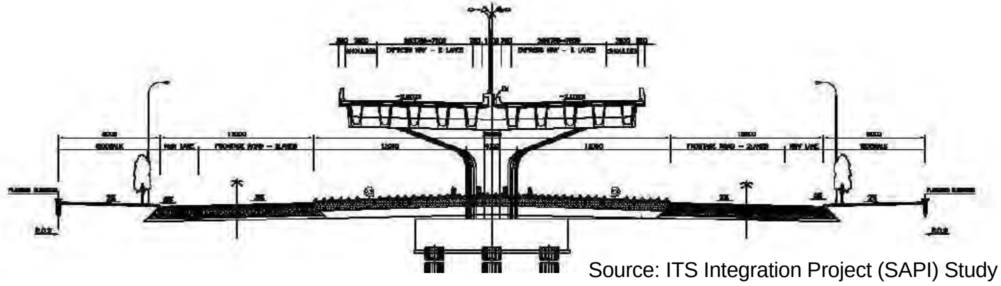
Expressway	**Ha Noi – Bac Ninh**	**Noi Bai – Bac Ninh**
Length	20 km	33 km
Design Speed	80 (km/h)	120 (km/h)
Number of Lane	- Number of Through Lanes: 4	- Number of Through Lanes: 4 - Number of Emergency Stop Lanes: 2
Major River to Pass		- Do Lo No.1 Bridge (Ca Lo River) - Do Lo No.2 Bridge (Ca Lo River) - Ca Lo Bridge (Ca Lo River) - Phong Khe Bridge (Ca Lo River)
Characteristics of Road Structure	Almost Embankment	Embankment
Access Control	Full Access Control	Full Access Control
Major Function	Expected to alleviate the existing traffic congestion and to support regional development and cargo transportation to Lang Son border with China.	Expected to alleviate the existing traffic congestion and to support regional development and cargo transport related to Noi Bai Airport and Cai Lan Port.
Expressway	**Noi Bai – Viet Tri**	
Length	80 km	
Design Speed	100 (km/h)	
Number of Lane	- Number of Through Lanes: 4 (or 6)	
Major River to Pass	About 19 bridges in total (Red River; Lo River; Pho Day River; Ca Lo River)	
Characteristics of Road Structure	Embankment	
Access Control	Full Access Control	
Expected Function	Expected to reduce transport cost and travel times for the movement of passengers and cargo between Chinese border at Lao Cai and Hanoi area.	

Source: Compiled by ITS Integration Project (SAPI) Study Team

3) Typical Cross Sections

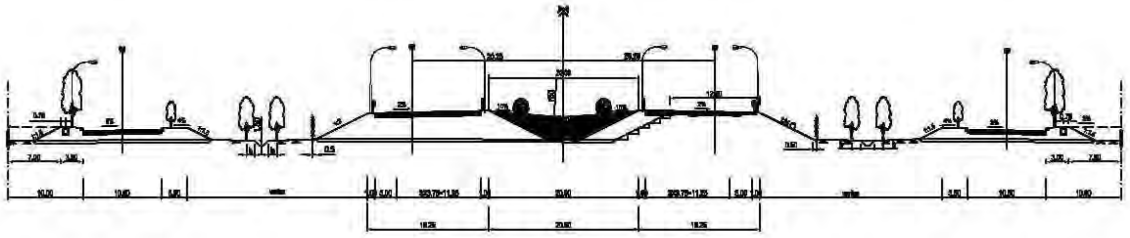
Typical cross section of each road section on the target road network is shown in the following figures. The most part of the Ring Road No.3 consists of viaducts and bridges and the other road sections are constructed mainly by earth work.

Figure 3.3 Mai Dich – Linh Dam (Ring Road 3)



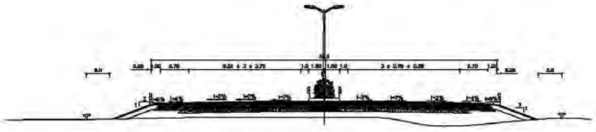
Source: ITS Integration Project (SAPI) Study Team

Figure 3.4 Lang – Hoa Lac



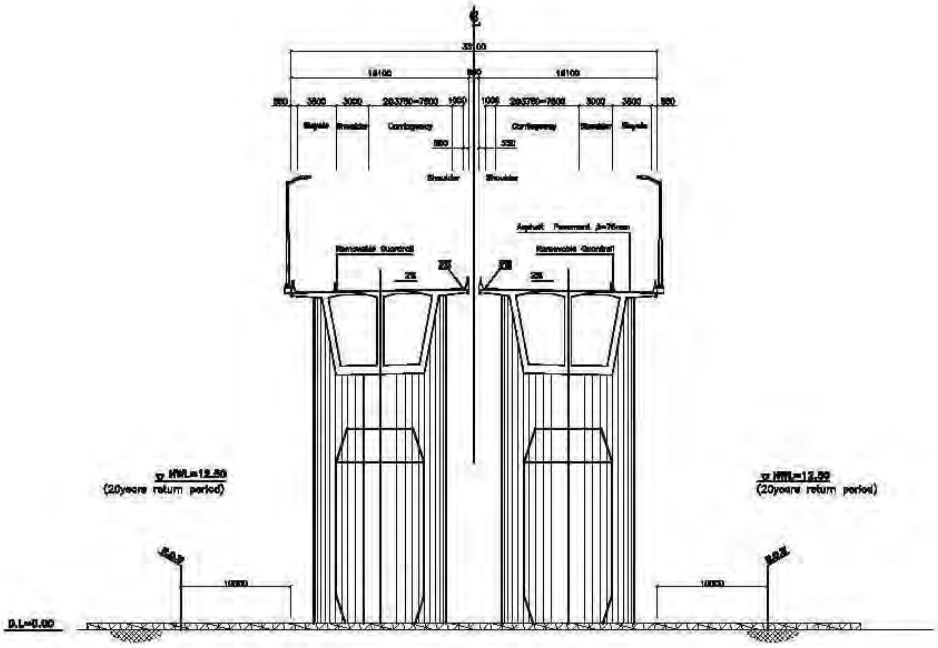
Source: ITS Integration Project (SAPI) Study Team

Figure 3.5 Phap Van – Cau Gie – Ninh Binh



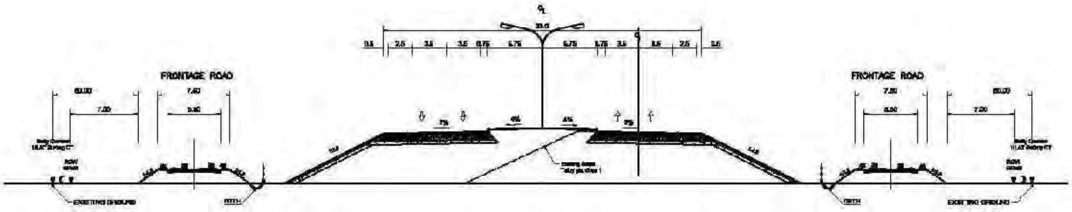
Source: ITS Integration Project (SAPI) Study Team

Figure 3.6 Thanh Tri Bridge (Ring Road 3)



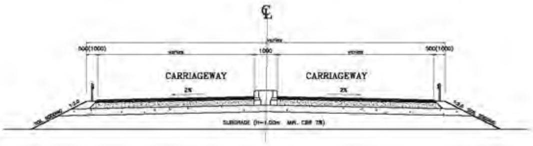
Source: ITS Integration Project (SAPI) Study Team

Figure 3.7 Ha Noi – Bac Ninh



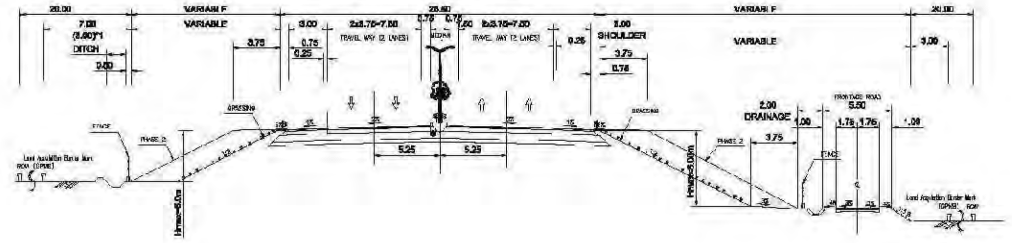
Source: ITS Integration Project (SAPI) Study Team

Figure 3.8 Noi Bai – Bac Ninh



Source: ITS Integration Project (SAPI) Study Team

Figure 3.9 Noi Bai – Viet Tri



Source: ITS Integration Project (SAPI) Study Team

4) Present Conditions on Road Network

Present conditions on the target road network are shown in the pictures below. Tollgates are located on the Ha Noi–Cau Gie Expressway, the National Highway No.1 and the 3rd ring Road. In addition, installation of CCTV cameras by traffic police has begun on the Ha Noi–Cau Gie Expressway as well as installation of VMS on the Lang–Hoa Lac Expressway and the 3rd Ring Road.

Figure 3.10 Present Conditions on Target Road Network (1)

VMS on Ring Road 3 at Mai Dich | TL of Ring Road 3 at Mai Dich | Viaduct on Ring Road 3 at Trung Hoa

Signs on Lang–Hoa Lac | Interchange on Lang–Hoa Lac | TL of Lang–Hoa Lac

Note: TL: Through lanes.

Source: ITS Integration Project (SAPI) Study Team

Figure 3.11 Present Conditions on Target Road Network (2)

Overview of Ring Road 3 Overview of Ring Road 3 Phap Van Junction

TL of Ha Noi–Cau Gie Signs on Ha Noi–Cau Gie Tollgate at Cau Gie

Mgt. Office at Vuc Vong Mgt. Office at Ring Road 3 TL on Thanh Tri Bridge

Tollgate at NH1 TL of Ha Noi–Bac Ninh Mgt. Office of Ha Noi–Bac Ninh

Bac Ninh Junction Mgt. Office of Noi Bai–Bac Ninh TL of Noi Bai–Bac Ninh

Tollgate at Noi Bai for Mai Dich Noi Bai Interchange Earth Work of Noi Bai–Viet Tri

Source: ITS Integration Project (SAPI) Study Team

3.3 Road Traffic

In Vietnam, use of expressway has begun only recently and occurrences of significant congestions have not been reported, while traffic volume has been increasing. In addition, a negative influence upon the use of expressway by collecting toll seems still large in this country. For example, it is reported that the traffic volume on the HCMC – Trung Luong Expressway, which was 32,000～35,000 vehicles/day in the period of free toll, decreased dramatically to 18,000 vehicles/day when toll collection was started.

The summary of of estimated traffic demand in the table below shows the traffic volume per lane of each section of the target road network of the Project estimated in consideration of the influence of toll mentioned above. As the results of estimates for the years 2015 and 2020 in this table, the value of the traffic volume per lane is not excess of 2,000 pcu/lane in any section and the possibility of occurred congestion is not so high. However, in order to respond to the occurrence of congestion in the future, it is extremely important to collect the data of traffic using ITS.

Table 3.3 Summary of Estimated Traffic Demand by Road Section

		Traffic Volume per Day				Traffic Volume per Peak Hour (pcu)	Traffic Volume per Lane (pcu/lane)
		Psgr.Car (Vehicles)	Bus (Vehicles)	Truck (Vehicles)	Total (pcu)		
Mai Dich - Thanh Tri	2015	15,633	6,733	12,950	58,367	7,588	1,138
	2020	25,317	9,550	16,500	82,192	10,685	1,603
Lang - Hoa Lac	2015	15,675	2,000	10,325	41,325	5,372	537
	2020	12,550	1,550	8,275	32,975	4,287	429
Phap Van - Cau Gie	2015	9,400	15,800	9,300	67,500	8,775	878
	2020	15,100	19,700	11,450	87,250	11,343	1,134
Cau Gie - Ninh Binh	2015	11,200	18,900	11,600	81,650	10,615	1,061
	2020	24,550	33,300	21,300	150,400	19,552	1,955
Ha Noi - Bac Ninh	2015	12,450	4,450	9,825	43,225	5,619	562
	2020	15,900	5,125	12,750	54,213	7,048	705
Noi Bai - Bac Ninh	2015	5,267	900	6,133	19,783	2,572	386
	2020	8,467	1,433	9,100	30,250	3,933	590
Noi Bai - Viet Tri	2015	3,767	500	900	6,817	886	89
	2020	7,533	633	1,833	12,783	1,662	166

Source: ITS Integration Project (SAPI) Study Team

Furthermore, in the Study, a survey of traffic condition was performed focused on the ring-shaped part of the target road network. The survey was carried out in the way to record data of vehicle position/speed (probe data) using the smart-phone with the function of GPS. The results are shown in the following table and figures and the details are shown in Appendix-1.

As evidenced obviously by the Table 3.4, the necessary time for a longer distance of the clockwise route is shorter than the necessary time for a shorter distance of the anti-clockwise route. At the same time, it can be observed the values of average speed of the clockwise route are between 60 and 70 km/h (excluding the result in a.m. of the Weekday 2), whereas the values of average speed of the anti-clockwise route are between 35 and 40 km/h.

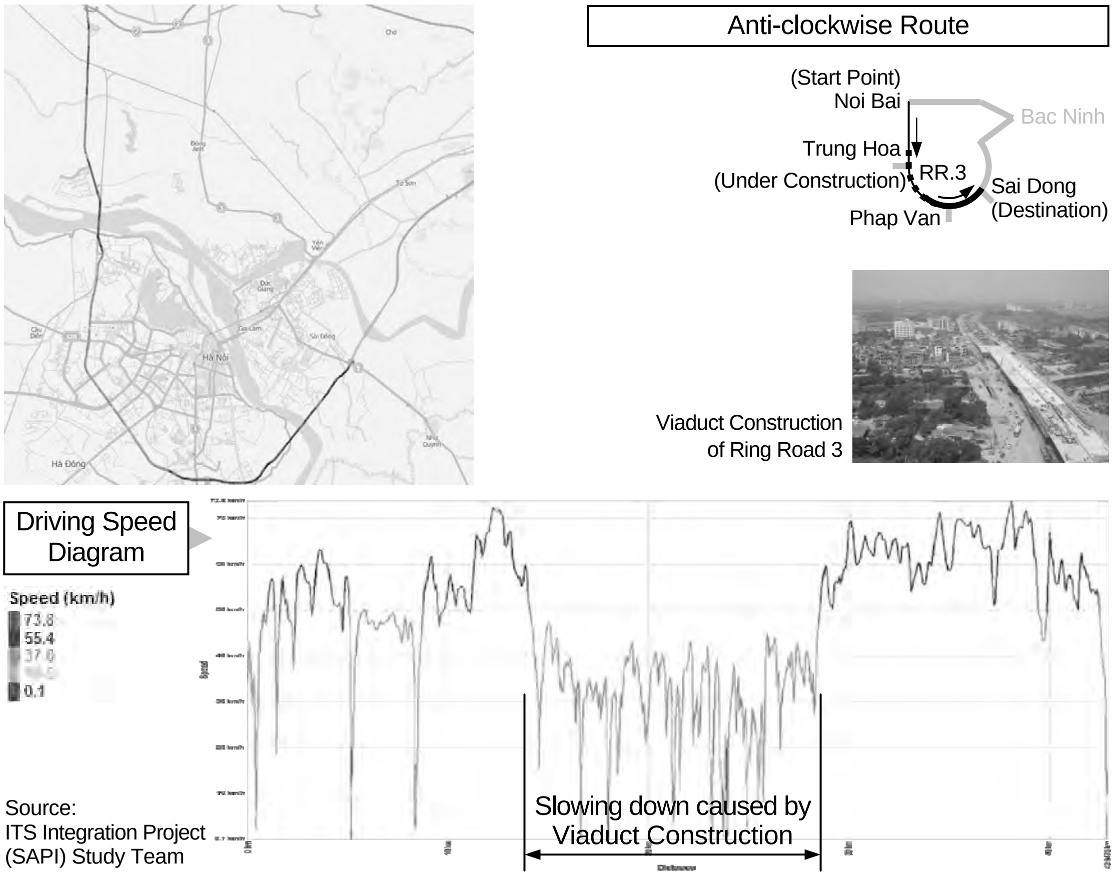
Table 3.4 Summary of Traffic Conditions on Ring-shaped Road Network

		Anti-clockwise Route (Noi Bai→Trung Hoa→Sai Dong)			Clockwise Route (Noi Bai→Bac Ninh→Phap Van)		
		Drive Distance (km)	Duration Time (min)	Average Speed (km/h)	Drive Distance (km)	Duration Time (min)	Average Speed (km/h)
Weekday 1	am	44	69	38.6	65	60	63.3
	pm		85	30.5		67	58.4
Weekday 2	am		70	37.4		106	36.8
	pm		78	33.7		58	66.7
Holiday	am		61	43.3		52	74.5
	pm		67	38.6		55	70.4

Source: ITS Integration Project (SAPI) Study Team

The prime reason of such traffic condition mentioned above is a slow speed in the section under viaduct construction on the Ring Road No. 3, which is shown by the driving speed diagram in Figure 3.12. Currently, in this section, the vehicles need to run on the existing frontage road and running speed has been significantly reduced. This condition takes place in common around the exit gates of expressways in the big cities. This fact suggest that there is a high possibility, also in Vietnam, of the occurrence of traffic congestion around the exit gates of expressways in the future.

Figure 3.12 Traffic Condition of Noi Bai→Trung Hoa→Sai Dong in the Morinig on Weekday 2



Source:
ITS Integration Project
(SAPI) Study Team

The land in the northeastern area of Ha Noi is mostly in use of agriculture and the number of trips generated in this area is not so large. Hence, the sections of Ha Noi – Bac Ninh and Noi Bai – Bac Ninh have very few traffic as shown in the picture below.

Figure 3.13 Existing Condition of Traffic in Northeastern Area of Ha Noi

(Ha Noi – Bac Ninh Section) (Noi Bai – Bac Ninh Section)

Source: ITS Integration Project (SAPI) Study Team

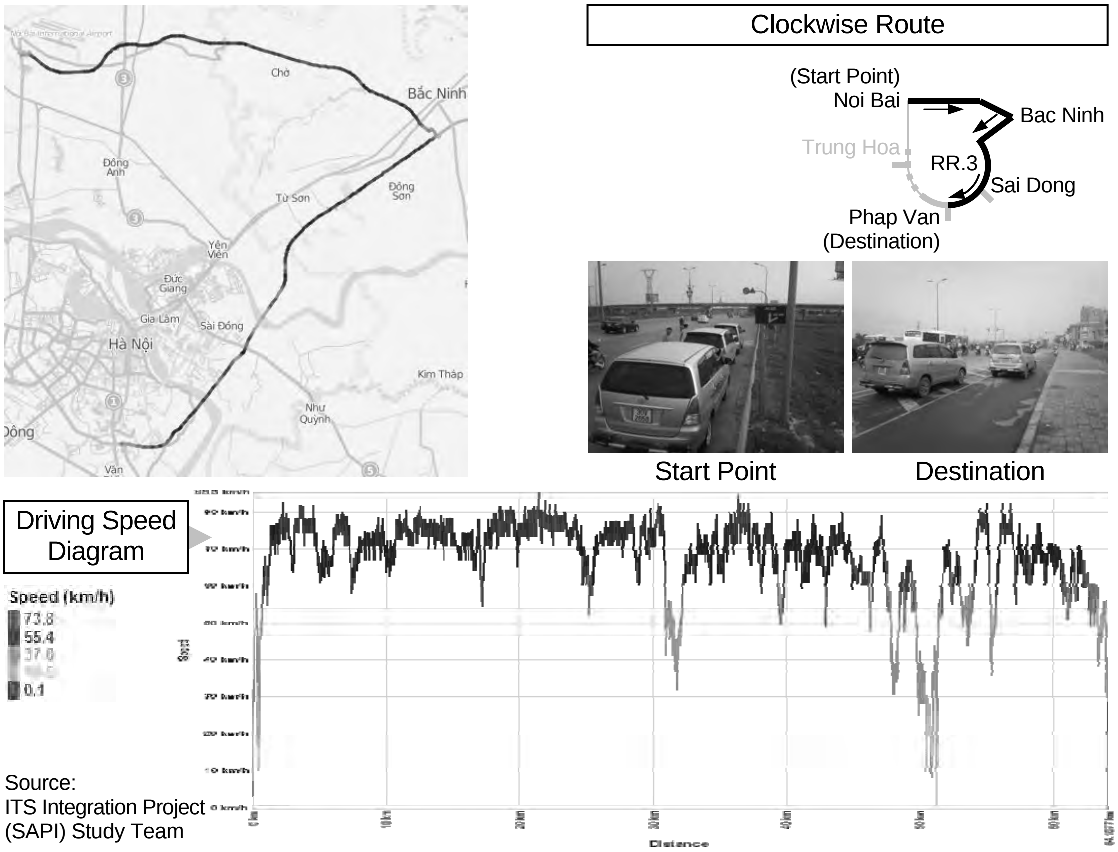
In contrast to this, the southwestern area of Ha Noi are in the midst of developing the new center of metropolis and a large number of high-rise buildings for offices and apartment, large-scale commercial establishment and hotels are being constructed. As a consequence, it has become daily routine that the trips generated this area cause crowdedness. Especially along the Ring Road No.3, the construction of the viaducts causes heavy congestion around intersections.

Figure 3.14 Existing Condition of Traffic in Southwestern Section of Ring Road 3

Source: ITS Integration Project (SAPI) Study Team

On the other hand, the situation described above has changed completely in the morning of the Weekday 2 when a serious traffic accident has occurred in the vicinity of the Phu Dong Bridge. The average speed of clockwise route falls to 36.8 km/h and the necessary time for going the destination is 106 minutes, which is nearly twice of the necessary time at the other dates. At the site of the accident, heavy truck overturned and blocked more than one lane as shown in the Figure 3.16. It is judged that reduction of average speed is obviously due to the congestion caused by the traffic accident.

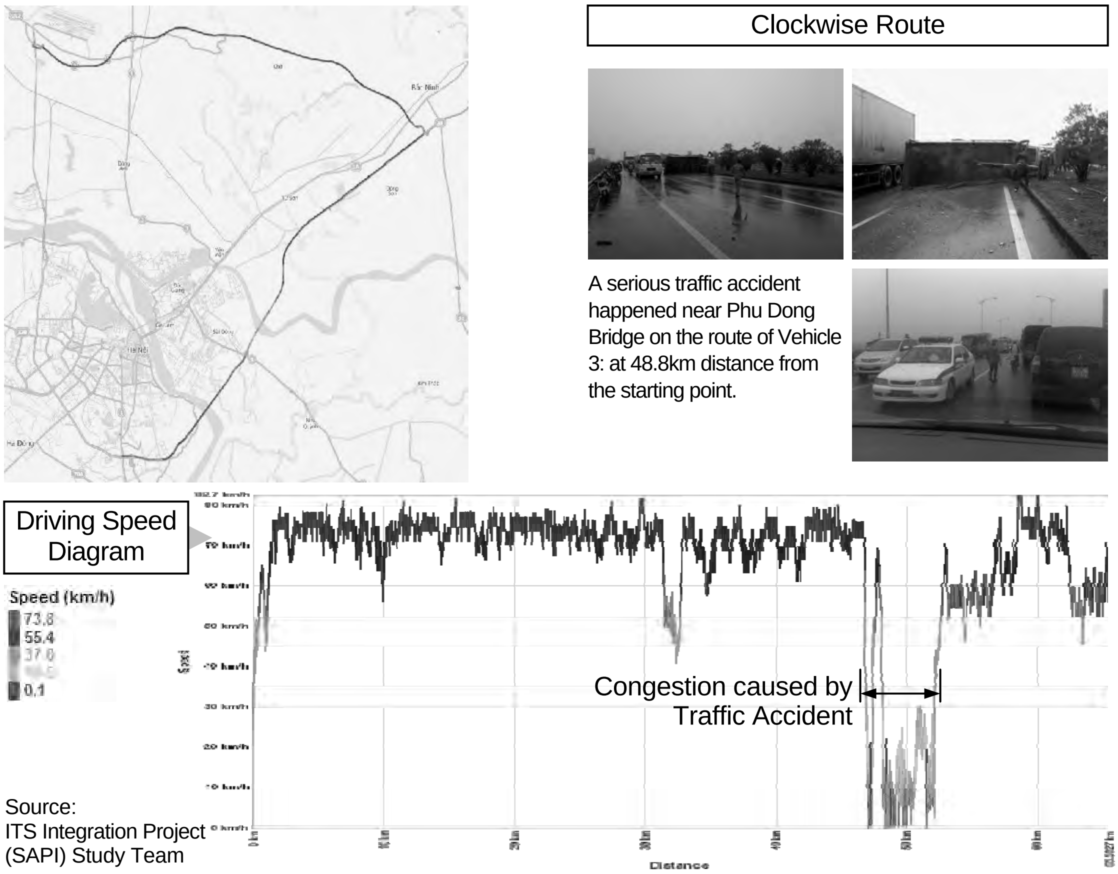
Figure 3.15 Traffic Condition of Noi Bai→Bac Ninh→Phap Van in the Morinig on Weekday 1



Start Point Destination

Source:
ITS Integration Project
(SAPI) Study Team

Figure 3.16 Traffic Condition of Noi Bai→Bac Ninh→Phap Van in the Morinig on Weekday 2



A serious traffic accident happened near Phu Dong Bridge on the route of Vehicle 3: at 48.8km distance from the starting point.

Congestion caused by Traffic Accident

Source:
ITS Integration Project
(SAPI) Study Team

Not only on the date of the survey foregoing, but frequently occur single-vehicle accidents in Vietnam. It is conceivable that such kind of acccidents are caused by the following reasons:

- Inexperience in high-speed driving
- Poor maintenance of the vehicle
- Overloading on the truck.

A traffic accident causes congestion in general and it is considerable that an ambulance is involved in the traffic congestion and is delayed in arrival at the iaccident site. Showtage of tow-cars frequently requires the supports of construction vehicles in Vietnam. The construction vehicles in the picture below was going to the accident site by reverse driving.

Figure 3.17 Traffic Accident on Thanh Tri Bridge

Source: ITS Integration Project (SAPI) Study Team

In Vietnam where the road network and detour has not been improved sufficiently, it is difficult to escape from the influence of a traffic accident while driving a vehicle like the case above. With such being the situation, it is extremely important to respond promptly to the accident and it is expected, for this reason, that significant effects on identifing quickly the accident occurrence/situation and disseminating the accident information can be achieved by ITS introduction. In addition, it goes without saying that the prompt response will contribute to reduce the number of fatalities caused by the traffic accidents.

Figure 3.18 Existing Condition of Vehicle Queueing at Tollgate

Source: ITS Integration Project (SAPI) Study Team

Congestion at the tollgates on the expressways around Ha Noi is not so serious. A reason of such condition is the small traffic volume on the expressways and another reason is the monthly tickets used by many drivers, which allow non-stop passage at the tollgates.

A large number of the heavy trucks carrying marine containers move up and down on the expressways mainly from Hai Phong to the inland areas passing by Ha Noi. It is reported that the heavy trucks commit overloading at high rates. Overloading regulation is to be considered as an urgent issue, because overloaded heavy trucks frequently cause traffic accidents by lowering in breaking force and traffic congestion by shortage of accelerating ability .

Figure 3.19 Heavy Trucks transporting Marine Containers on Expressways

Source: ITS Integration Project (SAPI) Study Team

3.4 Communication Network

On the existing expressways, communication ducts have not been installed in many sections. The communication ducts are often installed by telecommunication companies; however, it appears that the communication ducts is not get proper and sufficient maintenance.

In the case of the sections on the existing bridges, it is frequently seen that communication ducts have been attached using brackets to the hand rails as shown in the figure below

Figure 3.20 Existing Condition of Communiaction Ducts

Source: ITS Integration Project (SAPI) Study Team

3.5 ITS Implementation and Pre-existing Study Results

1) ITS Implementation

The following items were surveyed for the preparation of the Study.

- Traffic information (by Voice of Vietnam)
- VMS
- ETC

2) Pre-existing Study Results on ITS

(1) ITS Master Plan

The following items in the ITS Master Plan were reviewed for the preparation of the Study.

- Goals of ITS
- ITS user services
- Road map of ITS implementation
- Implementation packages
- Operation Framework of ITS
- Framework of Road Operation using ITS

(2) Draft ITS Standards

The following documents of the Draft ITS Standards prepared were reviewed:

- Draft ITS Design Standards (volumes organized by three priority ITS user services)
- Draft ITS Message/Data Standards
- Draft ITS Communication System Plan
- Draft ITS General Specifications (volumes organized by the functional packages).

Table 3.5 Existing Documents and Volumes of Draft ITS Standards

Draft Design Standards (3 Volumes)	(1) Traffic Information/Control (2) Automated Toll Collection/Management	(3) Vehicle Weighing
Draft Message/Data Standards (1 Volume)	Message List	Data Dictionary
Draft Communication System Plan (1 Volume)	General Communication System Plan	Design Standards of Communication System
Draft General Specifications (23 Volumes)	(1) Voice Communication (2) CCTV Monitoring (3) Event Detection (by Image) (4) Vehicle Detection (5) Traffic Analysis (6) Weather Monitoring (7) Traffic Event Management (8) Traffic Supervision (9) VMS Indication (10) Mobile Radio Communication (11) Traffic Information (12) Integrated Data Management	(13) Tollgate Lane Monitoring (14) Vehicle/Class Identification (15) Lane Control (16) Road-to-Vehicle Communication (17) IC-card Recording (18) Toll Data Management (19) OBU Management (20) Axle Load Measurement (21) Measurement Lane Monitoring (22) Communication System (23) Communication Ducts

Source: ITS Standards & Operation Plan Study Team

3.6 Legal Affairs Relevant to ITS

1) States Papers and Standards in Vietnam

For a consistency with relevant legal systems, the following state papers and standards in Vietnam were reviewed:

- No. 23/2008/QH12: Law on Road Traffic
- No.1734/QĐ-TTg (DECREE): The Vietnam Expressway Network Development Master Plan toward 2020 and a vision beyond 2020
- No.140/QD-TTg (DECISION): Detailed Planning on the Eastern North-South Expressway
- No.05/2011/QD-TTg (DECISION): The Master Plan on Transport Development in the Northern Region up to 2020 with a Vision towards 2030
- No.10/2010/TT-BGTVT (CIRCULAR/MOT): Providing for Road Administration and Maintenance
- No.11/2010/ND-CP (DECREE): Prescript the Management and Protection of Road Infrastructure Facilities
- No.07/2010/TT-BGTVT (CIRCULAR/MOT): Regulations on the Loading Capacity, Limit of Roads; Circulation of Oversized, Overloaded Vehicles & Caterpillars; Transportation of Extra-long & Extra-heavy Cargoes; and Cargoes Loading Limits of Road Vehicles in Road Traffic
- No. 90/2004/TT-BTC (CIRCULAR/MOF): Guidance Collection, Remittance, Management and Road Usage Fee
- No. 36/2009/TT-BTTTT(CIRCULAR/MOIC): Stipulating specifications and exploiting conditions of short range Radio Frequency Devices of conditional use
- National Standards TCVN5729/Draft Revision: Expressway-Specifications for Design
- National Standards QCVN 33:2011/BTTTT: Installation Standards for Telecommunications Cable (Outside Plant) **
- National Standards TCVN6909: Information technology – 16 bit coded Vietnamese Character Set **
- 34/2010/ND-CP (DECREE): Government Stipulating on Penalization due to Administrative Violations on the Field of Road Traffic **
- 06/2009/TT-BCA(C11)(CIRCULAR/MOPS): Standard of Vietnamese License Plate Number **.

Note: ** : Vietnamese version only.

2) Existing Frameworks Relevant to ITS

The following existing frameworks for road operation in Vietnam need were reviewed:

- Routine patrol & emergency care
- Incident notification and clearance
- Traffic restriction
- Ambulance service
- Traffic information
- Toll collection and data management
- Bank IC-card operation/management
- Vehicle registration
- Toll enforcement
- Overloading regulation (by vehicle-weight/axle-load measurement)

4. Basic Understanding of Total Expressway Operation

4.1 General

The discussion in the Study is focusing on the three priority ITS user services and that aims to focus on the expressway operation by using ITS. Basic understanding of total expressway operation is to be prepared in the beginning of the discussion accordingly.

In this chapter, the following items are to be discussed as basic understanding of the total expressway operation.

- Minimal Service Requirements for Expressway Operation
- Access Control of Expressway Network
- Toll Rate System for Expressway Network
- Outline of Expressway Operation

4.2 Minimal Service Requirements for Expressway Operation

1) Role Sharing on Road Operation/Maintenance

The ownership of road facilities is in a public organization; however role sharing between public and private organizations is necessary for road operation/maintenance. In the Study, role sharing through operation/maintenance concession is adopted as a premise for discussion.

Table 4.1 Role Sharing between Public and Private Organization

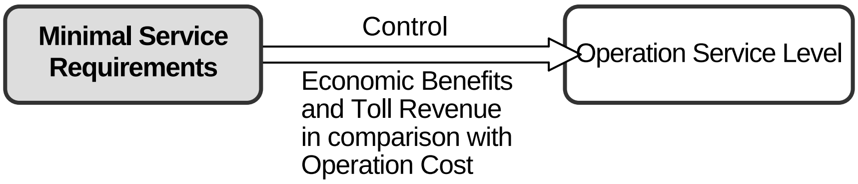
	Service Contract	Management Contract	Lease Contract	O/M Concession
Roles of Public Org.	- Ownership of road facilities - Responsibility for providing O/M service, funding capital investments and tariff setting.	- Ownership of road facilities - Ultimate responsibility for providing O/M service - Responsibility for funding capital investments and tariff setting.	- Ownership of road facilities - Responsibility for new and replacement investments, establishing performance standard and monitoring.	- Ownership of road facilities - Responsibility for establishing performance standard and monitoring.
Roles of Private Org.	- Responsibility for providing services of O/M only in working level by fee payment from public org.	- Responsibility for providing services of O/M including daily management level by fee payment from public org. - Responsibility for preparation of working capital.	- Responsibility for providing services of O/M and toll collection, and making a specified lease payment to public org. - Responsibility for working capital and rehabilitation cost.	- Responsibility for providing services of O/M and toll collection based on the concession contract - Responsibility for all capital investment as well as for working capital.
Revenue Risk	Public	Public	Private	Private
In Vietnam	--	--	--	Adopted for trial (→See Figures 5.7, 5.11)

Source: ITS Integration Project (SAPI) Study Team

2) Minimal Service Requirements for the Expressways

In order to enhance a road operator's motivation, minimal service levels required for the expressway operation shall be defined as a standard. The Minimal Service Requirements allow to control the operation service levels provided by a road operator as shown in the figure below. The operator's achievement in expressway operation is to be evaluated in reference to the Minimal Service Requirements.

Figure 4.1 Minimal Service Requirements for Controlling Operation Service Level



Source: ITS Integration Project (SAPI) Study Team

The following benefits to be provided through expressway operation shall be specified in the Minimal Service Requirements:

- Accessibility
- Mobility
- Safety & response to incident
- Environmental protection.

These benefits of expressway operation can be specified as shown in the table in the following page with reference to the ITS Master Plan. In the Study, these are defined as the Minimal Service Requirements for the discussion on ITS operation, which is to be included in the expressway operation.

In the table, the Minimal Service Requirements are described with correspondence to the services of road operation/maintenance (→See Table 4.9 and Figuer 5.7) indicated by the following symbols (a) to (e):

(a) : Road structure/facility management
(b) : Toll collection/management →Non-stop toll collection (as a priority ITS user service)
(c) : Traffic information/control →Traffic information/control (as a priority ITS user service)
(d) : Heavy truck control →Heavy truck control (as a priority ITS user service)
(e) : Communication system management.

As shown above, the services (b) to (d) are corresponding also to the three priority ITS user services aforementioned in Table 1.1.

Table 4.2 Minimal Service Requirements for Expressway Operation

Accessibility	• Establishment of appropriate access control system to expressway network: - Rejection of vehicles above the dimensional limits to reduce damage to road structure →(a) - Rejection of impermissible type of vehicles including motor bikes →(b) - Rejection of overloading heavy trucks to reduce damage to road structure →(d) - Rejection of vehicles without payment adequate for regulated toll rate →(b) • Establishment of fair and reliable toll collection system based on the latest toll rate regulation for expressway network: - Availability for any drivers who intend to use expressway network rightfully →(b) - Reliability of automated toll collection: Error ratio by frequency less than 0.0001% on checking sufficiency of prepaid balance with reference to the vehicle class defined by the regulation →(b) • Provision of sufficient vehicle processing capacity at the tollgate by non-stop and one-stop toll collection responding to traffic volume: - Non-stop toll collection at average service-time less than 4.5 sec/vehicle →(b) - One-stop toll collection at average service-time less than 9.0 sec/vehicle →(b). • Connectability of communication network in conformity with the Standards. →(e) • Inter-operability of information/data in conformity with the Standards. →(e)
Mobility	• Establishment of road management offices equipped with adequate system for monitoring traffic, patrol crews for restoring road functions and enforcing/releasing traffic restrictions and vehicles for road operation including tow car, police car and ambulance →(a), (c), (e) • Provision of smooth traffic flow by dispatching routine patrol using operation vehicles: more than 4 times a day →(a), (c) • Provision of smooth traffic flow through traffic information/control: responding to locations of the vehicle on the road network and traffic volume →(c) • Maximum speed: 120 km/hr →(c) • Lowest speed to be secured: 50 km/hr (to be not less than maximum speed –70 km/hr, otherwise coming-in traffic shall be restricted) →(c) • Average travel speed: more than 60 km/hr →(c) • Traffic surveillance and information dissemination with update intervals: 5 minutes →(c).
Safety & Response to Incident	• Establishment of adequate organization to keep road structure/facility well-maintained to secure safety for road traffic →(a), (c) • Establishment of appropriate framework to address incidents including traffic accidents notified by emergency calls (including 113 and 115) →(c), (e) • Securing of means for emergency call with a delay time less than 10 minutes from the incident occurrence even in mountainous areas →(c) • Provision of traffic safety by dispatching road operation vehicles to an incident site with a delayed time less than 1 hour from the reception of emergency call →(c) • Enforcement of adequate traffic restrictions responding to the incident occurrences and the traffic conditions →(c) • Information dissemination of incident with a delay time less than 1 hour →(c), (e).
Environmental Protection	• Promotion of installation and dissemination of non-stop toll collection →(b) • Keeping smooth traffic flow by enhancing traffic information/control →(c).

Note: (a), (b), (c), (d), (e) are to be referred to Table 4.9.

Source: ITS Integration Project (SAPI) Study Team

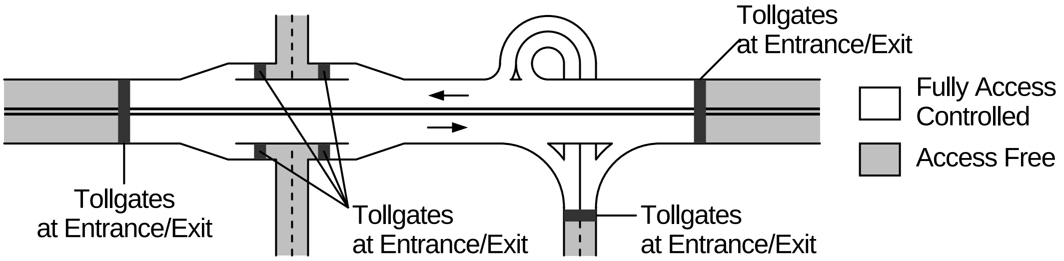
4.3 Access Control of Expressway Network

1) Typical Access Control

(1) Closed System

In this system, a road section concerned is to be separated from all other road sections by tollgates at entrances and exits as shown in the figure below. The vehicle access to the road section is fully controlled and no vehicle can come into or go out from the section without check at the tollgate. Unlawful passages, such as toll-cheating, overloading and reverse driving, can be completely rejected from the road section accordingly. If necessary, motorbikes also can be rejected from the road section. However, in the case overloading regulation is enforced in front of the entrance tollgates, large land acquisition is necessary for preparing discharge ramps for overloading vehicles.

Figure 4.2 Closed System (Full Access Control by Tollgates at Entrances/Exits)



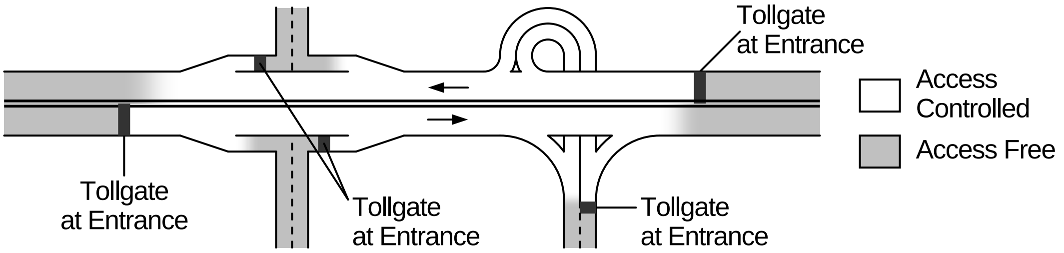
Source: ITS Integration Project (SAPI) Study Team

(2) Open System

In this system, tollgates are to be installed at entrances or exit or on the through lanes of a road section.

In the case tollgates are installed at the entrance as shown in the figure below, the vehicle access to the road section is controlled at the entrance tollgates and unlawful passages, such as toll-cheating and overloading, can be rejected. However, imprudent vehicles can come into the road section by reverse driving from the exit. And in the case overloading regulation is enforced in front of the entrance tollgates, large land acquisition is necessary as in the case of closed system.

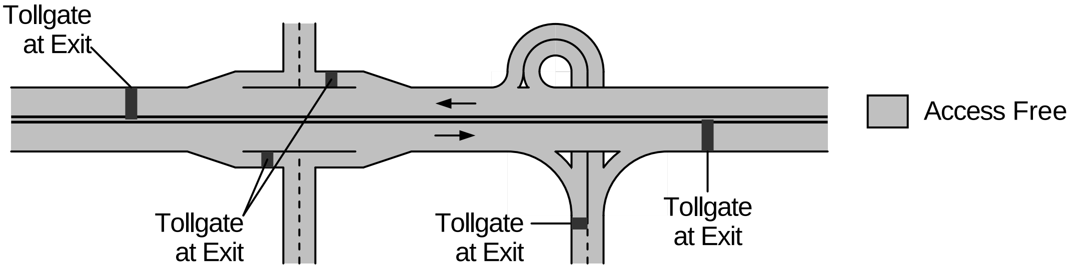
Figure 4.3 Open System (Access Control by Tollgates at Entrances)



Source: ITS Integration Project (SAPI) Study Team

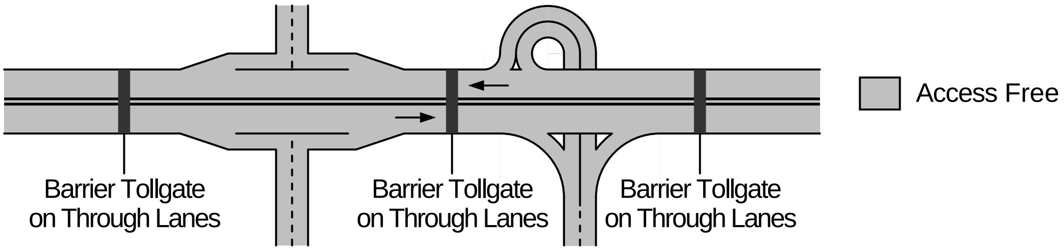
In the case tollgates are installed at the exit or on the through lanes, all vehicles including imprudent vehicles with overloading can come into and drive on the road section concerned to the exit tollgate. There is no traffic lane where access is controlled in this system and, even if necessary, motorbikes also cannot be controlled and rejected from the road section.

Figure 4.4 Open System (Access Control by Tollgates at Exits)



Source: ITS Integration Project (SAPI) Study Team

Figure 4.5 Open System (Access Control by Barrier Tollgate on Through Lanes)



Source: ITS Integration Project (SAPI) Study Team

Under present circumstances in Vietnam, the open system by the barrier tollgates on through lanes is popularly practiced.

Table 4.3 Comparison on Typical Access Control

	Closed System	Open System		
		Entrance Tollgate	Exit Tollgate	Barrier Tollgate
Access to Road Section	Fully Controlled	Controlled	Free	Free
Rejection of Toll-cheating	Capable	Capable	Capable	Capable
Rejection of Overloading	Capable	Capable	Incapable	Incapable
Rejection of Motorbike	Capable	Capable	Incapable	Incapable
Rejection of Reverse Driving	Capable	Incapable	Capable	Capable
Experiences in Vietnam	None (Only Planned)	Many (Generally for Short Section)	Many (Generally for Short Section)	Many (Generally for Short Section)

Source: ITS Integration Project (SAPI) Study Team

2) Access Control of Expressway Network

The types of access control is strongly related with the types of toll rate system, Accordingly, appropriate type of access control for the expressway network in Vietnam will be selected based on the discussion on toll rate system in the following chapter in consideration of the feature of traffic on the inter-city road network and the arteries in urban areas.

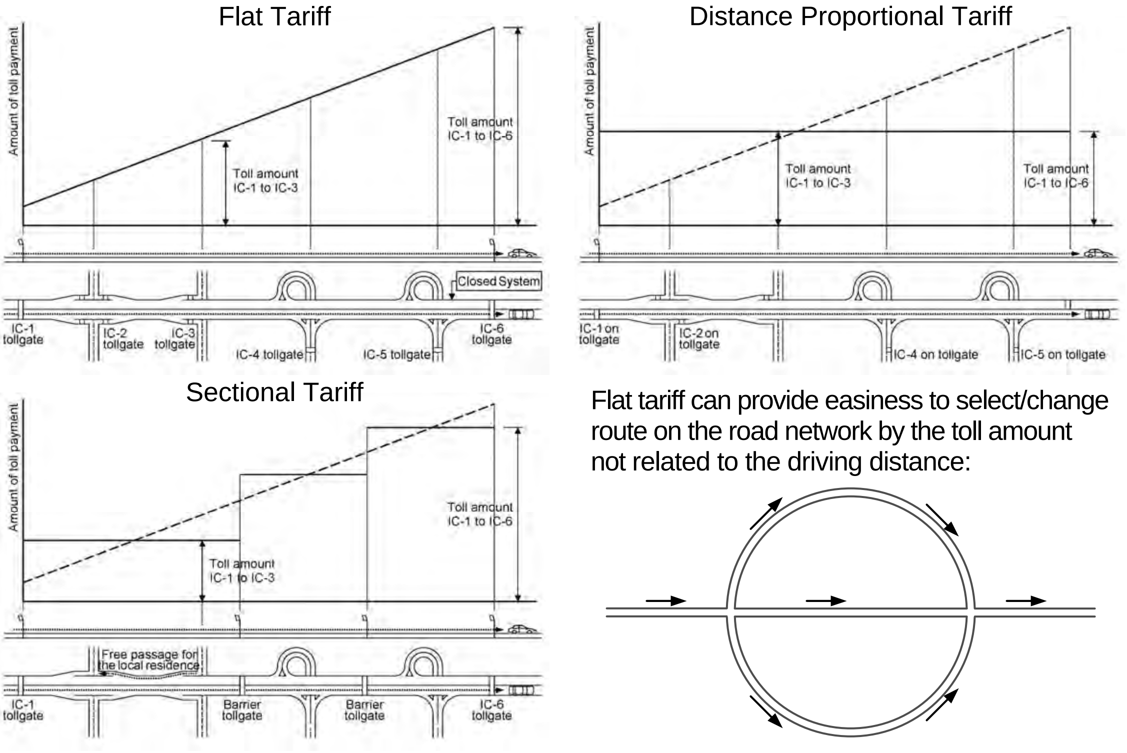
4.4 Toll Rate System for Expressway Network

Toll rate is an important budgetary constraint on the road operation/maintenance as well as construction. At the same time, it affects the arrangement of the tollgates and the roadside equipment. The following two toll rate system policies are adopted in the Study.

1) Typical Toll Rate System

Toll rate is an important precondition that should give a budgetary constraint on the road operation/maintenance as well as construction. At the same time, that affects the arrangement of the tollgates and the roadside equipment. Three typical toll rate systems below are to be taken up in the discussion.

Figure 4.6 Three Typical Toll Rate Systems



Flat Tariff

Distance Proportional Tariff

Sectional Tariff

Flat tariff can provide easiness to select/change route on the road network by the toll amount not related to the driving distance:

Source: VITRANSS2 Study Team

Table 4.4 Comparison on Typical Toll Rate Systems

	Distance Proportional Tariff	Flat Tariff	Sectional Tariff
Suitable Type of Access Control	Close	Open	Open
Need to stop on Through Lanes for Driver	Few times	Few times	Many times
Fairness for Driving Distance	Secured	Not secured	Secured
Evenness of Alternative Driving Route	Not secured	Secured	Not secured
Free Passage for Local Residents	Not available	Not available	Available
Total number of Tollgates	Large	Average	Average
Applicability to Inter-city Expressways	Suitable	Not Suitable	Suitable
Applicability to Urban Expressways	Not Suitable	Suitable	Average

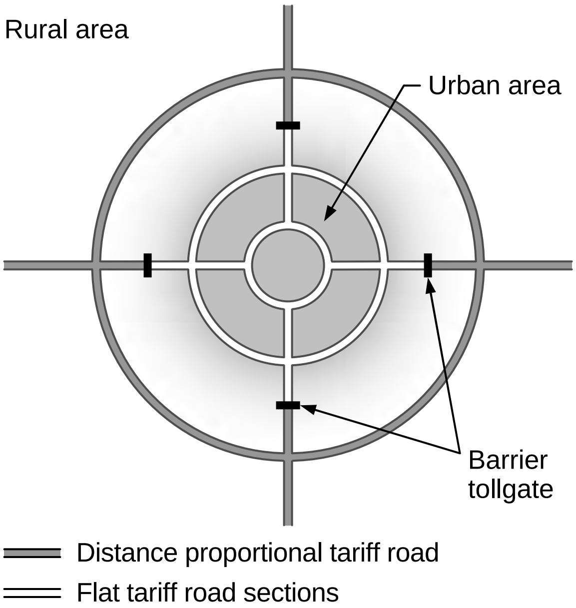
Source: VITRANSS2 Study Team

2) Toll rate System for Metropolitan Area

Distance proportional tariff is suitable for the inter-city road network in the rural area. However, in the near future, it will become main issue in urban areas in Vietnam to disperse concentrated traffic. Flat tariff will provide good effect for this purpose. On that account, a combined toll rate system shown in the figure is recommended for metropolitan areas. In many Asian countries which is characterized by huge metropolises and less-populated countryside, this combined system is already applied to major cities such as Tokyo and Jakarta.

Both the distance proportional tariff system and the flat tariff system will be discussed in the Study, accordingly.

Figure 4.7 Combined Toll Rate System for Metropolitan Area



Source: VITRANSS2 Study Team

3) Toll Rate System for Expressway Network

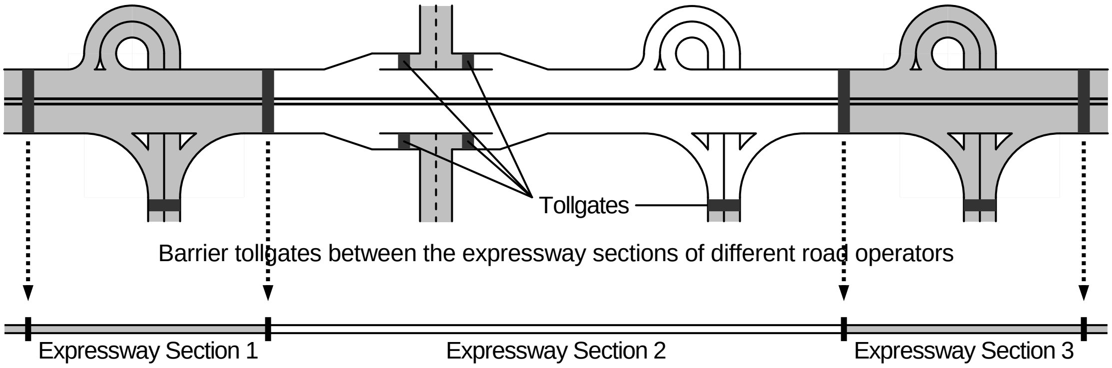
Distance proportional tariff, which provides road users with fairness for driving distance, is suitable for a wide inter-city expressway network. However, the inter-city expressway network is composed of many sections operated by different road operators in Vietnam. Such network has a difficulty in calculating toll amount to be paid by a road user who drives continuously through different expressway sections. Because a toll rate system is usually defined only for each road section and toll revenue cannot be shared clearly among relevant road operators.

There are the following two alternative methods to address this problem.

(1) Separation of Expressway Sections by Barrier Tollgates

In this method, the road sections operated by different road operators are to be separated by barrier tollgates in order to easily calculate toll amount to be paid by a road user who drives continuously through these sections and to share toll revenue clearly among the operators.

Figure 4.8 Separation of Expressway Sections by Barrier Tollgate



Source: ITS Integration Project (SAPI) Study Team

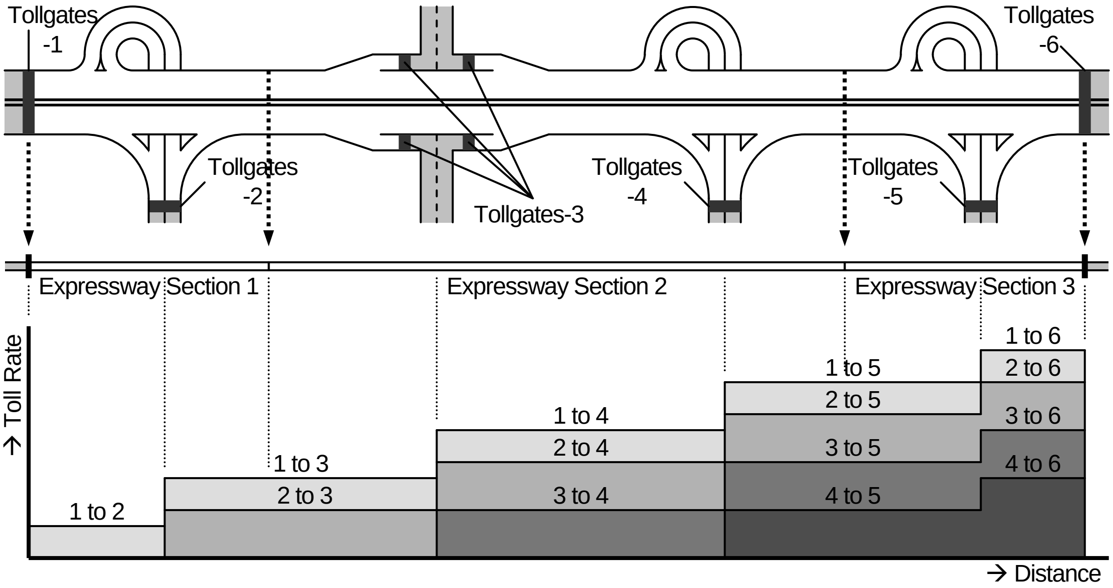
(2) Toll Rate Table for Whole Inter-city Expressway Network

A method using a toll rate table for the whole expressway network is recommended for inter-city expressway network as a premise for discussion in the Study.

In this method, a toll rate table, in which toll amounts are defined respectively for all pairs of tollgates on the whole expressway network, shall be prepared in advance. The table make it easy to calculate toll amount to be paid by a road user who drives through different sections continuously and make it clear to share toll revenue among the different road operators. And the cost for constructing barrier tollgate can be cut by use of the table.

For this method, the toll rate table shall be revised and maintained when a new expressway section comes into service. A specific organization is to be in charge of the revision and maintenance of the table. The figure below shows an example of this method applied to an expressway network consists of three adjacent sections.

Figure 4.9 Toll Rate Table for Whole Inter-city Expressway Network



Toll Rate Table		Exit					
		Tollgates-1	Tollgates-2	Tollgates-3	Tollgates-4	Tollgates-5	Tollgates-6
Entrance	Tollgates-1	--	1 to 2	1 to 3	1 to 4	1 to 5	1 to 6
	Tollgates-2	2 to 1	--	2 to 3	2 to 4	2 to 5	2 to 6
	Tollgates-3	3 to 1	3 to 2	--	3 to 4	3 to 5	3 to 6
	Tollgates-4	4 to 1	4 to 2	4 to 3	--	4 to 5	4 to 6
	Tollgates-5	5 to 1	5 to 2	5 to 3	5 to 4	--	5 to 6
	Tollgates-6	6 to 1	6 to 2	6 to 3	6 to 4	6 to 5	--

Note: A tollgate-ID is to be defined by using a pair of an expressway-ID and a number of kilometer post.

Source: ITS Integration Project (SAPI) Study Team

4) Toll Levels

Specific toll amount for the expressway network is to be defined considering the following factors:

- Costs of construction and operation/maintenance of each expressway section
- Benefits that road users can obtain by using each expressway section

- Harmonization with the tariff rates of the existing national highways and the existing inter-city buses/railways
- Financial independence/profitability of the road operator of each expressway section.

At the current stage in Vietnam, toll amount for ordinary vehicles is fixed for 10,000 VND as the flat tariff to be applied to a travel distance more than 70 km between two tollgates, which is defined by the Circular No.90/2004/TT-BTC of MOF. In addition, for the expressway network in the next stage, distance proportional tariff, which amount is around 1,000 VND/km, has been discussed among MOT, MOF and MPI.

5) Vehicle Classification

Vehicle Classification in VIETNAM

In Vietnam, vehicle classification for national highway is defined in the Circular No.90/2004/TT-BTC of MOF and vehicle classification and toll rate of epxressway is defined in the Circular No.14/2012/TT-BTC of MOF as shown below. The discussion in the Study is based on them.

The vehicle classification is defined by the combination of the number of seats and the loading capacity, focusing on the benefits provided by road use. This classification can be enforced automatically by using license plate scanners based on license plate system.

Table 4.5 Vehicle Classification in VIETNAM

Vehicle Class		Definition	Unit Toll Rate (VND/km)
Ordinary Vehicle	1	Cars with seats of 12 or less, trucks with a capacity less than 2 tons, mass transit buses	1000
	2	Cars seats between 12 and 30, trucks with a capacity between 2 and 4 tons	1500
	3	Cars with seats of 30 or more, trucks with a capacity between 4 and 10 tons	2200
	4	Trucks with a capacity between 10 and 18 tons, 20ft-container lorries	4000
	5	Trucks with a capacity of 18 tons or more, 40ft-container lorries	8000
MOD Vehicle	6	Military vehicles in the missions	0
Police Vehicle	7	Public security vehicles in the missions	0

Note, MOD: Ministry of Defence

Source: ITS Standards & Operation Plan Study Team

Vehicle Classification in INDONESIA

In Indonesia, vehicle classification by the number of axles is adopted for the toll rate system focusing on the damage by the trucks to the road structure. This classification can be enforced with simple sensors.

Table 4.6 Vehicle Classification in INDONESIA

Vehicle Class	Definition
Class I	Sedan, Jeep, Pickup truck, Small truck and Bus
Class II	Truck with 2 axles
Class III	Truck with 3 axles
Class IV	Truck with 4 axles
Class V	Truck with 5 or more axles

Source: VITRANSS2 Study Team

Vehicle Classification in MALAYSIA

In Malaysia, vehicle classification by the number of axles is adopted for the toll rate system focusing on the damage by the vehicles to the road structure. In addition, lower toll rates are prepared for the highly public buses and the taxis. This classification can be enforced with simple sensors.

Table 4.7 Vehicle Classification in MALAYSIA

Vehicle Class	Definition
Class 0	Motorcycles, bicycles or vehicles with 2 or less wheels
Class 1	Vehicles with 2 axles and 3 or 4 wheels excluding taxis
Class 2	Vehicles with 2 axles and 5 or 6 wheels excluding buses
Class 3	Vehicles with 3 or more axles
Class 4	Taxis
Class 5	Buses

Source: VITRANSS2 Study Team

Vehicle Classification in JAPAN

In Japan, vehicle classification for the toll rate system is by the combination of the number of axles, the vehicle weight and the vehicle dimensions focusing on the damage by the vehicles to the road structure and on occupancy on the road. This classification can be enforced using many kinds of sensors including treadles and vehicle detectors, and by using a license plate scanner based on the license plate system.

Table 4.8 Vehicle Classification in JAPAN

Vehicle Class	Definition
Light Vehicle	Light vehicle /Motorcycle
Ordinary Vehicle	Small size vehicle (excluding light vehicle and motorcycle) /Sedan /Light tractor with trailer (which has an axle)
Medium Vehicle	Small bus with 11 to 29 seats and a weight less than 8 tons /Truck with a weight less than 8 ton and axles of 3 or less /Light tractor with trailer (which has 2 or more axles) /Tractor with trailer (which has an axle)
Large Vehicle	Bus with 30 or more seats or a weight more than 8 tons, and a length less than 9 m /Truck with a weight of 8 to 25 tons and axles of 3 or less /Tractor with trailer (which has 2 or more axles) /Large tractor with trailer (which has an axle)
Extra Large Vehicle	Bus with 30 or more seats, a weight more than 8 tons, and a length more than 9 m /Truck with axles of 4 or more /Large tractor with trailer (which has 2 or more axles) /Large construction vehicle

Source: VITRANSS2 Study Team

Vehicle Classification assumed for Study

For discussion in the Study, it is assumed that the vehicle classification is based on the Circular No.90/2004/TT-BTC of MOF.

However, it needs to be brought into view that new vehicle classification has been discussed among MOT, MOF and MPI for the expressway network in the next stage. The new vehicle classification is to be realized by using simple sensors, such as a license plate scanners and an axle load scale, for cutting costs. For example, the vehicle classification responding to the vehicle weight can be realized only by counting the number of axles without equipment for vehicle weight measurement.

4.5 Outline of Expressway Operation

1) Services of Road Operation/Maintenance

Based on the minimal service requirements, the operator is to provide the services shown in the table below. It is assumed as a premise for discussion in the Study that ITS is to be applied to a part of the road operation, which includes road structure/facility management, toll collection/management, traffic information/control and communication system management.

Table 4.9 Services of Road Operation/Maintenance

Operation	Maintenance
(a) Road Structure/Facility Management Cleaning-up, green space management, disaster recovery, energy and water supply and checkups of structure and facility in order to secure safety and comfort in road use.	Maintenance for restoring structure and facility to their original state of function and performance. - Pavement - Bridge - Tunnel - Semi-underground structure - Architectural structure - Mechanical equipment - Electrical equipment.
(b) Toll Collection/Management Toll collection from the road users and its management.	
(c) Traffic Information/Control (d) Heavy Truck Control Routine patrol, regulation against illegal vehicles and traffic control for safe/comfortable drive and smooth traffic flow.	
(e) Communication System Management Fiber optic cable network system operation and management	

Applicable Scope of ITS

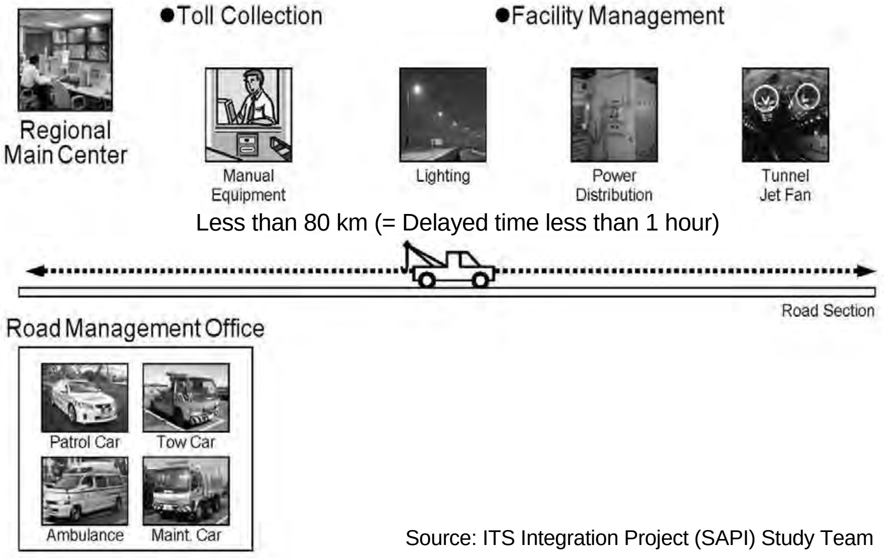
Source: ITS Integration Project (SAPI) Study Team

A single organization can be in charge both of construction and operation/maintenance of the road section; however, some parts of the work can be transferred to the other organization under contract.

2) Facilities and Offices for Road Operation

The services of road operation are actualized through many kinds of facilities and vehicles as shown below.

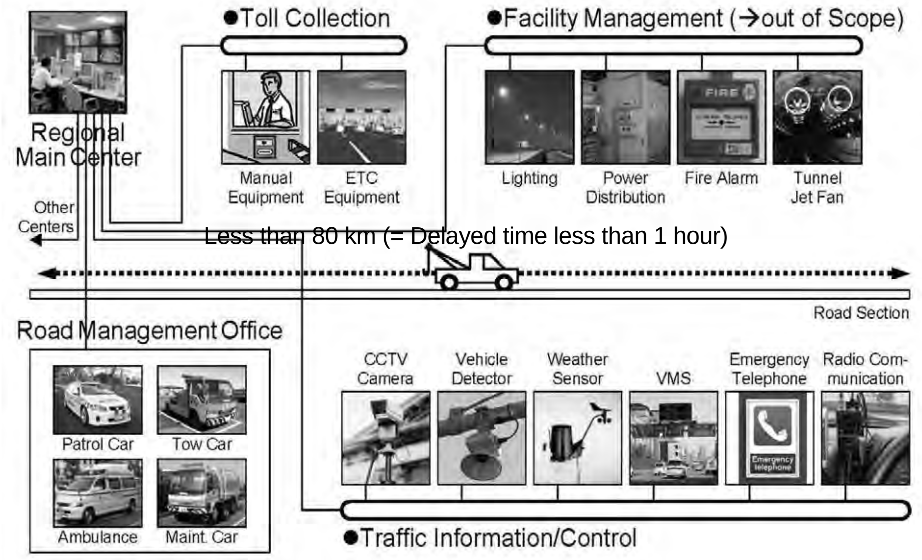
Figure 4.10 Illustration of Basic Road Operation



Source: ITS Integration Project (SAPI) Study Team

On the other hand, advanced method of road operation, which allows proper judgment and prompt action, is based on ITS and is supported by data exchange through a communication network.

Figure 4.11 Illustration of Advanced Road Operation Using ITS



Source: ITS Integration Project (SAPI) Study Team

A border of the road management office jurisdiction is to be located at a location of the interchanges arranged at 15 km intervals on the expressway network. And according to the minimal service requirements, the travel speed of a vehicle is more than 50 km/h and less than 120 km/h on the one-way lanes and an operation vehicle needs to be dispatched and arrive at an incident site within less than 1 hour from the reception of emergency call.

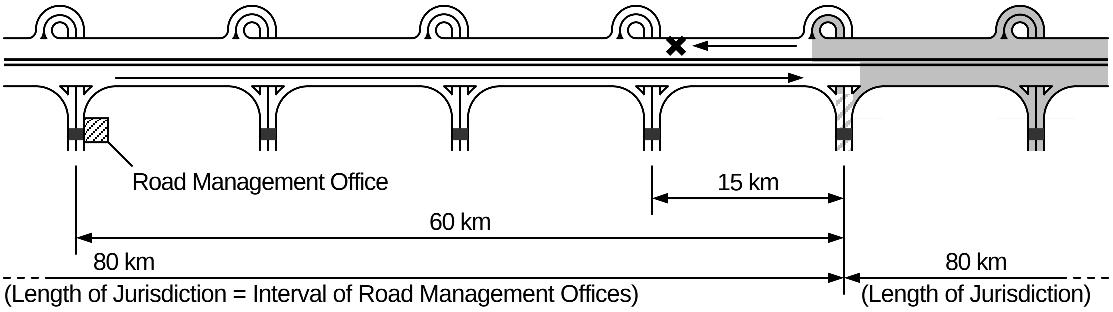
3) Location/Structure Outline of Offices

On the conditions above, it is required that the maximum interval of the road management offices on the expressway network is less than 120 km as calculated below.

Maximum interval of road management offices = 120 km = ((100+50) / 2 –15) x 2

In the Study, the interval of the road management offices is assumed as 80 km considering disproportionate location of the road management office within the length of its jurisdiction.

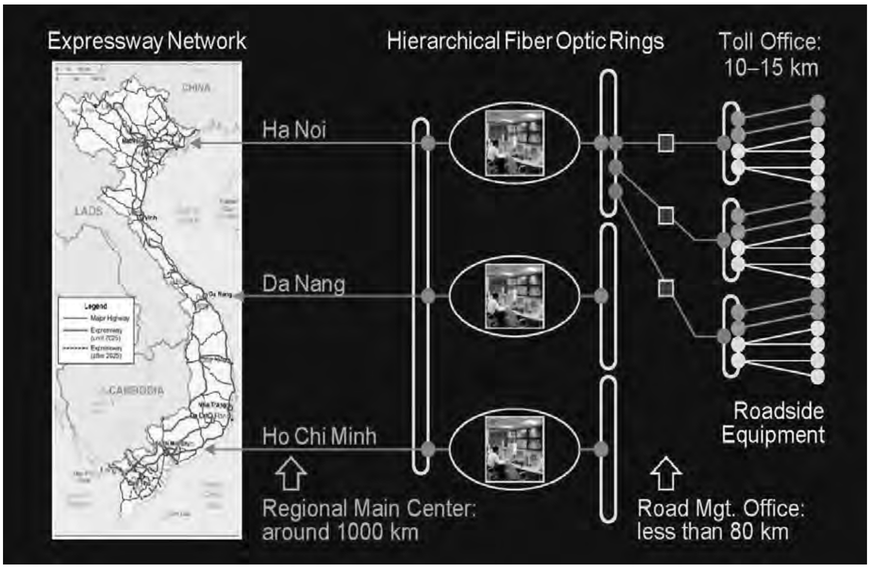
Figure 4.12 Maximum Interval of Road Management Offices



Source: ITS Integration Project (SAPI) Study Team

The location/structure outline of the offices for expressway operation is illustrated in the ITS Master Plan as shown in the figure below. The regional main centers are to be located in Ha Noi, Da Nang and Ho Chi Minh.

Figure 4.13 Structure Outline of Offices for Expressway Operation



Source: VITRANSS2 Study Team

Table 4.10 Function/Location of Offices

Classification	Functions/Locations
Regional Main Center	This center is to perform the functions of integration of road management offices, traffic regulation, traffic control and traffic information and is to be located in the major cities such as Ha Noi, Da Nang and HCMC.
Road Management Office	This office is to perform the functions of patrol for surveying current road/traffic conditions and integration of communication nodes in a jurisdiction and is to be installed one or more in an expressway section.
Toll Office	This office is to be installed at the tollgate, which has two or more toll booths, and perform the function of toll collection. A communication node, which integrates pieces of roadside equipment for ITS, is to be installed usually in a toll office.

Source: ITS Integration Project (SAPI) Study Team

5. Framework of Expressway Operation using ITS

5.1 General

In this chapter, the following frameworks needed for expressway operation are to be discussed and recommended one is to be itemized for each.

- Total Framework of Expressway Operation
- Framework for Service Level Control
- Framework for Traffic Control
- Framework for Police Car Dispatch
- Framework for Ambulance Dispatch
- Framework for Incident Notification to Road Operator
- Framework for Traffic Restriction
- Framework for Road/Traffic Monitoring
- Framework for Traffic Event Data Management
- Framework for Traffic Information Dissemination
- Framework for Toll Management
- Framework for Toll Settlement
- Framework for IC-card Issuance/Operation
- Framework for OBU Registration/Management
- Framework for Toll Enforcement
- Framework for Overloading Regulation
- Framework for Integrated Data Management
- Framework for Communication Network Management
- Framework for Radio Frequency Allocation
- Framework for System Maintenance

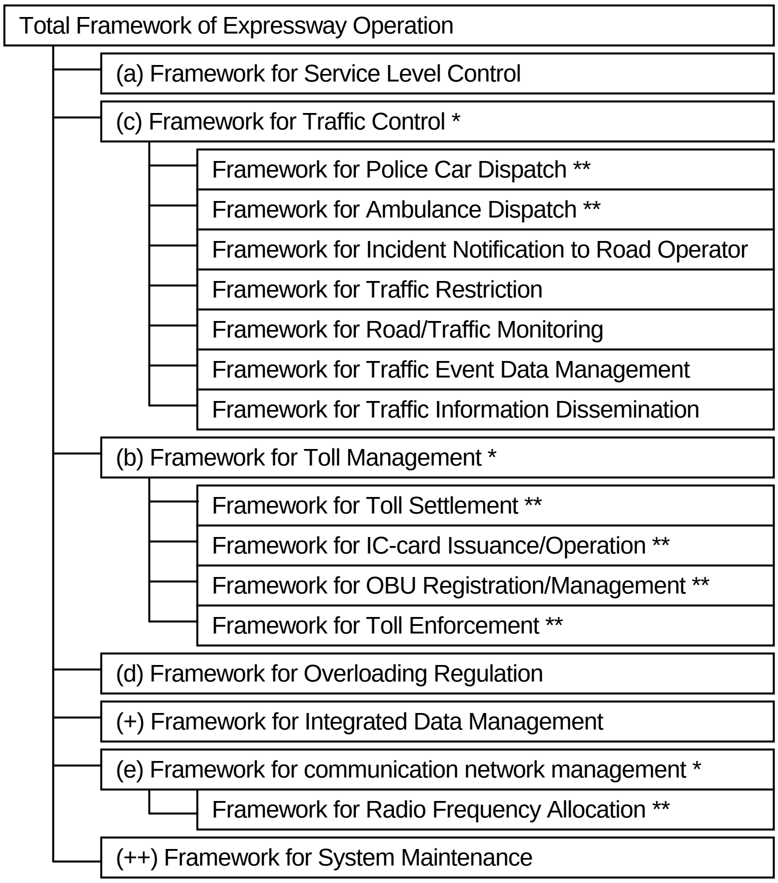
These frameworks are totally to cover the following five fields, which are the services of the road operation/maintenance aforementioned, and the services of (b), (c), (d) and (e) are to be supported by ITS:

(a) Road structure/facility management
(b) Toll collection/management
(c) Traffic information/control
(d) Heavy truck control
(e) Communication system management.

To be supported by ITS

The correspondence between the frameworks and the services of road operation/maintenance can be illustrated in the following figure. The total framework of expressway operation on the top of the figure shows the whole picture of expressway operation using ITS and includes other frameworks conceptually.

Figure 5.1 Composition of Frameworks



Note:
* : Key Framework
** : Framework included mainly in organization other than road operator
\+ : Integration of data for (b), (c) and (d)
++ : Maintenance covering (b), (c), (d) and (e)

Source: ITS Integration Project (SAPI) Study Team

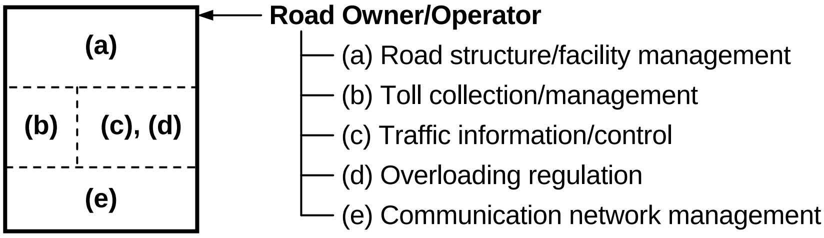
5.2 Total Framework of Expressway Operation

For clarifying appropriate division on the total framework of expressway operation for a precondition of discussion in the Study, a comparison is made among typical total frameworks.

1) FW-1: Operations Performed by Road Owner/Operator

In this framework, the road owner/operator is required to perform many different parts of expressway operation by preparing skilled manpower. All parts of operation need to be financed solely by toll revenue.

Figure 5.2 Burden Sharing in Framework FW-1



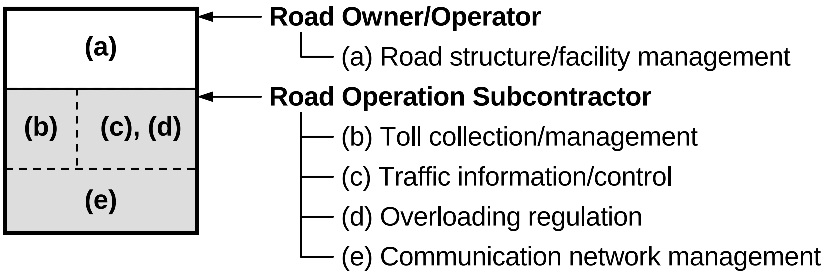
	Cost	Revenue
Road Owner/Operator	- All implementation/O&M cost	- Toll revenue

Source: VITRANSS2 Study Team

2) FW-2: Operations Delegated to Road Operation Subcontractor

In this framework, the road owner/operator is required only to manage road structure and facilities paying implementation/maintenance cost; however, a road operation subcontractor is required to perform many different parts of expressway operation by preparing skilled manpower. All parts of operation need to be financed solely by toll revenue.

Figure 5.3 Burden Sharing in Framework FW-2



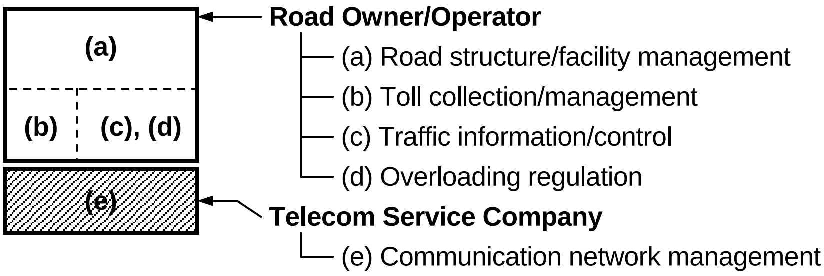
	Cost	Revenue
Road Owner/Operator	- Implementation/maintenance cost of (a) (b), (c), (d), (e) - Operation of (a) - Payment to the road operation subcontractor	- Toll revenue
Road Operation Subcontractor	- Operation cost of (b), (c), (d), (e)	- Payment by the road operator

Source: ITS Integration Project (SAPI) Study Team

3) FW-3: Operations Shared by Road Owner/Operator and Telecom Service Company

In this framework, communication network system and its operation is transferred to a telecom service company; however, the road owner/operator is still required to perform many different parts of expressway operation by preparing skilled manpower. Communication service revenue can be obtained in addition to toll revenue.

Figure 5.4 Burden Sharing in Framework FW-3



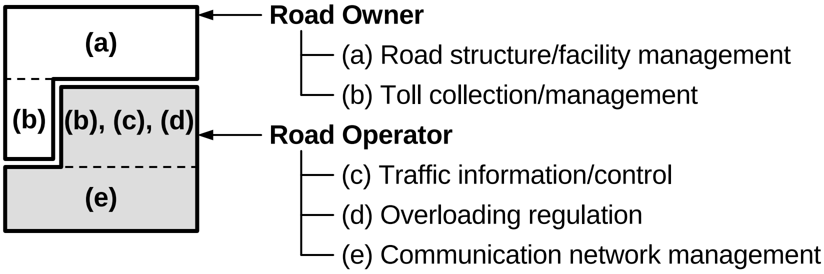
	Cost	Revenue
Road Owner/Operator	- Implementation/O&M cost of (a), (b), (c), (d)	- Toll revenue - Payment by the telecom service company
Telecom Service Company	- Implementation/O&M cost of (e) - Payment to the road owner/operator	- Communication service revenue

Source: ITS Integration Project (SAPI) Study Team

4) FW-4: Operations Shared by Road Owner and Road Operator

In this framework, the road owner can concentrate on managing toll revenue for paying implementation/maintenance cost of road structure and facilities, and the road operator can concentrate on proper expressway operation and communication network management. All parts of operation need to be financed solely by toll revenue.

Figure 5.5 Burden Sharing in Framework FW-4



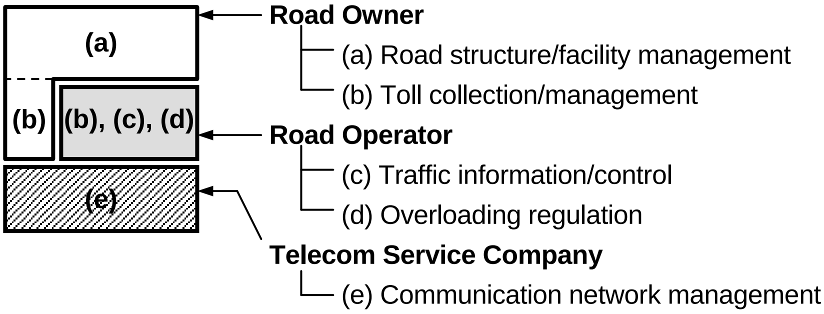
	Cost	Revenue
Road Owner	- Implementation/O&M cost of (a), (b) - Payment to the road operator	- Toll revenue
Road Operator	- Implementation/O&M cost of (b), (c), (d), (e)	- Payment by the road owner

Source: ITS Integration Project (SAPI) Study Team

5) FW-5: Operations Shared by Road Owner, Road Operator and Telecom Service Company

In this framework, the road owner can concentrate on managing toll revenue for paying implementation/maintenance cost of road structure and facilities, and the road operator can focus only on proper expressway operation by transferring communication network management to a dedicated telecom service company. Communication service revenue can be obtained in addition to toll revenue.

Figure 5.6 Burden Sharing in Framework FW-5



	Cost	Revenue
Road Owner	- Implementation/O&M cost of (a), (b) - Payment to the road operator	- Toll revenue - Payment by the telecom service company
Road Operator	- Implementation/O&M cost of (b), (c), (d)	- Payment by the road owner
Telecom Service Company	- Implementation/O&M cost of (e) - Payment to the road owner	- Communication service revenue

Source: ITS Integration Project (SAPI) Study Team

6) Selection of a Type of Expressway Operation Framework

FW-5 is selected as the recommended type and FW-4 is regarded as the reasonable type for the discussion on ITS operation in the Study based on the comparison of advantages and disadvantages of the types of framework aforementioned, which is shown in the table below.

Table 5.1 Advantage/Disadvantages on Types of Framework

	Advantage	Disadvantage	Grading
FW-1	-	- Many different parts of expressway operation need to be done by the road operator - All parts of operation need to be financed solely by the toll revenue.	Available for peculiar need
FW-2	-	- Many different parts of expressway operation need to be done by the road operation subcontractor - All parts of operation need to be financed solely by the toll revenue.	Available for peculiar need
FW-3**	- Communication network management can be transferred to and integrated by a dedicated telecom service company - Communication service revenue can be obtained.	- Many different parts of expressway operation need to be done by the road owner/operator. - Dedicated telecom service company (existing or newly-organized) needs to be prepared.	Available for peculiar need
FW-4**	- The road owner can concentrate on implementation/maintenance of road structure/facility comparing with toll revenue - The road operator can concentrate on proper expressway operation and communication network management	- All parts of operation need to be financed solely by the toll revenue.	Available for peculiar need
FW-5**	- The road owner can concentrate on implementation/maintenance of road structure/facility comparing with toll revenue - The road operator can focus only on proper expressway operation and expertise and scale effects covering many expressway sections can provide cost cutting - Communication network management can be transferred to and integrated by a dedicated telecom service company - Communication service revenue can be obtained.	- Dedicated telecom service company (existing or newly-organized) needs to be prepared.	Recommended

** : Subcontract can be brought into the framework

Source: ITS Integration Project (SAPI) Study Team

However, it should be noted that communication service in the case FW-3 and FW-5 requires introduction of a large-capacity transmission method such as DWDM, which is adopted by a number of telecom service companies and is capable of allocating a wide bandwidth for each basic service.

7) Recommended Total Framework for Expressway Operation

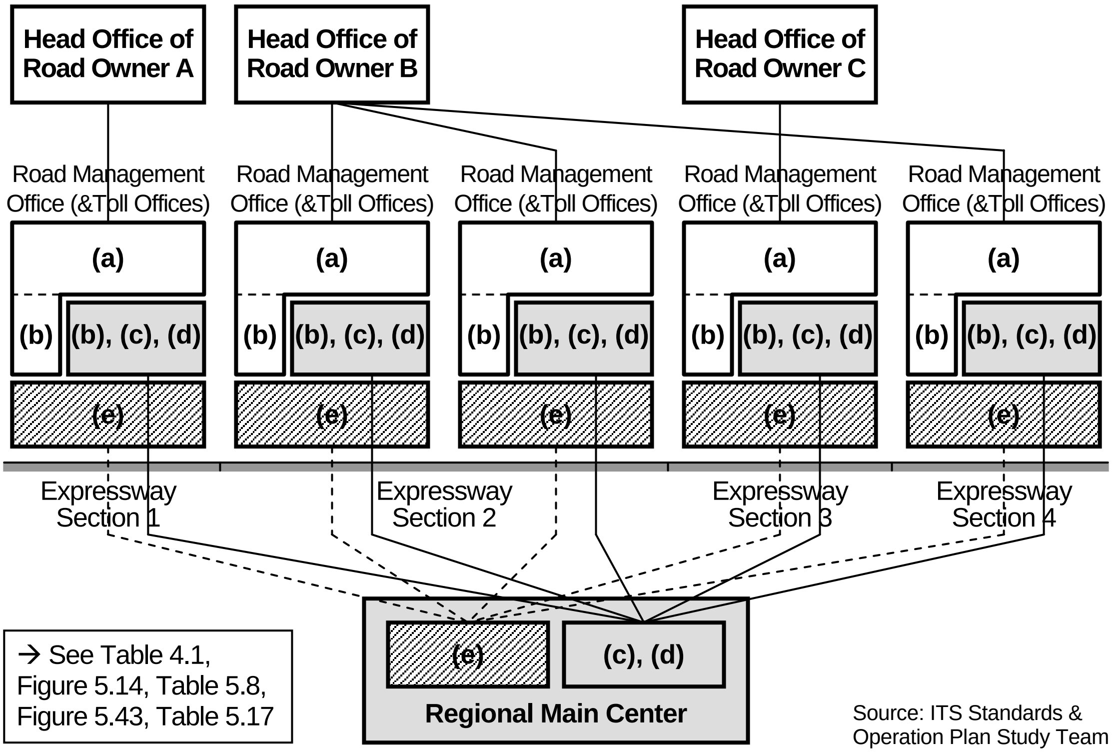
An expressway network will be constructed/operated by section; however, the operation needs to be integrated by field. Road structure/facility management and toll collection/management are to be integrated by the head offices of the road owners. Proper expressway operation and communication network management are to be integrated by the Regional Main Center in the total framework FW-5 (or FW-4).

- Head office of road owner
  - (a) Road structure/facility management
  - (b) Toll collection/management
- Regional Main Center
  - (c) Traffic information/control
  - (d) Overloading regulation
  - (e) Communication network management

Based on this condition, a total framework is proposed as shown in the figure below, which includes the following road owners:

- Road owner A: has an expressway section
- Road owner B: has many expressway sections
- Road owner C: has an expressway section.

Figure 5.7 Total Framework based on FW-5 Integrated by Regional Main Center



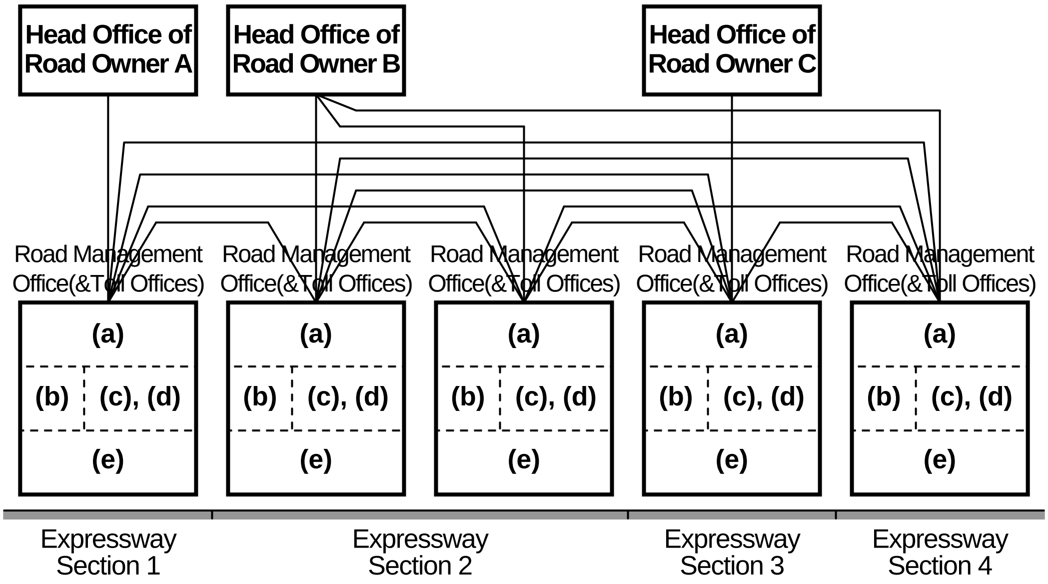
→ See Table 4.1, Figure 5.14, Table 5.8, Figure 5.43, Table 5.17

Source: ITS Standards & Operation Plan Study Team

In this framework, some roles of the road operator are to be consolidated to and conducted in the Regional Main Center as shown above. The system needs to be built up in considration of the cooperation among the offices of different purposes and covering the required fields.

If the Regional Main Center is not set up, such complicated framework without integrateion by field as shown in the figure below can be developed responding only to the road construction by section, which provides unclear sharing of responsibility on information exchange.

Figure 5.8 Undesirable Complecated Framework without Integrateion

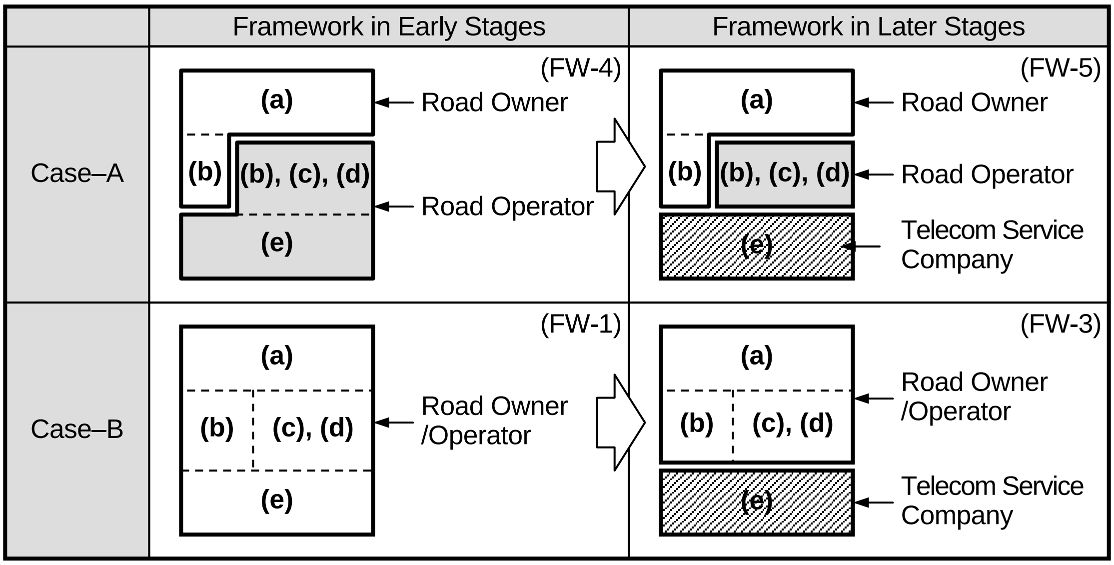


Source: ITS Integration Project (SAPI) Study Team

8) Expected Shift on Total Framework

In the early stage of ITS installation role sharing among organizations will not be minutely; however, it will be broken into parts minutely for covering extensive expressway network in later stages. Total frame work can shift accordingly as shown in the figure below. It is proposed by Decision No.3569/VPCP-KTN VNPT (Vietnam Posts & Telecommunications) is in the position of the telecom service company in the figure.

Figure 5.9 Expected Shift on Total Framework



Note: →See Figures 5.2, 5.4, 5.5, 5.6 and 5.69, Shift on framework inclusing implementationm of the Project is shown in Section 14.2.

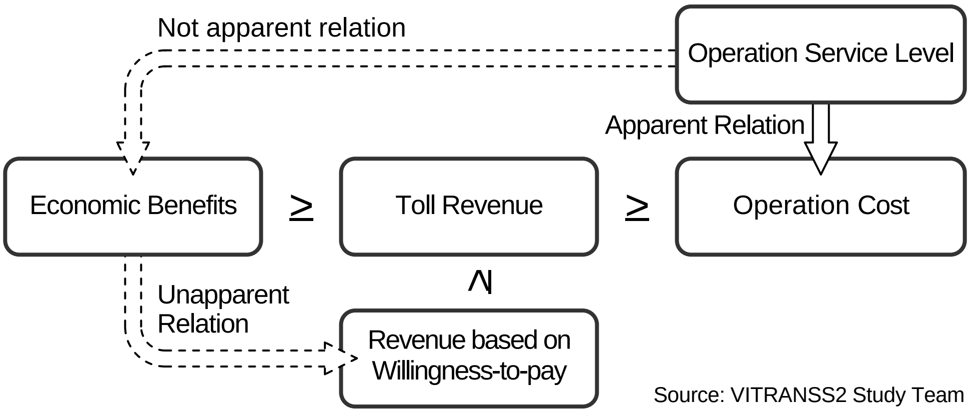
Source: ITS Integration Project (SAPI) Study Team

5.3 Framework for Service Level Control

1) Necessity of Service Level Control

Unfortunately, improvement in expressway operation service causes apparently a cost rise and a decrease in profits for a road operator. In addition, it is not easy for the road operator to raise the toll amount, because an increase in the benefit from or the user's willingness to pay arising from the improvement is not apparent. On this account, road operators tend to be effortless in the improvement of operation service in many countries.

Figure 5.10 Relation between Operation Service Level and Toll Revenue



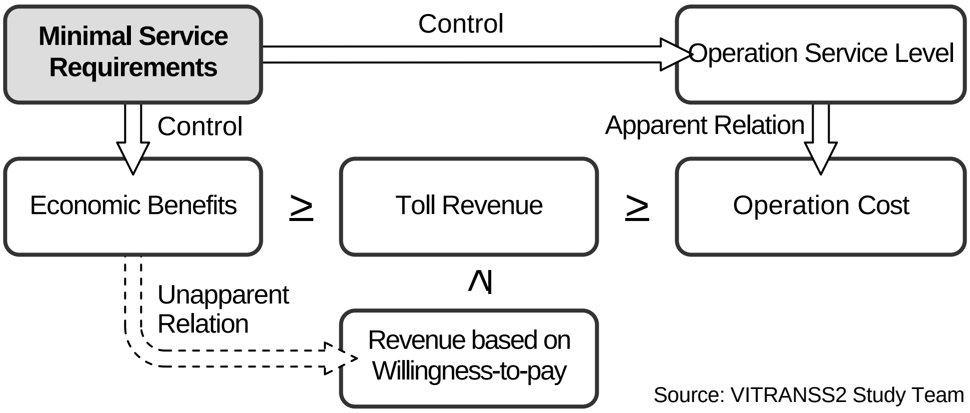
Source: VITRANSS2 Study Team

Accordingly, in order to enhance the road operator's motivation, the minimal service levels required for expressway operation shall be defined as a standard.

2) Recommended Framework for Service Level Control

The Minimal Service Requirements allow to control the operation service levels provided by a road operator as shown in the figure below. A set of specific Minimal Service Requirements is shown in Chapter 3.

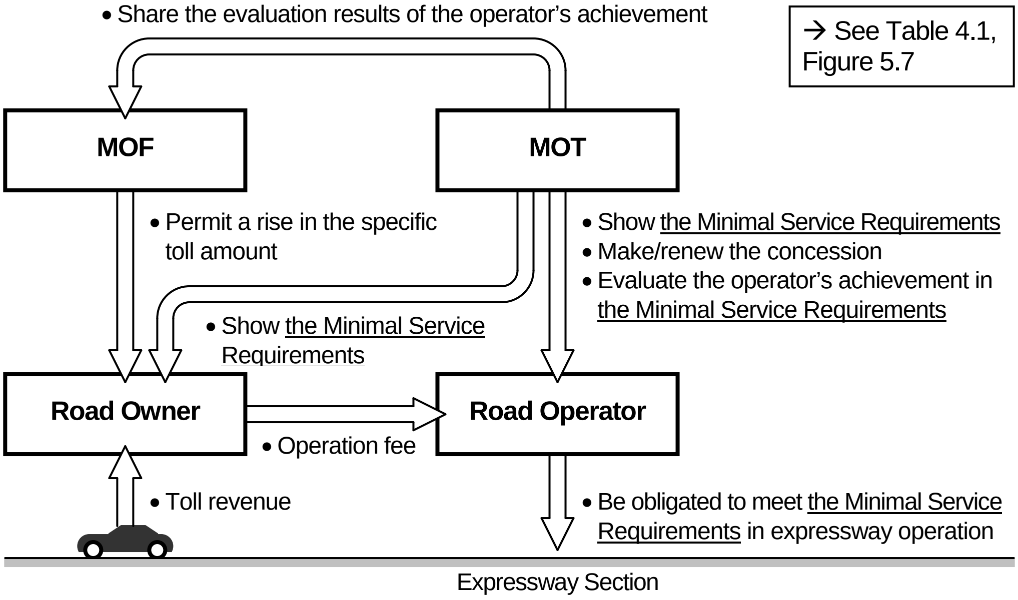
Figure 5.11 Minimal Service Requirements for Controlling Operation Service Level



Source: VITRANSS2 Study Team

A framework shown in the following figure is proposed for service level control on expressway operation. In the framework, a set of Minimal Service Requirements shall be shown by MOT to the road operator and the road owner in the process of making a concession of expressway operation. The road operator is to be obliged to meet the Minimal Service Requirements. And on the occasion when the concession is renewed, rises in the specific toll amount of the road owner and in the operation fee paid by the road owner to the road operator are to be permitted by MOF based on an evaluation on the degree of the road operator's achievement by MOT in reference to the requirements.

Figure 5.12 Recommended Framework for Service Level Control



Source: ITS Integration Project (SAPI) Study Team

For example, VEC is one of the road owner and VEC Expressway O/M Company is one of the road operator.

In Vietnam, O/M concession is to be applied to the contract between MOT and the road operator for trial. This type of contract will achieve the following role sharing. (→ See Figure 4.1)

Roles of MOT (Public Organization):

- Ownership of road facilities
- Responsibility for establishing performance standard and monitoring.

Roles of the road operator (Private Organization):

- Responsibility for providing service including O/M and collecting toll based on the concession contract
- Responsibility for all capital investment as well as for working capital.

5.4 Framework for Traffic Control

5.4.1 Key Framework

1) Required Actions for Traffic Control

The framework for traffic control needs to achieve the following actions on the expressway network:

- Police Car Dispatch
- Ambulance Dispatch
- Incident Notification to Road Operator
- Traffic Restriction
- Road/Traffic Monitoring
- Traffic Event Data Management
- Traffic Information Dissemination

As shown in the beginning of this chapter, detailed frameworks respectively for the required actions above will be specified in the following sections.

2) Road Operator's Offices Required for Expressway Operation

The framework for traffic control on the expressway network is to include the following road operator's offices:

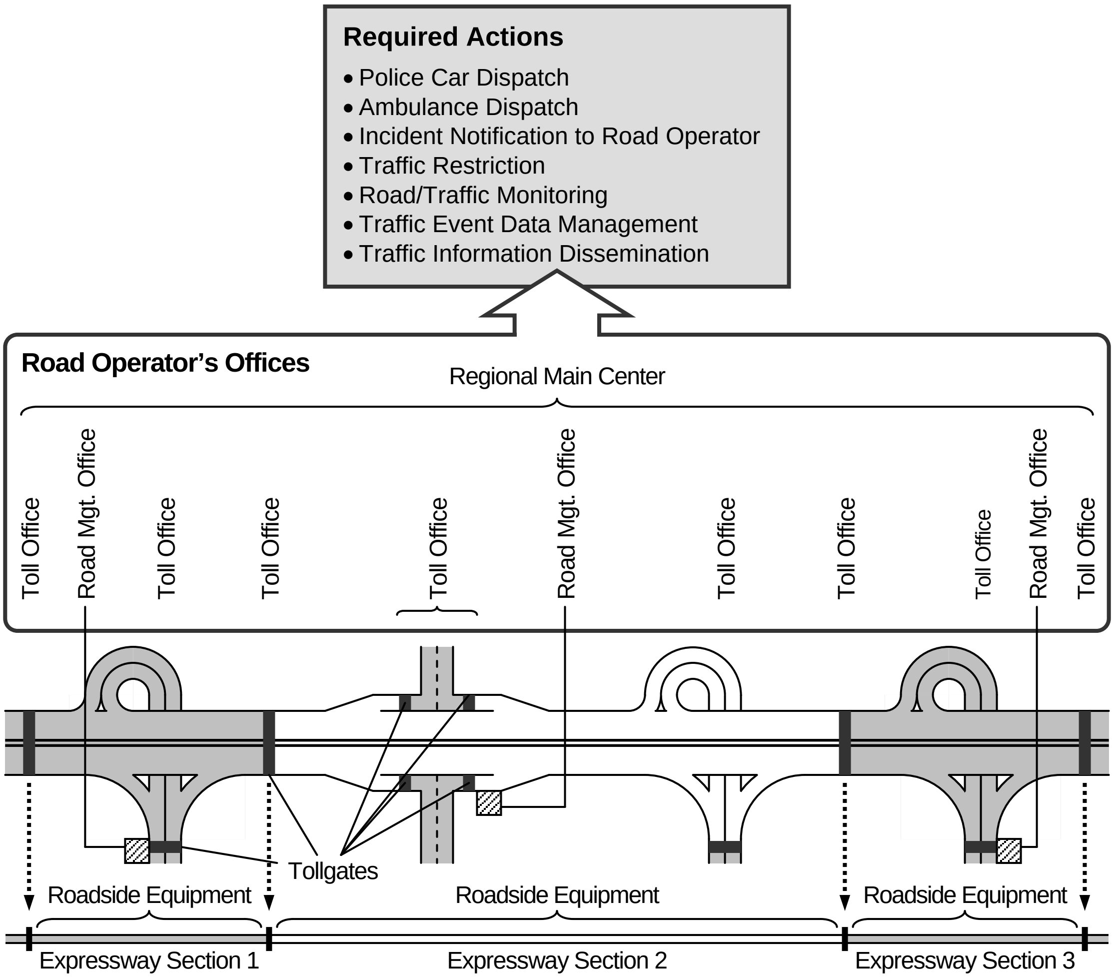
- **Toll Office and Roadside Equipment:** Toll Office is to be established near the tollgate which include two or more tollbooths, and functions as toll collection. In most of the cases, communication node which transmits data from roadside equipment components of ITS is installed in toll office.

- **Road Management Office:** Road Management Office manages patrol to comprehend latest road/traffic conditions and controls communication node of own management section, and at least one office will be established for each expressway section. This office is to be the base for dispatching patrol for surveying current traffic conditions on the expressway.

- **Regional Main Center:** Regional Main Center controls road management offices, and functions traffic monitoring, traffic control and provision of traffic information dissemination. This center is to be set up in principle city such as Ha Noi, Da Nang, and Ho Chi Minh and to integrate the management offices.

Additionally, in Vietnam, the traffic control of the expressway network will be shared by many different road operators; however, the framework for traffic control needs to be integrated into a single hierarchical structure for the whole expressway network.

Figure 5.13 Required Actions and Road Operator's Offices for Traffic Control

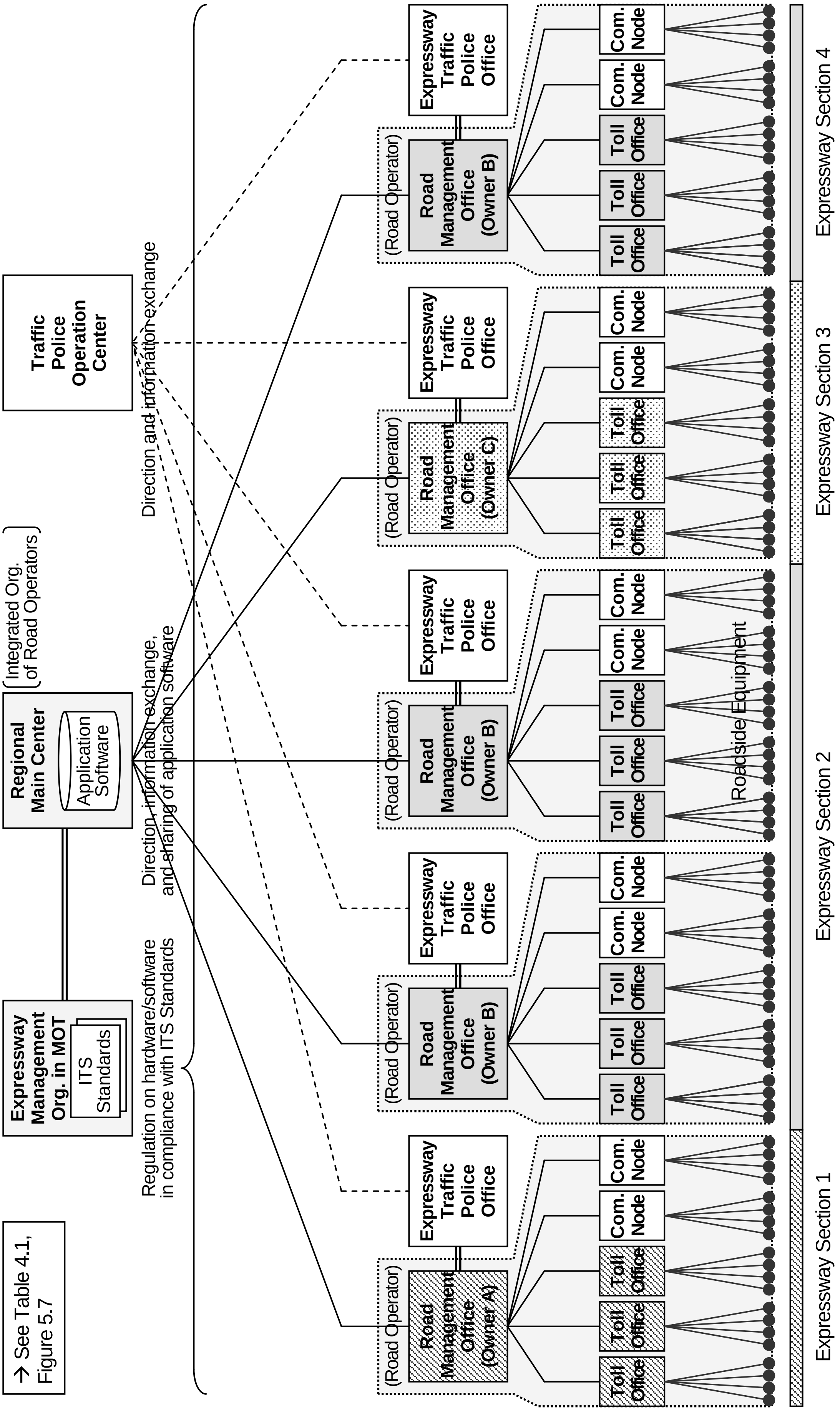


Source: ITS Integration Project (SAPI) Study Team

3) Recommended Framework for Traffic Control on Expressway Network

The framework for traffic control in the following figure is to be defined as a premise for discussion in the Study, which is based on the total framework FW-5 previously mentioned in the section of the total framework for expressway operation. This framework shows that the expressway traffic police offices are to be organized corresponding to the expressway sections that are the jurisdictions respectively of road management offices. The Standards on hardware is to be managed by the Expressway Management Organization in MOT and the application software in the Regional Main Center is to be shared/used by the road operators.

Figure 5.14 Recommended Framework for Traffic Control of Expressway Network



Source: ITS Integration Project (SAPI) Study Team

5.4.2 Framework for Police Car Dispatch

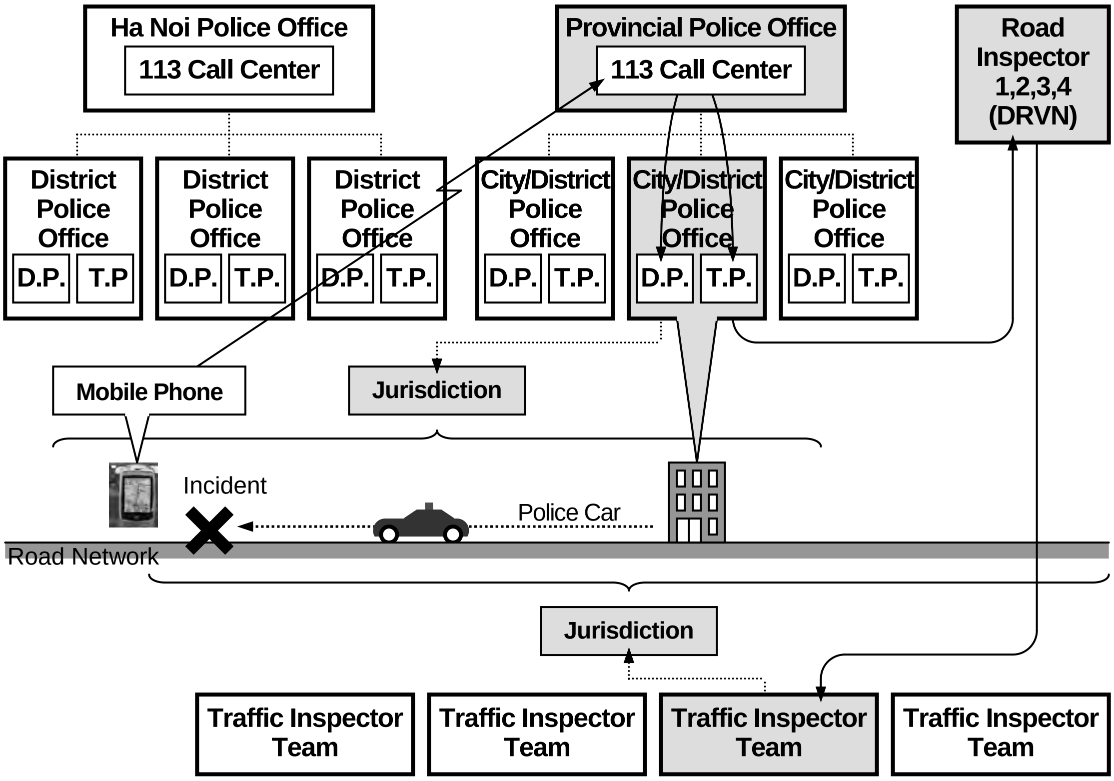
1) Existing Framework for Police Car Dispatch on National Highways

As for the regulations related to the Framework for Police Car Dispatch, the following regulations are to be applied;

- No. 23/2008/QH12: Law on Road Traffic
- MOPS Decision No. 18/2007/QĐ-BCA (C11): 113 Force and Traffic Police

When traffic incident occurs and someone calls 113, all calls are connected to the Urgent Reaction Center in the nearest police office of a Central Governed City or a Province. No area code is necessary for 113 call. When an operator in the center receives phone call, he/she analyses the information and contacts to the responsible parties. In the case of traffic accident without injured persons, the traffic police in a district police or a city police is responsible, but in the case with injured persons, the detective police is to be included in the parties. The same framework is built up in each Central Governed City and Province. Additionally, in the case of traffic accident with damaged infrastructure, the police office needs to contact to the traffic inspector under DRVN.

Figure 5.15 Existing Framework for Police Car Dispatch on National Highways



Note: Police office of centralized governed cities: Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho
D.P. : Detective police to be dispatched for traffic accidents with fatalities
T.P. : Traffic police to be dispatched for traffic accidents without fatalities
Traffic Inspector to be dispatched from their office in Ha Noi, Vinh, Da Nang or Ho Chi Minh under DRVN for traffic accidents with damaged infrastructure.

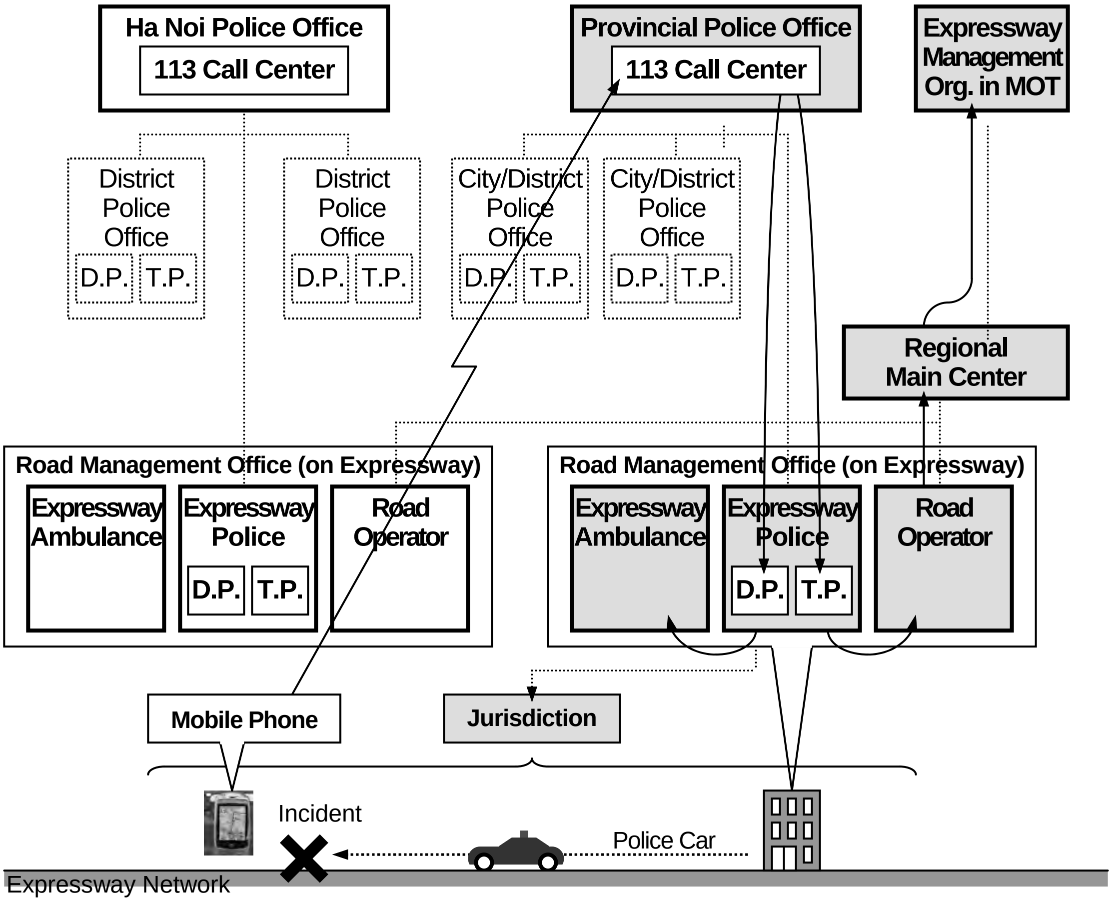
Source: ITS Integration Project (SAPI) Study Team

Currently, there are 2 expressways in Vietnam: the Lang – Hoa Lac Expressway, called Thang Long Avenue, and the Ho Chi Minh – Trung Luong Expressway. Both expressway section has its own managing unit related to the traffic police organization. The Hanoi Traffic Police Office manages the Lang – Hoa Lac Expressway, which is located inside of Hanoi City. On the other hand, the traffic police department under the Ministry of Public Security manages the Ho Chi Minh – Trung Luong Expressway, which passes throughh 3 provinces.

2) Recommended Framework for Police Car Dispatch on Expressway Network

A team of "Expressway Police" is proposed to be assigned to each road management office with teams of the road operator and the ambulance service with an identical jurisdiction. It is recommended as a premise for discussion in the Study that the three teams in the framework are to cooperate responding to 113 calls in case of traffic accidents.

Figure 5.16 Recommended Framework for Police Car Dispatch on Expressway Network



Note: Police office of centralized governed cities: Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho
D.P. : Detective police to be dispatched for traffic accidents with fatalities
T.P. : Traffic police to be dispatched for traffic accidents without fatalities
Crew of road operator under the Expressway Management Office to be dispatched for traffic accidents with damaged infrastructure.

Source: ITS Integration Project (SAPI) Study Team

5.4.3 Framework for Ambulance Dispatch

1) Existing Framework for Ambulance Dispatch

Ambulance services (first aid) belong to Ministry of Health, according to the Decision No. 01/2008/QD-BYT dated January 21, 2008 issuing the regulation of first aid, active recuperation and detoxification, the provinces and cities under central management must have their ambulance service centers. The provinces, where such center is out of reach owing to the lack of some conditions, must have ambulance team belonging to provincial general hospital. Districts and townships must have first aid teams outside hospitals.

The people can call the emergency number 115 to ask for the fist aid service at very small cost. After receiving calls for first aid service, the permanent staff will verify the accuracy of information, locate the address and dispatch the ambulance car, which is the nearest to the required place. An ambulance crews consist of a doctor, a nurse and a driver. The ambulance crews provide the first aid treatment for injured people and bring them to the nearest hospital. The ambulance dispatch decision is made by the 115 call receiver. The ambulance driver decides the route to reach the incident site by his own experience. The service is available 24 hours a day.

The call to 115 is routed through the telecommunication operator's network to the nearest ambulance station. No area code is required. If the caller needs to call ambulance from the specific province, he needs to add the area code before 115.

For example, Ha Noi city has a 115 center and there are 4 ambulance stations operated by several ambulances for each. The photo below shows the ambulance service center in Hanoi for receiving of 115 calls and dispatching ambulance team. There are 4 telephone liens and two operators in this center. The operators belong to as a permanent staff who receives information and dispatches an ambulance.

Figure 5.17 Center for Receiving of 115 Calls and Ambulance Dispatch

Source: VITRANSS 2 Study Team

According to the interview survey, the service level of 115 center of Ha Noi is said that it is averaged about 2 minutes required after receiving the call to dispatch ambulance in daytime and about 3 minutes in night time; however, it should depend on the condition of available ambulances and traffic. Normally, the average time to dispatch ambulance is about 10 to 15 minutes after receiving the call. It is also mentioned in the decision above that the 115 center shall be indicated on area administrative/transport maps and GPS if it is available.

The ambulance service is available not only in Ha Noi but also in Hai Phong, Da Nang, Hue and HCMC. However, the ambulance system is started under a new decision, so that this service is available not in every cities and provinces. Because the number of the first aid facilities including the ambulance cars is limited, it is reported that the service met only 10% of demand even in Hanoi and HCMC at its outset. In future, when the provincial 115 center will be organized, all calls for the first aid can be connected to the provincial 115 center, and the center will assign a district first aid team to rescue a patient.

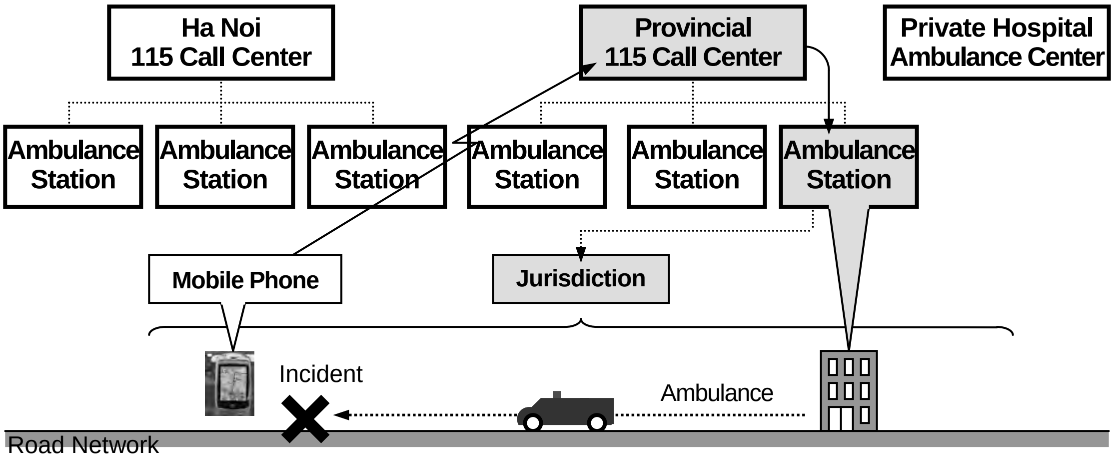
In rural areas, this emergency service is supported by the provincial and district hospital. The current situation of hospitals in Vietnam is as below.

- A large number of public and private hospitals are in Hanoi and HCMC; however only public hospitals are in rural area
- Even a provincial hospital does not have equipment supported by advanced technologies such as CT scan and MRI
- A user of the ambulance service, except the resident appointed to the hospital, need to pay responding to the used distance.
- Some hospitals provide their own emergency medical services by their own ambulance.

As for the expressway section between Cau Gie and Ninh Binh, VEC made an agreement with local government about ambulance operation. In this road section, two ambulances will be stationed at the related road management office.

When a 115 call center in a Centralized Governed City or a Province receives a call, an ambulance is to be dispatched to the incident site to bring injured persons. Some of private hospitals have their ambulance centers and can dispatch ambulances as well. However, in both case, few information is exchanged between the ambulance team and the road operator.

Figure 5.18 Existing Framework for Ambulance Dispatch



Note: Ambulance center of centralized governed cities: Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho

Source: ITS Integration Project (SAPI) Study Team

2) Recommended Framework for Ambulance Dispatch on Expressway Network

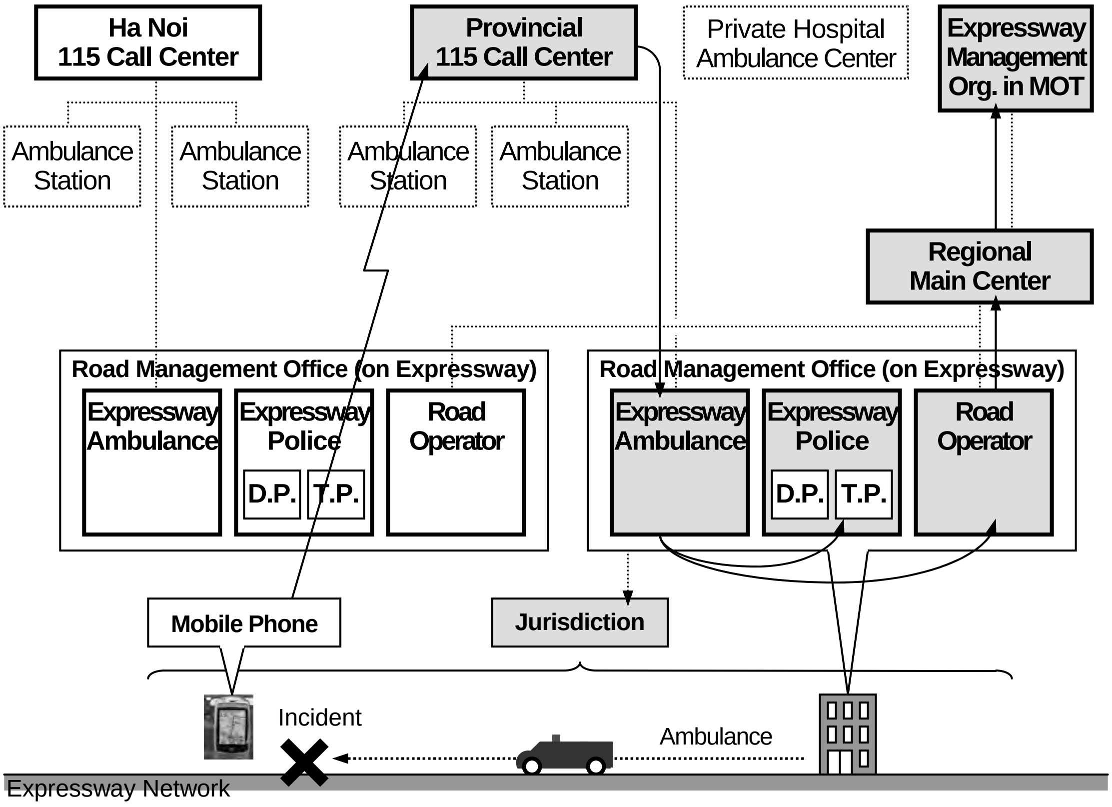
The information of ambulance dispatch to an incident site needs be shared among ambulance station, related road management offices and toll offices for cooperation. And the following information is to be shared among operators of ambulance stations for making decision:

- Contact telephone number list of ambulance stations
- Contact telephone number of road management offices
- Map of expressway network including locations of entrances and exits.

The information is to be updated when a new ambulance station, a new road management office or an expressway sections is constructed.

A team of “Expressway Ambulance” is proposed to be assigned to each road management office with teams of the road operator and the police with an identical jurisdiction. It is recommended as a premise for discussion in the Study that the three teams in the framework are to cooperate responding to 115 calls in case of incidents.

Figure 5.19 Recommended Framework for Ambulance Dispatch on Expressway Network

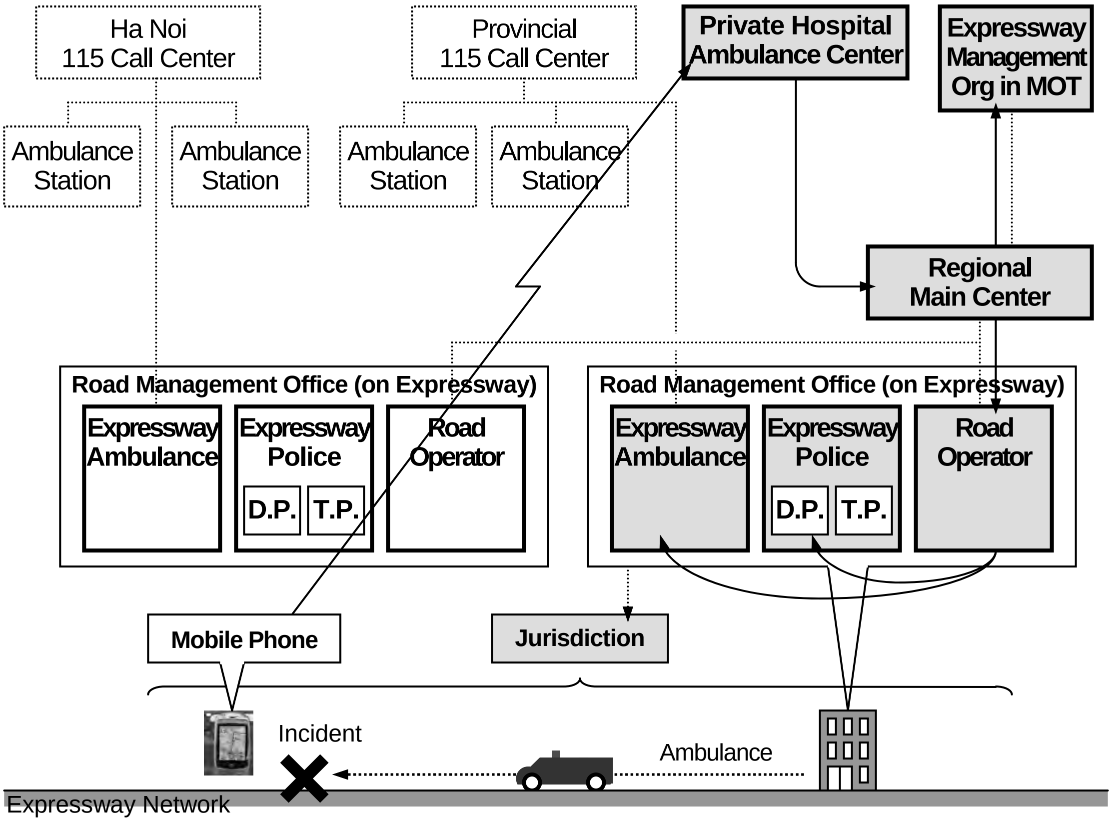


Note: Ambulance center of centralized governed cities: Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho
D.P. : Detective police to be dispatched for traffic accidents with fatalities
T.P. : Traffic police to be dispatched for traffic accidents without fatalities
Crew of road operator under the Expressway Management Office to be dispatched for traffic accidents with damaged infrastructure.

Source: ITS Integration Project (SAPI) Study Team

Even though the ambulance request comes to some specific private hospital, response to the incident needs to be performed rapidly in the relationship with the road operator and the police. Hence, it is recommended to establish a framework that the hospital can inform to the road operator through the Regional Main Center as shown in the following figure.

Figure 5.20 Additional Framework for Ambulance Dispatch on Expressway Network



Note: D.P. : Detective police to be dispatched for traffic accidents with fatalities

T.P. : Traffic police to be dispatched for traffic accidents without fatalities

Crew of road operator under the Expressway Management Office to be dispatched for traffic accidents with damaged infrastructure.

Source: ITS Integration Project (SAPI) Study Team

5.4.4 Framework for Incident Notification to Road Operator

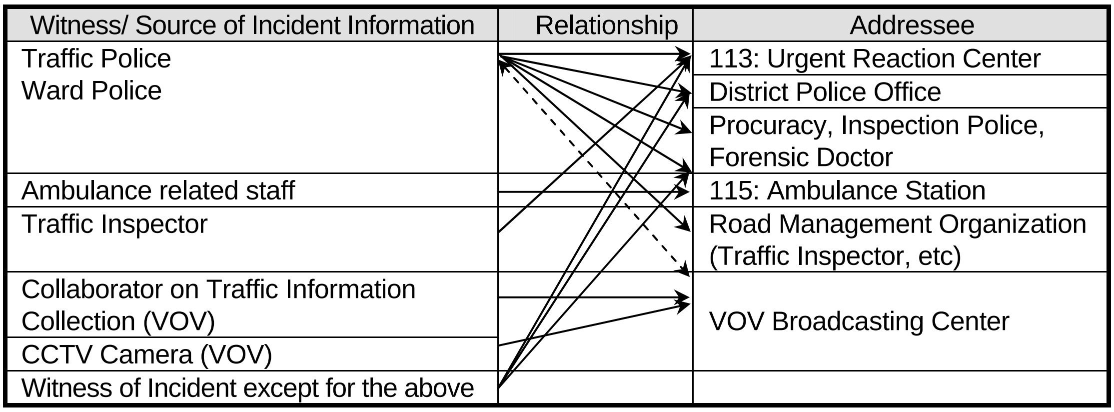
1) Conditions of Incident Notification on Existing Roads

As for the regulations related to the Framework for Incident Notification, the following regulations are to be applied;

- No. 23/2008/QH12: Law on Road Traffic
- MOPS Decision No. 1922/2006/QĐ-BCA (C11): Duties, Powers and Operation of Road Traffic Police's Inspection and Control
- MOT Draft Circular No. /2010/TT – BGTVT: Stipulate functions, duties, powers and organization of Directorate of Road for Vietnam's Inspector

As for the incident notification, there seems to be no clear framework on notifying to the road management organization so far. The relationship between witnesses or source of incident and information addressee is shown in the table below;

Table 5.2 Relationship between Witness and Addressee on Incident Notification



Witness/ Source of Incident Information	Relationship	Addressee
Traffic Police Ward Police		113: Urgent Reaction Center
		District Police Office
		Procuracy, Inspection Police, Forensic Doctor
Ambulance related staff		115: Ambulance Station
Traffic Inspector		Road Management Organization (Traffic Inspector, etc)
Collaborator on Traffic Information Collection (VOV)		VOV Broadcasting Center
CCTV Camera (VOV)		
Witness of Incident except for the above		

Note: The arrow line means possible addressees and not conclusive ones.

Source: ITS Integration Project (SAPI) Study Team

In general, if traffic accident happens, and any witness information is incoming into the police related organization, this organization should analyze the information and be responsible for accessing, protecting, examining the incident site conditions, and controlling traffic flow to avoid congestion. If it is a serious accident with death, Procuracy, Inspection Police and Forensic Doctor should be involved.

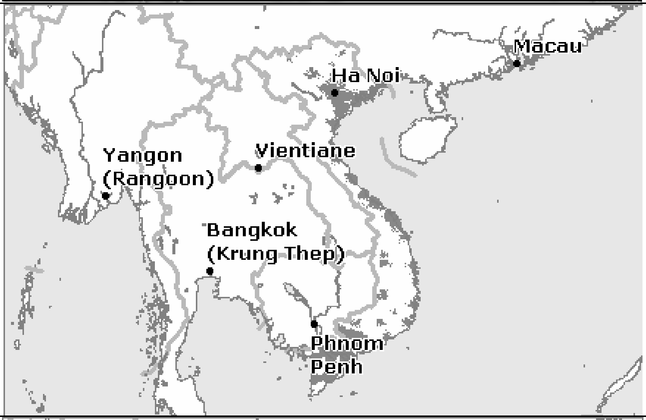
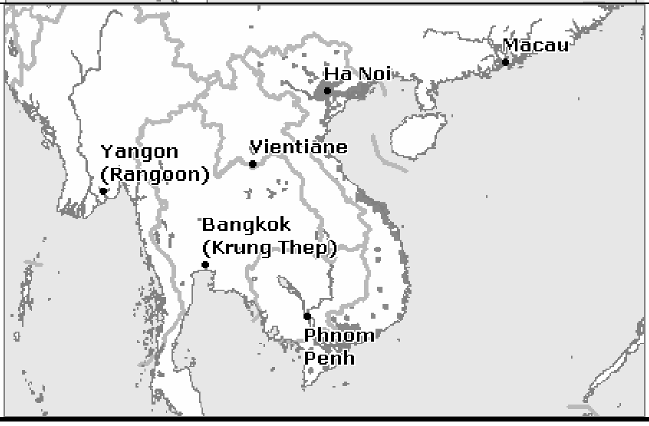
As for the relation between 115 and 113, there is almost no relationship to share the incident information each other. If 115 center is the first organization to receive the call about incident from someone, the ambulance will come to the incident site and carries the victim to the hospital without noticing 113 center. If 113 center is the first organization to receive the call about incident, it dispatches its own first aid team to the incident site for victims, block traffic and protect the incident site. If traffic police is unable to come to the incident site immediately, district police has the right to protect and settle the incident site.

If the traffic inspector finds the incident, he inform it to the traffic police first for on-site investigation and then inform it to the related road management organization for clearing the road.

2) Existing Conditions of Coverage/Diffusion of Mobile Phones

For considering the availability for use mobile phone on expressway, study team collected the coverage of mobile phone of GSM system.

Table 5.3 Coverage/Diffusion of Mobile Phones

	Coverage in Vietnam	Share %
Viettel GSM900		34%
Mobifone GSM900		41%
VINAPHONE GSM900		20%

Legend: ■ High, □ Variable
Source: GSM Coverage Website

3) Expected Procedures of Incident Notification on Expressway Network

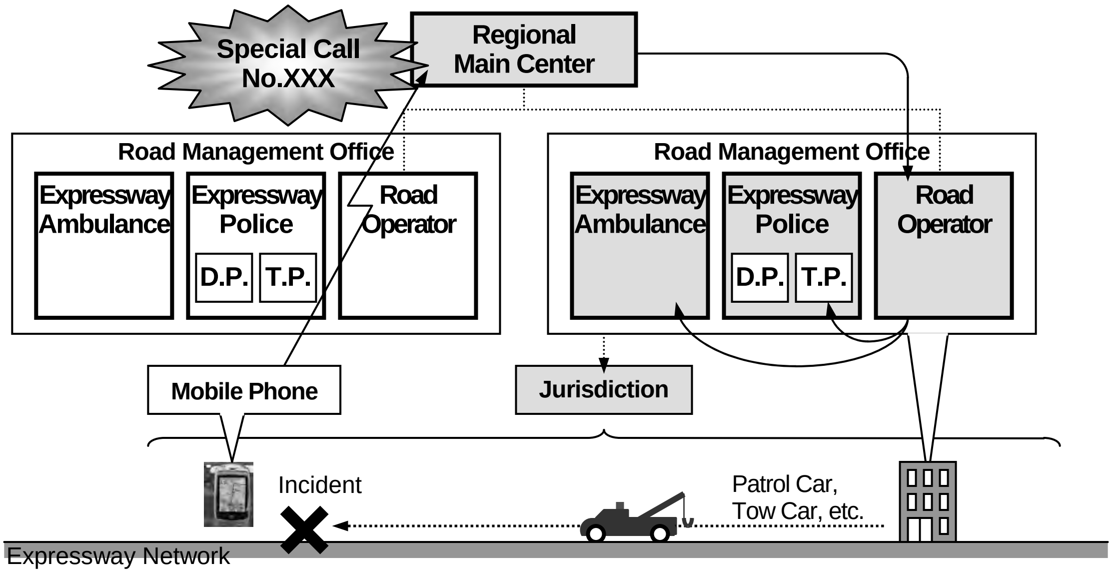
Two types of telephone systems can be used for emergency call to the road operator at an incident occurrence, which outlines, advantages and issues are shown in the following. Mobile phones are recommended as a major tool for emergency call in the Study.

(1) Case-1: Procedure Using Mobile Phone

Advantages: - Low implementation cost for road operator

Issues:
- Necessity of the coverage of mobile phone service over the expressway
- Necessity to set up a special telephone number to call the Regional Main Center
- Difficulty to precisely identify the location of incident site.

Figure 5.21 Incident Notification by Mobile Phones



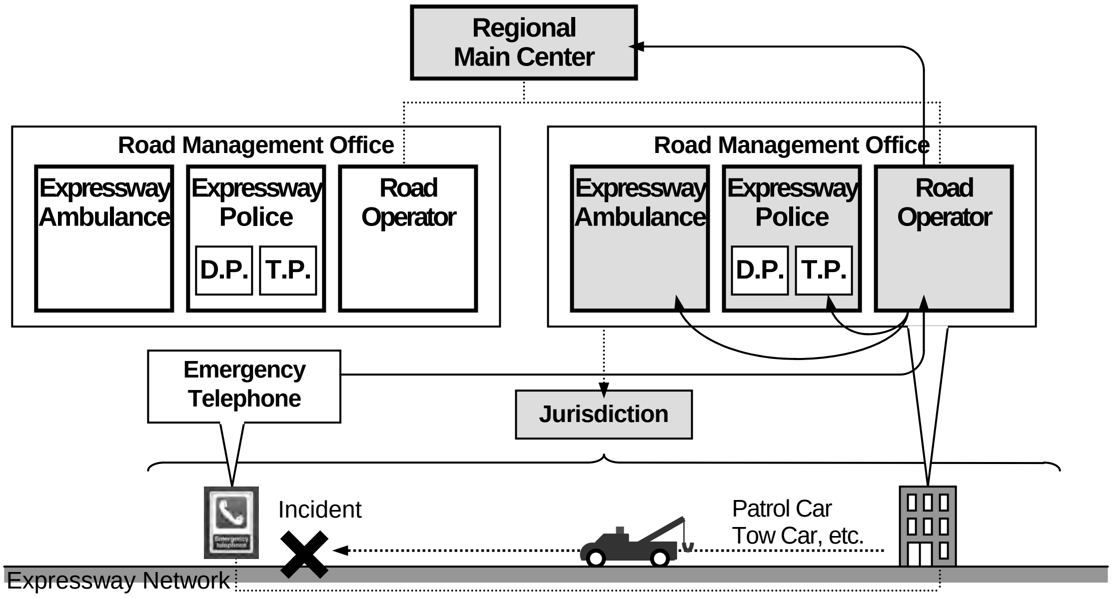
Source: ITS Integration Project (SAPI) Study Team

(2) Case-2: Procedure Using Emergency Telephone (Complementary Use)

Advantages:
- Complementary use for outside of the coverage of mobile phone service such as mountainous area or a tunnel section
- Ease to identify the location of incident site for road operator

Issues:
- High implementation cost for road operator.

Figure 5.22 Incident Notification by Emergency Telephone



Source: ITS Integration Project (SAPI) Study Team

4) Recommended Framework for Incident Notification on Expressway Network

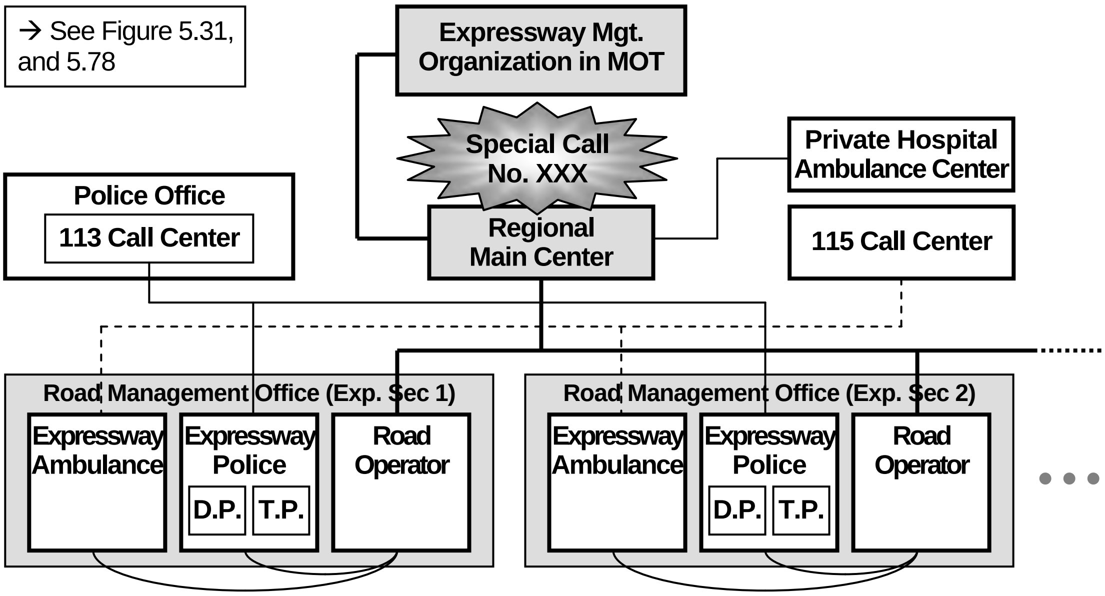
As for the incident on the expressway, major information source from the incident site is originated by the witness or injured person himself calling to 113 or 115. The incident information should be transferred to the related Road Management Organizations immediately and precisely so as to settle the incident with related organizations such as Expressway Police, Expressway Ambulance, and Expressway Traffic Inspector. Even though the incident information is incoming directly to the Road Management Office, the system that this information is reported to the Regional Main Center is required so as to transfer it to the related other Road Management Offices. Therefore the following framework for Incident Notification is recommended based on the above conditions.

The framework below is to be prepared for the road operator to receive notification at the occurrence of incident on the expressway network:

- Main part is to be formed by the Expressway Management Organization in MOT, the Regional Main Center and road management offices
- A special call number is to be prepared for the road operator to receive incident notification
- The Regional Main Center is to cooperate with the Police offices including 113 Call Center
- The Regional Main Center is to cooperate with the Ambulance Centers
- A team consists of the expressway police, the expressway ambulance and the road operator is to be assigned to each road management office.

Figure 5.23 Recommended Framework for Incident Notification on Expressway Network

→ See Figure 5.31, and 5.78



Note: Police office and ambulance office of centralized governed cities: Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho
D.P. : Detective police to be dispatched for traffic accidents with fatalities
T.P. : Traffic police to be dispatched for traffic accidents without fatalities
Crew of road operator under the Expressway Management Office to be dispatched for traffic accidents with damaged infrastructure.

Source: ITS Integration Project (SAPI) Study Team

5.4.5 Framework for Traffic Restriction

1) Existing Framework for Traffic Restriction

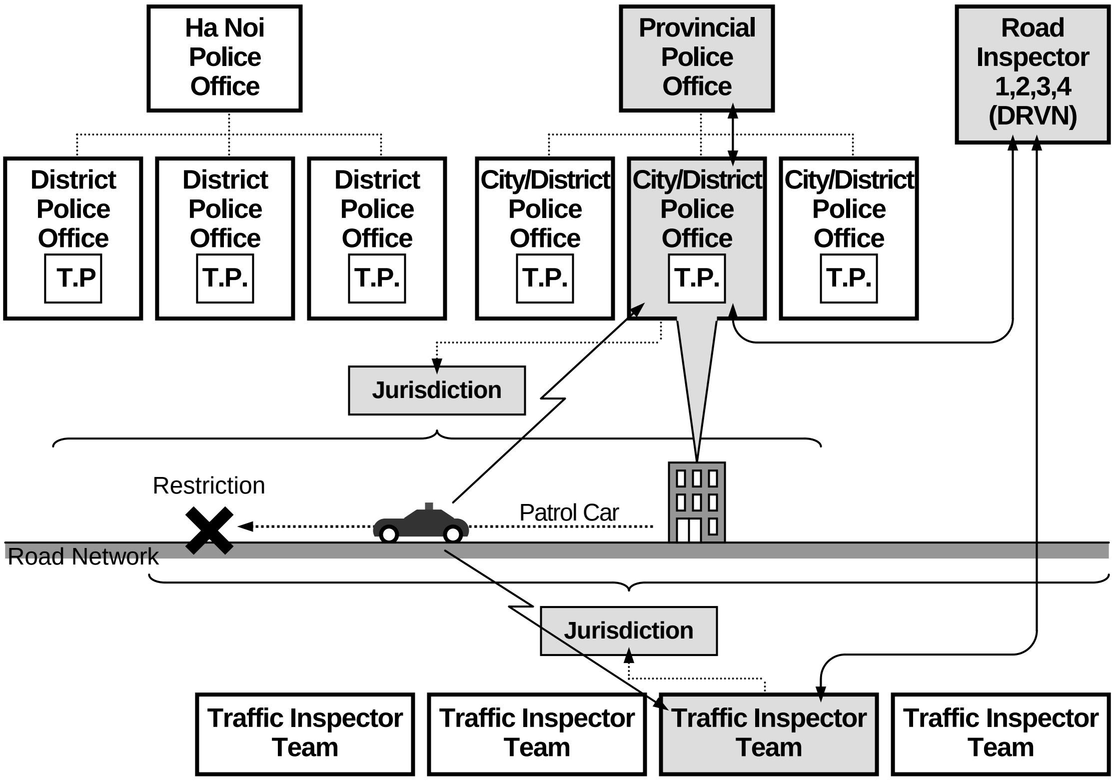
The following regulations are to be applied to the framework for traffic restriction:

- No. 23/2008/QH12: Law on Road Traffic
- MOPS Decision No. 18/2007/QĐ-BCA (C11): 113 Force and Traffic Police

These regulations include the clauses on traffic restriction at the occurrence of traffic accident. The accident site needs to be protected in order to rescue the injured and bring them to a hospital and to preserve belongings of the injured and goods of the vehicles concerned. The police who receive the accident notification have a responsibility to manage the traffic.

In case of bad weather, such as heavy rain or dense fog, an appropriate restriction need to be applied to the road traffic. However, there is no specific regulation on procedure to enforce traffic restrictions for bad weather. Only in case a typhoon is forecast to approach to Vietnam, measures such as a closure can be enforced by the General Committee of Storm and Flood Defend based on information from the National Center for Hydro-meteorological Forecasting.

Figure 5.24 Existing Framework for Traffic Restriction



Note: Police office of centralized governed cities: Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho
D.P. : Detective police to be dispatched for traffic accidents with fatalities
T.P. : Traffic police to be dispatched for traffic accidents without fatalities
Traffic Inspector under DRVN to be dispatched for traffic accidents with damaged infrastructure.

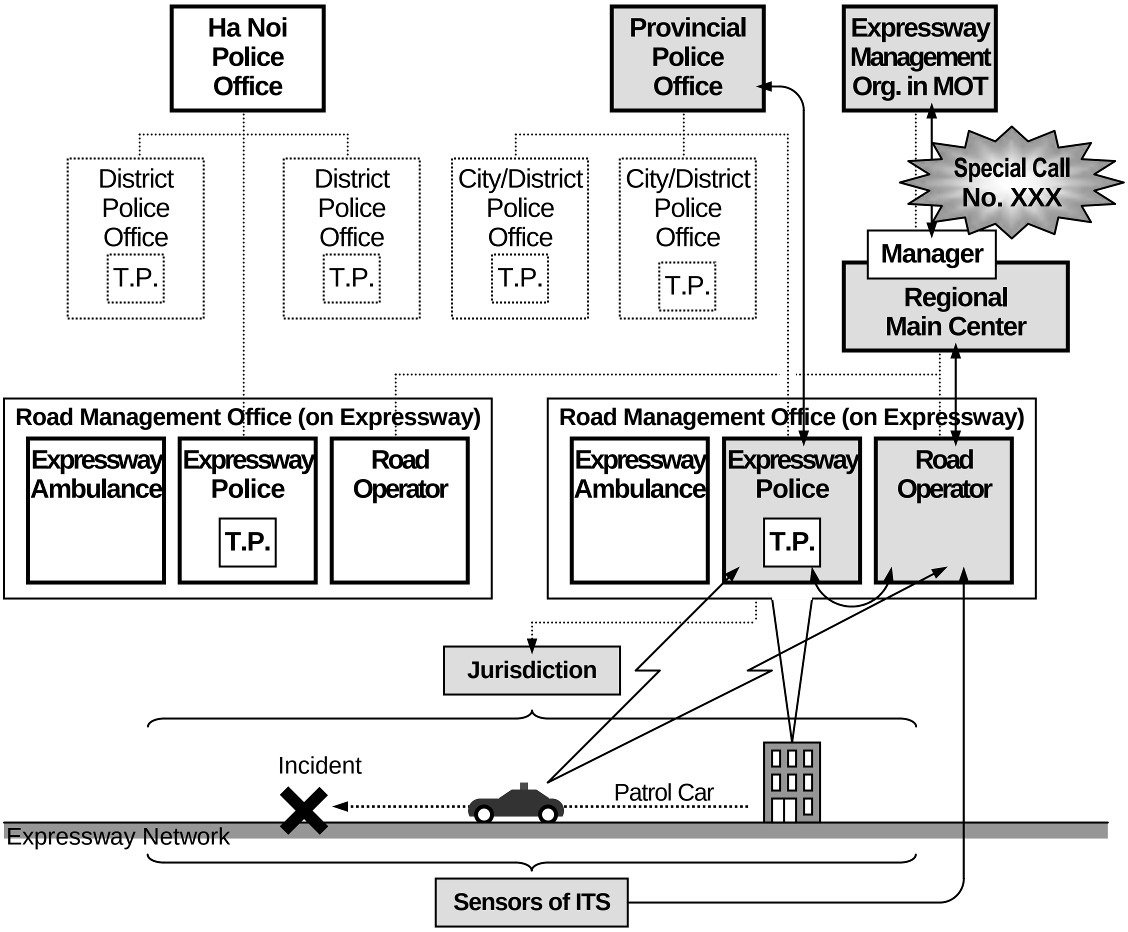
Source: ITS Integration Project (SAPI) Study Team

The decision to enforce a traffic restriction on a national highway is to be made by the traffic police officers or the traffic inspectors under DRVN as shown in the figure. However, in many cases, information for a reason of the decision is acquired only by a patrol, but the procedure and criteria for the decision are not clear.

2) Recommended Framework for Traffic Restriction on Expressway Network

It is recommended as a premise for discussion in the Study that the road operator, who makes decisions to enforce the traffic restrictions on the expressway as well as the police, is to be organized under the Expressway Management Organiation in MOT. In addition, the information for deciding the traffic restrictions is to be acquired through the special call number or sensors of ITS.

Figure 5.25 Recommended Framework for Traffic Restriction on Expressway Network



Note: Police office of centralized governed cities: Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho
D.P. : Detective police to be dispatched for traffic accidents with fatalities
T.P. : Traffic police to be dispatched for traffic accidents without fatalities
Crew of road operator under the Expressway Management Office to be dispatched for traffic accidents with damaged infrastructure.

Source: ITS Integration Project (SAPI) Study Team

Traffic restriction is to be enforced based on specific information, which consists of some traffic events such as incident, traffic congestion, bad weather, construction work and traffic restriction. The definitions of traffic events including traffic restrictions are shown in the following table.

Table 5.4 Definition of Traffic Events including Correlations

Category	Traffic Event		Definition	Traffic Event to be Correlated												
Special Event	Special Event		Special event which may prevent vehicle traffic	X	X	X	X	X	X	X	X	X	X	X	X	X
Incident	Traffic Accident		Serious traffic accident	X	X	X	X	X	X	X	X	X	X	X	X	X
	Incident in Tunnel		Incident in tunnel including fire	X	X	X	X	X	X	X	X	X	X	X	X	X
	Reverse Driving		Vehicle driven in the reverse direction	X	X	X	X	X	X	X	X	X	X	X	X	X
	Broken-down Vehicle		Vehicle stopping on the road	X	X	X	X	X	X	X	X	X	X	X	X	X
	Left Obstacle		Object*** on the road which may prevents vehicle traffic	X	X	X	X	X	X	X	X	X	X	X	X	X
	Natural Disaster		Natural disaster which may prevent vehicle traffic	X	X	X	X	X	X	X	X	X	X	X	X	X
	Vandalism		Wilful destruction of facilities or obstruction to traffic on the road	X	X	X	X	X	X	X	X	X	X	X	X	X
Construction Work	Construction Work		Construction work which may prevent vehicle traffic	X	X	X	X	X	X	X	X	X	X	X	X	X
Bad Weather	Heavy Rain	1	Heavy rain more than HR1 mm/h**	X	X	X	X	X	X	X	X	X				
		2	Heavy rain more than HR2 mm/h**	X	X	X	X	X	X	X					X	
		3	Heavy rain more than HR3 mm/h**	X	X	X	X	X	X	X						X
	High Wind	1	High wind more than HW1 m/sec** on average	X	X	X	X	X	X	X	X	X				
		2	High wind more than HW2 m/sec** on average	X	X	X	X	X	X	X					X	
		3	High wind more than HW3 m/sec** on average	X	X	X	X	X	X	X						X
	Dense Fog	1	Dense fog with visibility less than DF1 m**	X	X	X	X	X	X	X	X	X				
		2	Dense fog with visibility less than DF2 m**	X	X	X	X	X	X	X					X	
		3	Dense fog with visibility less than DF3 m**	X	X	X	X	X	X	X						X
	High Temperature		High temperature more than HT1 degrees C**													
Traffic Congestion	Congestion on Trough Lanes	1	VS continuously slower than V1 km/h** on av. with VQ longer than 4 km													
		2	VS continuously slower than V1 km/h** on av. with VQ longer than 2 km													
		3	VS continuously slower than V1 km/h** on av. with VQ longer than 1 km													
	Crowdedness on Trough Lanes		VS slower than V1 km/h** on av. with no or short VQ													
	Congestion at Exit	1	VS continuously slower than V1 km/h** on av. with VQ longer than 4 km at exit													
		2	VS continuously slower than V1 km/h** on av. with VQ longer than 2 km at exit													
		3	VS continuously slower than V1 km/h** on av. with VQ longer than 1 km at exit													
Traffic Restriction	Entry Closure		Restriction to stop inflow traffic at entrance													
	Closure		Restriction to stop traffic on through lanes													
	Exit Closure		Restriction to stop traffic at exit													
	Lane Closure		Restriction to stop through traffic partially on some lanes													
	Speed Limitation	1	Restriction to limit the fastest vehicle speed less than 50 km/h													
		2	Restriction to limit the fastest vehicle speed less than 80 km/h													

Note: VS: Vehicle speed, VQ : Vehicle queuing, ** : Specific values are to be defined, *** : Excluding vehicles.

As shown in the tables below, the traffic restrictions responding to traffic events are to be applied to the expressway network with reference to existing system for the national highways. In our recommendation, the traffic restrictions responding to the incidents caused by the vehicles are to be enforced under the decisions of the traffic police and that responding to the other kind of incidents, bad weather and construction work are to be decided by the Expressway Management Organization in MOT.

Table 5.5 Recommended Traffic Restriction System for Expressway Network

Category	Traffic Event	Information Source	Traffic Restriction				Final Decision Maker
			W	SL.	LC.	C.	
Special Event	Special Event	Submitted Materials	XX	XX	XX	XX	TP (MOT**)
Incident	Traffic Accident	Camera, Tel, Patrol	XX	XX	XX	XX	TP (MOT**)
	Tunnel Fire	Camera, Tel, Patrol	XX	XX	XX	XX	TP (MOT**)
	Reverse Driving	Camera, Tel, Patrol	XX	XX	XX	XX	TP (MOT**)
	Broken-down Vehicle	Camera, Tel, Patrol	XX	XX	XX	XX	TP (MOT**)
	Left Obstacle	Camera, Tel, Patrol	XX	XX	XX	XX	RO (MOT**)
	Natural Disaster	Camera, Tel, Patrol	XX	XX	XX	XX	RO (MOT**)
	Vandalism	Camera, Tel, Patrol	XX	XX	XX	XX	RO (MOT**)
Construction Work	Construction Work	Submitted Materials	XX	XX	XX	XX	RO (MOT**)
Bad Weather	Heavy Rain	WFC, Sensor, Patrol	XX	XX		XX	RO (MOT**)
	High Wind	WFC, Sensor, Patrol	XX	XX		XX	RO (MOT**)
	Dense Fog	WFC, Sensor, Patrol	XX	XX		XX	RO (MOT**)
Traffic Congestion	Traffic Congestion	Camera, Tel, Patrol	XX			XX	RO (MOT**)

Note: Tel: Telephone call, WFC: Weather forecasting, W: Warning, SL: Speed limitation, LC: Lane closure, C: Closure, exit closure or entry closure, TP: Traffic police, RO: Road operator, **: Speed limitation, lane closure and closure are to be enforced receiving the permission of the Expressway Management Organization in MOT.

Table 5.6 Existing Traffic Restriction System for National Highways

Category	Traffic Event	Information Source	Traffic Restriction				Final Decision Maker
			W	SL.	LC.	RC.	
Special Event	Special Event	Submitted Materials	XX	XX	XX	XX	TP (DRVN)
Incident	Traffic Accident	Tel, Patrol	XX		XX	XX	TP (DRVN)
	Tunnel Fire	Tel, Patrol	XX			XX	TP (DRVN)
	Reverse Driving	Tel, Patrol	XX				TP (DRVN)
	Broken-down Vehicle	Tel, Patrol	XX		XX	XX	TP (DRVN)
	Left Obstacle	Tel, Patrol	XX		XX	XX	DRVN
	Natural Disaster	Tel, Patrol	XX		XX	XX	DRVN
	Vandalism	Tel, Patrol	XX			XX	DRVN
Construction Work	Construction Work	Submitted Materials	XX	XX	XX	XX	DRVN
Bad Weather	Heavy Rain	WFC, Patrol	XX			XX	DRVN
	High Wind	WFC, Patrol	XX				DRVN
	Dense Fog	WFC, Patrol	XX				DRVN
Traffic Congestion	Traffic Congestion	Tel, Patrol	XX				

Note: Tel: Telephone call, WFC: Weather forecasting, W: Warning, SL: Speed limitation, LC: Lane closure, RC: Road closure, TP: Traffic police.

5.4.6 Framework for Road/Traffic Monitoring

1) Conditions of Road/Traffic Monitoring on Existing Roads

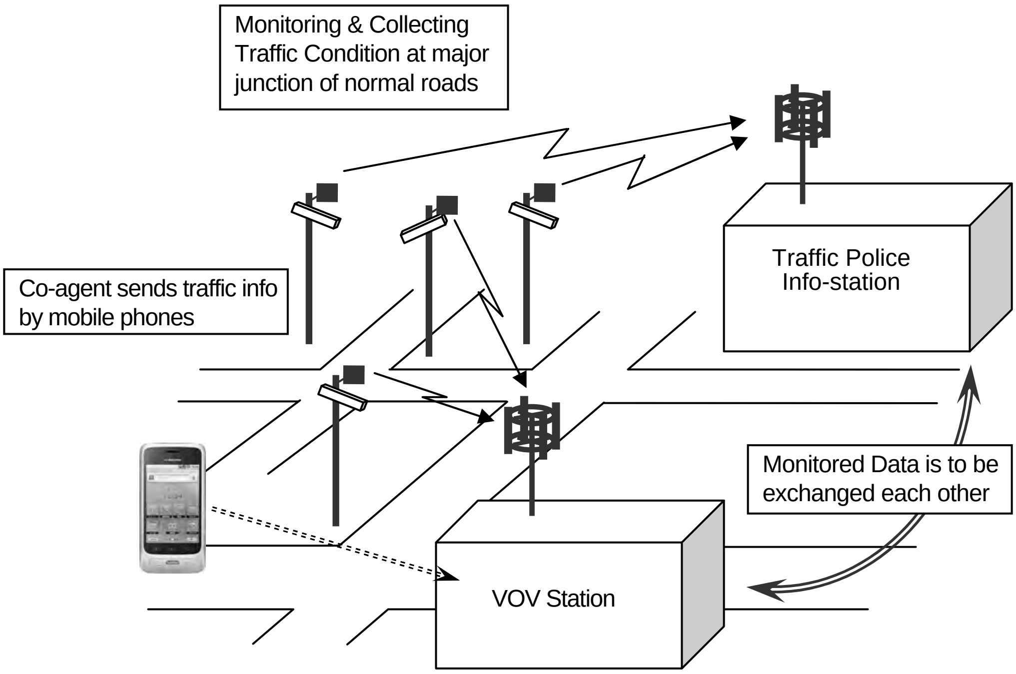
As for the road/traffic Monitoring on Existing Roads, there seems to be no clear framework related to road management organization. In Hanoi area, the road/traffic monitoring is currently made by mainly VOV and Traffic Police, and they exchange monitored information each other.

The road/traffic monitoring of VOV is implemented in Hanoi and HCM city currently and it will be extended to whole NH1 route. Although the road/traffic information is collecting from CCTV camera, major information is provided by the people who are driving on the roads and by the VOV reporters and collaborators. The collecting information is mainly traffic jam, heavy traffic, and construction site. There is no weather sensor monitored by VOV, however the weather information is received from Center of Weather Forecast.

VOV installed 66 CCTV cameras in major intersections in urban area of Hanoi city, and the monitored moving image is transmitted to VOV center with wireless communication. The cameras are able to control from VOV center. The collected images are provided to traffic police also and utilized for its purpose.

On the other hand, the traffic police installed 20 CCTV cameras at major intersections within the area of Ring Road 3 in Hanoi and monitoring them. The Hanoi Traffic Police has a plan to install 60 CCTV cameras additionally in 2011. The monitored moving image is transmitted to traffic police center through optical fiber cable. In this system, the image processing technology is not applied, and only utilized for visual judgment. The monitored images are provided to VOV also.

Figure 5.26 Existing Framework for Road/Traffic Monitoring



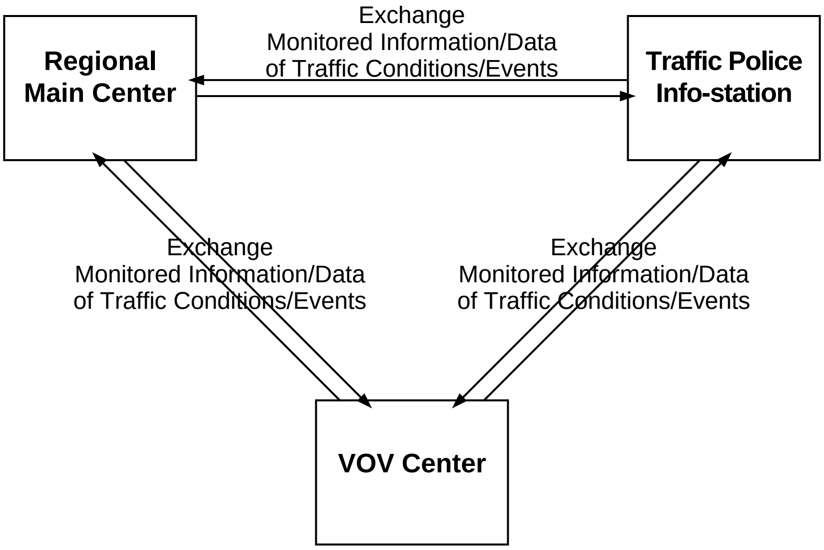
Source: ITS Integration Project (SAPI) Study Team

2) Recommended Framework for Road/Traffic Monitoring on Expressway Network

The road/traffic conditions are to be monitored continuously by operators in the Regional Main Center. Occurrences of incidents and other traffic events also are to be monitored or detected In the Regional Main Center. These monitored information/data of traffic conditions/ events are to be transferred to the Traffic Police Station and the VOV Center.

On the other hand, the information/data of traffic conditions/events on the national highways or the arteries around the exits of expressways are to be exchanged among the Regional Main Center, the Traffic Police Station and the VOV Center in the framework below.

Figure 5.27 Recommended Framework for Road/Traffic Monitoring on Expressway Network



Source: ITS Integration Project (SAPI) Study Team

5.4.7 Framework for Traffic Event Data Management

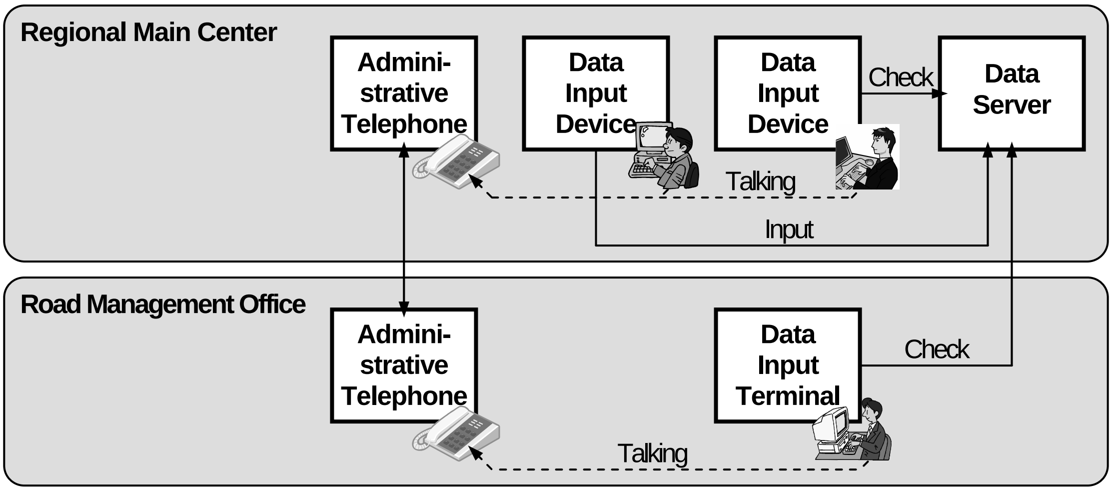
1) Expected Procedures of Traffic Event Data Management

The following three procedures, with details shown in the following figures, are to be allowed for inputting traffic event data:

- By an operator in the Regional Main Center
- By an operator in the road management office
- By patrol personnel on site through a mobile data input terminal.

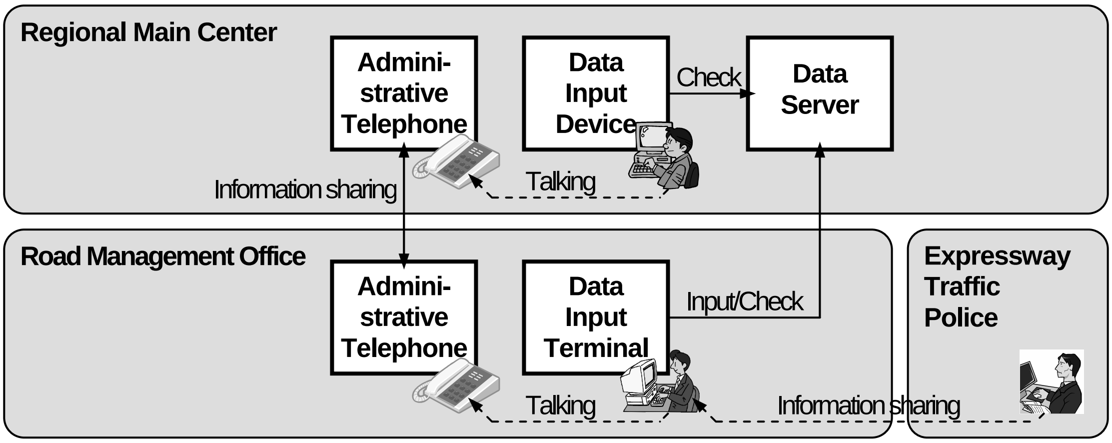
In all cases, it is required to receive approval of responsible persons in the Regional Main Center and the road management office. Through this doubled approval, traffic event data can be generated appropriately even in the case that operating body of the Regional Main Center which is in charge of traffic information/control is different from the road management office which is in charge of patrol for current traffic condition surveillance. Data input without the approval by the Regional Main Center and/or that by the road management office is to be given the status "non-approved", and is not to be used for traffic information/Control.

Figure 5.28 Traffic Event Data Input by "Staff in the Regional Main Center"



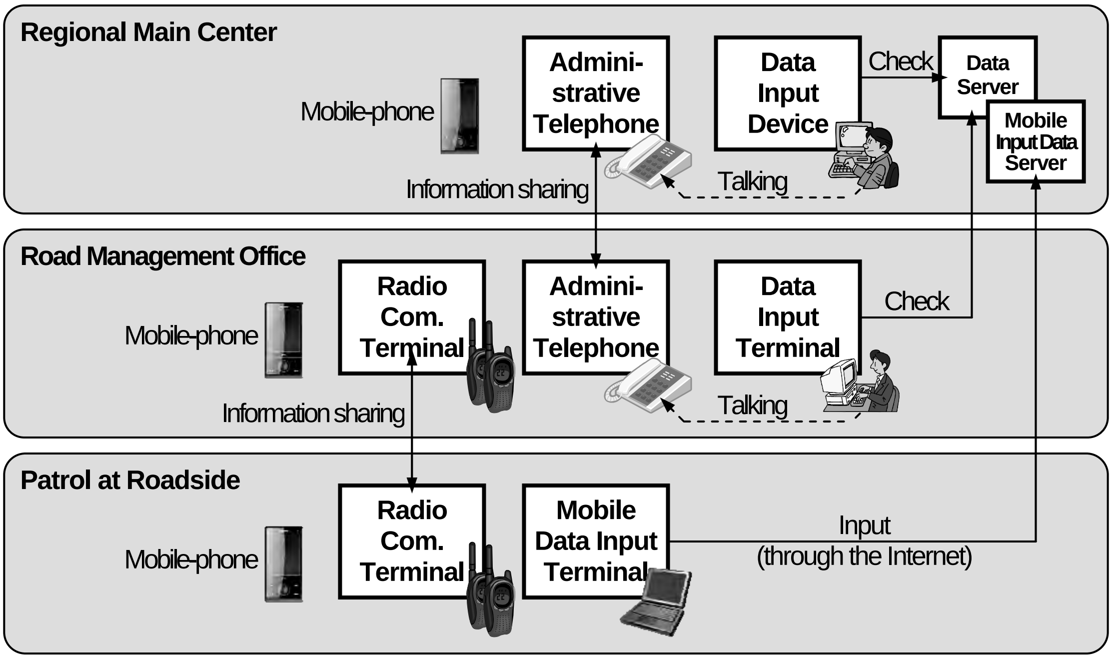
Source: ITS Standards & Operation Plan Study Team

Figure 5.29 Traffic Event Data Input by "Staff in Road Management Office"



Source: ITS Standards & Operation Plan Study Team

Figure 5.30 Traffic Event Data Input by "Patrol Staff at Roadside"



Source: ITS Standards & Operation Plan Study Team

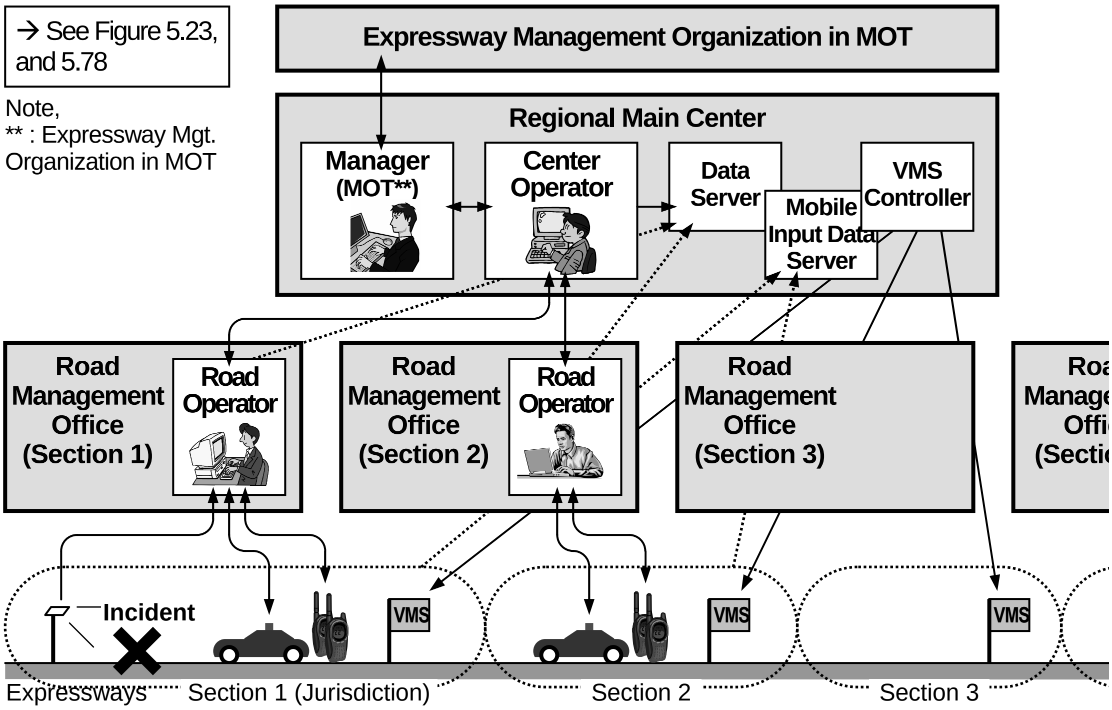
2) Recommended Framework for Traffic Event Data Management on Expressway Network

When a traffic event is identified, its data can be input directly at a road management office or roadside as well as the Regional Main Center. The validity of the data needs to be checked at both the Regional Main Center and the road management office. Especially in case of a closure of expressway, the check is to be done for getting permission by the inspector under the Expressway Management Organization in MOT assigned in the Regional Main Center.

Figure 5.31 Recommended Framework for Traffic Event Data Management

→ See Figure 5.23, and 5.78

Note,
** : Expressway Mgt. Organization in MOT



Source: ITS Integration Project (SAPI) Study Team

5.4.8 Framework for Traffic Information Dissemination

1) Conditions of Traffic Information Dissemination

In order to cut down the situations of traffic congestion and accident in cities nationwide, General Director of VOV (Voice of Vietnam) has issued a decision to set up “Traffic VOV”. In the short term, the channel broadcasts 18 hours per day (from 6:00 to 24:00) and be available in Hanoi area providing information of traffic condition for the capital. The trial broadcasting started from 11:00 on 18th May 2009 to the official broadcasting time on 21st June 2009.

The main content of Traffic VOV is traffic information and guidance to drivers as well as road authorities. The live broadcasting of traffic information and guidance is on rush hours from Monday to Friday weekly: 6:30–8:30, 11:00–12:00 and 16:30–19:00 (the duration is more than 30% of total broadcasting time). On Sunday, the live broadcasting starts from 17:00 to 18:00. The remaining time is for providing traffic related information such as transport culture, urban transport, transport means and information related to politics, economic, culture, social, sport, music and advertisements. Road users can access traffic information via Radio, SMS, or direct call to Information Center. The hot line of Traffic VOV (04) - 6.272.9191/ 6.282.9191/ 6.292.9191.

With the continuing broadcasting daily, Traffic VOV mostly satisfies drivers about traffic information in their trips. General news of traffic issue, on-time announcement of traffic situation as well as weather condition in routes, warnings of accident possibility, guide of optimal routes for drivers will be broadcasted lively via voice broadcasting wave to listeners based upon the actual information in site.

Figure 5.32 Traffic Monitoring Centre and Sound Recording Room

Source: VITRANSS 2 Study Team

At this moment, Hanoi city has installed 40 cameras at major intersections since April of this year, to provide traffic information to Traffic Signal Controlling Center to manage and control traffic for reducing congestion and accident. Hanoi Public Security has assigned the task to Department of Traffic Police in combination with Voice of Vietnam.

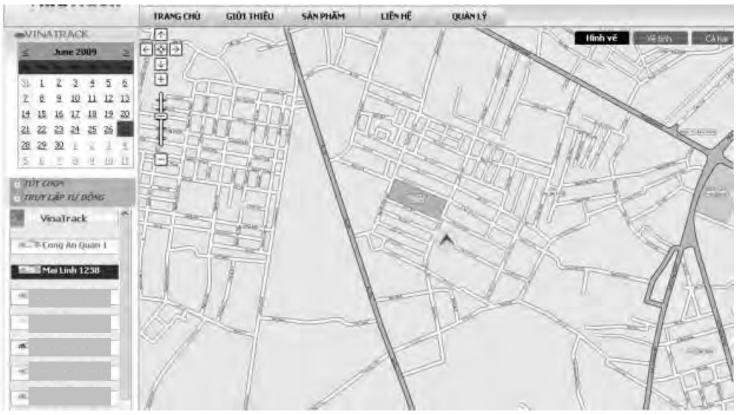
According to the plan of VOV, 100 cameras will be installed at 60 stations in the center of Hanoi for continuing recording traffic situation to transmit to National Voice Broadcasting Center.

With high significance, the project of Traffic VOV has been added to the list of major programs towards Festival of 1000 years Thang Long–Hanoi.

And more, as it discussed section before, some bus and taxi company have already installed the GPS monitoring system for their driving location at their own operation centre. (Figure below shows the sample of GPS trucking application software for Vina Track)

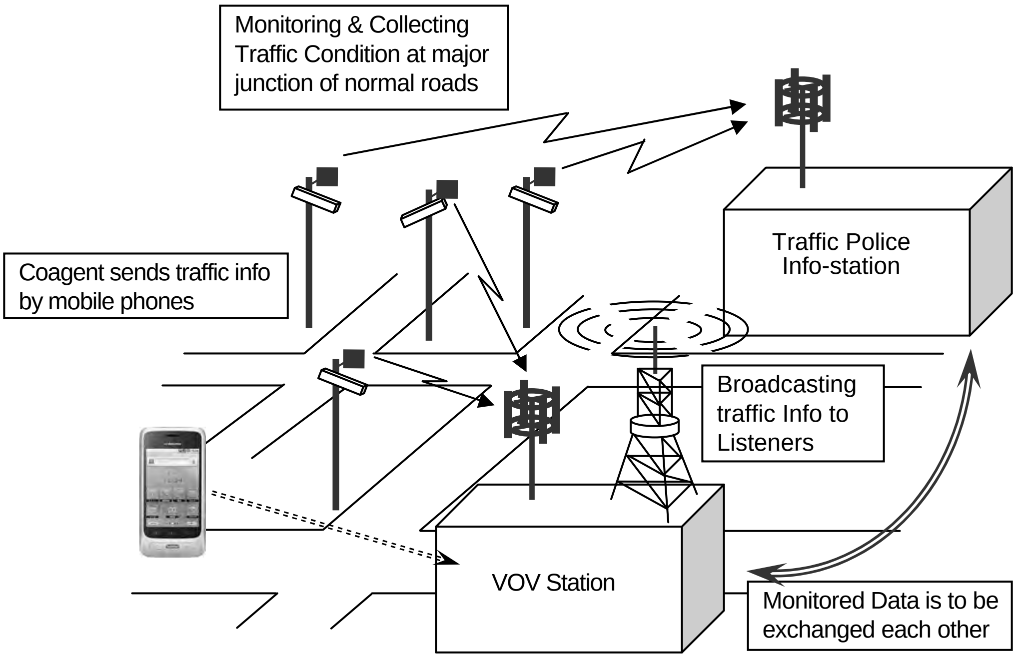
If actual traffic conditions is able to be acquired from these systems, more reliable and systematic traffic data will be provided in future.

Figure 5.33 Sample of GPS Tracking Application Software



Source: Vinatrack JSC

Figure 5.34 Existing Framework for Traffic Information Dissemination

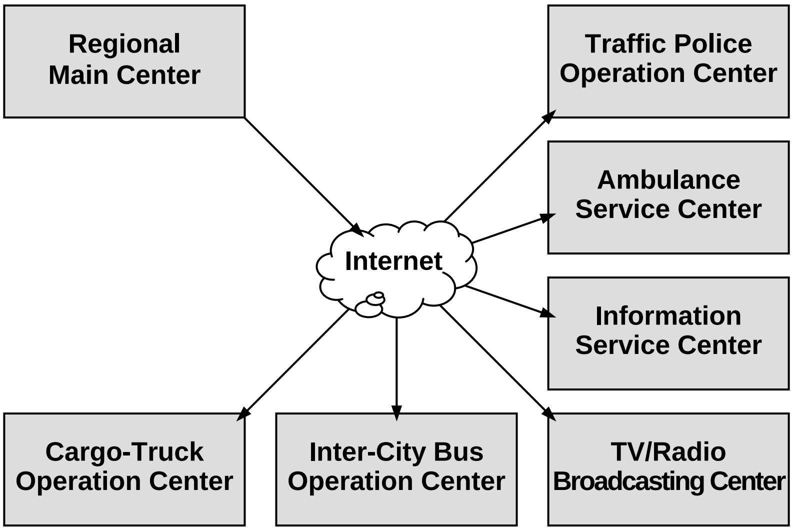


Source: ITS Integration Project (SAPI) Study Team

2) Recommended Framework for Traffic Information Dissemination

Traffic Information, which consists of standardised messages and standardised data elements, is to be disseminated to organizations concerned through the Internet.

Figure 5.35 Recommended Framework for Traffic Information Dissemination



Source: ITS Standards & Operation Plan Study Team

5.5 Framework for Toll Management

5.5.1 Key Framework

1) Conditions of Toll Management on Existing Roads

In Vietnam, there are 63 toll booths which are installed in 2008. The list of these tool booths are shown in the table below. The following figure shows the location of toll booths in 2004. Since 2003, 5 booths have been already implemented as a non-stop toll collection by infrared method. There are also other one-stop toll booths which are applied "barcode receipts".

Table 5.7 Toll Booths along National Highway Network as of 2008

No.	Name of Road	Name of Tollbooth	Station (Km)	Operator	Province	State Management Agency	No. of Lane	Toll Collection Method	Moving to One stop collection	Combination with free flow
Toll booths under VRA management										
1	NR 1	Hoang Mai	391	RRMU IV	Nghe An	VRA	4	One Stop	completed	
2	NR 1	My Thuan	2027	RRMU VII	Tien Giang	VRA	8	One Stop	completed	
3	NR 6	Chuong My	31	RRMU II	Ha Noi	VRA	4	One Stop	completed	
4	NR 14	No. 4	731	RRMU V	Dac Lac	VRA	6	One Stop	completed	
5	NR 14	No. 2	957	RRMU VII	Binh Phuoc	VRA	6	One Stop	completed	
6	NR 1	Luong Met	97	RRMU II	Lang Son	VRA	6	Two Stop	under construction	
7	NR 1	Phu Bai	840	RRMU IV	Th.Th. Hue	VRA	6	Two Stop	under construction	under appraisal
8	NR 1	North Hai Van tunnel	892	RRMU IV	Th.Th. Hue	VRA	3	Two Stop	under construction	under appraisal
9	NR 1	Sourth Hai Van tunnel	902	RRMU V	Da Nang	VRA	3	Two Stop	under construction	under appraisal
10	NR 2	Viet Tri	54	RRMU II	Vinh Yen	VRA	4	Two Stop	under construction	
11	NR 3	Soc Son	30	RRMU II	Ha Noi	VRA	4	Two Stop	under construction	
12	NR 10	Tien Cuu	41	RRMU II	Hai Phong	VRA	6	Two Stop	under construction	
13	NR 18	Pha Lai	21	RRMU II	Hai Duong	VRA	4	Two Stop	under construction	
14	NR 21	My Loc	137	Nam Dinh DOT	Nam Dinh	VRA	4	Two Stop	under construction	
15	NR 1	Ninh An	1408	RRMU V	Khanh Hoa	VRA	6	Two Stop	under bidding	
16	NR 18	Uong Bi	58	Quang Ninh DOT	Quang Ninh	VRA	4	Two Stop	under bidding	
17	NR 20	Dinh Quan	52	RRMU VII	Dong Nai	VRA	4	Two Stop	under bidding	
18	NR 32	Trung Ha	63	Phu tho DOT	Phu Tho	VRA	4	Two Stop	under bidding	
19	NR 38	Cau Ho	10	RRMU II	Bac Ninh	VRA	4	Two Stop	under bidding	
20	NR 1	Gianh	625	RRMU IV	Quang Binh	VRA	6	Two Stop	project approved	
21	NR 18	Ba Che	198	Quang Ninh DOT	Quang Ninh	VRA	2	Two Stop	designed appraised cost estimation is under appraisal	
22	NR 1	Cam Thinh	1517	RRMU V	Khanh Hoa	VRA	6	Two Stop	prooject documents is under revision	
23	NR 7	Yen Thanh	18	RRMU IV	Nghe An	VRA	4	Two Stop	prooject documents is under revision	
24	NR 8	Hong Linh	2	RRMU IV	Ha Tinh	VRA	4	Two Stop	prooject documents is under revision	
25	NR 80	Lo Te	65	RRMU VII	Kien Giang	VRA	4	Two Stop	prooject documents is under revision	
26	NR 14	Buon Ho	681	RRMU V	Dac Lac	VRA	4	Two Stop	under appraisal	
27	NR 19	Nhon Tan	30	RRMU V	Binh Dinh	VRA	4	Two Stop	under appraisal	
28	NR 26	Madrak	62	RRMU V	Dac Lac	VRA	4	Two Stop	under appraisal	
29	NR 37	Cau Binh	17	RRMU II	Hai Duong	VRA	6	Two Stop	wating for MOT opinion on utilizationi of Da Bac equipment	
30	NR 14	No. 3	871	RRMU V	Dac Nong	VRA	4	Two Stop	waiting for moving to other location	
31	NR 19	Chu A	120	RRMU V	Gia Lai	VRA	4	Two Stop	waiting for moving to other location	
32	NR 20	Duc Trong	203	RRMU VII	Lam Dong	VRA	4	Two Stop	waiting for moving to other location	
33	NR 22A	Suoi Sau (Go Dau)	30	RRMU VII	Tay Ninh	VRA	6	Two Stop	waiting for moving to other location	
34	NR 1	Ban Thach (Da Rang)	1333	RRMU V	Phu Yen	VRA	4	Two Stop	wating for authorization of toll collection to other body	
35	NR 18	Bai Chay	114	Quang Ninh DOT	Quang Ninh		8	Two Stop	wating for authorization of toll collection to other body	
36	Thang Long - Noi Bai	Noi Bai	10	RRMU II	Ha Noi	VRA	8	Two Stop	wating for authorization of toll collection to other body	under appraisal
37	NR 51	No. 1	11	RRMU VII	Dong Nai	VRA	8	Two Stop	wating for authorization of toll collection to other body	
Toll booths under BOT project or under authorized toll collection companies										
38	LHL	Km15	15	RRMU II	Ha Noi	VINACONEX	4	Two Stop		
39	NR 1	Lien Chieu	917	Da Nang DOT	Da Nang	Da Nang PC	4	Two Stop		
40	NR 1	Phu Dong	159	RRMU II	Ha Noi	VEC	8	Two Stop		
41	NR 1	Nam Cau Gie	226	Hai Chau Group	Ha Nam	VEC	6	Two Stop		
42	NR 1	An Suong-An Lac	1910	ASAL BOT	Ho Chi Minh	ASAL BOT	12		completed	Completed
43	NR 1	Song Phan	1725	RRMU VII	Binh Thuan	CC1 BOT	6	Two Stop	designed appraised	
44	NR 1	Tao Xuyen	318	Thanh Hoa Bypass BOT	Thanh Hoa	Cienco1 BOT	4	Two Stop	under construction	
45	NR 1	Ben Thuy	468	Vinh Bypass BOT	Nghe An	Cienco4 BOT	4	One Stop	completed	
46	NR 1	Hoa Cam-Hoa Phuoc		HCHP BOT	Da Nang	Cienco5 BOT	6	One Stop	under completion	
47	NR 1	Tam Ky	965	Hiep Phuoc BOT	Quang Nam	Hiep Phuoc BOT	4	Two Stop		
48	NR 1	Deo Ngang Tunnel	592	Deo Ngang BOT	Ha Tinh	Song Da BOT	6	Two Stop	under documents revision/waiting for handover	
49	NR 1	Dong Ha	770	RRMU IV	Quang Tri	Truong Thinh BOT	6	Two Stop		
50	NR 1	Cau Rac	539	RRMU IV	Ha Tinh	BOT...	6	Two Stop		
51	NR 1	Quan Hau	671	RRMU IV	Quang Binh	BOT...	6	Two Stop		
52	NR 1K	T1-T2		NR 1K - BOT	Ho Chi Minh	NR1K BOT	6	Two Stop		
53	NR 2	T1-T2		Noi Bai - Vinh Yen BOT	Vinh Yen	Associated BOT	3	One Stop	completed	
54	NR 2	T2		Noi Bai - Vinh Yen BOT	Vinh Yen	Associated BOT	3	One Stop	completed	
55	NR 5	Km 18	18	Dai Duong Co.	Hung Yen	VIDIFI	8	Two Stop	under project preparation	
56	NR 5	Quan Toan	83	Dai Duong Co.	Hai Phong	VIDIFI	8	Two Stop	under project preparation	
57	NR 10	Tan De	98	Tasco BOT	Thai Binh	TASCO	6	Two Stop	under appraisal	
58	NR 13	Thu Dau Mot	20	BECAMEX	Binh Duong	Binh Duong PC	6	Combination 1-stop&2stop		
59	NR 21	Do Quan	150	Nam Dinh DOT	Nam Dinh	Nam Dinh PC	4	Two Stop		
60	NR 37	Nong Tien	136	Company Ltd.	Tuyen Quang	Tuyen Quang DOT	4	Two Stop		
61	NR 39	Trieu Duong	44	Thai Binh DOT	Thai Binh	Thai Binh DOT	4	Two Stop		
62	NR 50	Cau Ong Thin	11	CIENCO 5- BOT	Ho Chi Minh	Cienco 5 - BOT	6	Two Stop		
63	NR 51	Co May	70	Hai Chau-BOT	B.Ria V.Tau	Hai Chau	8	Two Stop		

Source: VITRANSS 2 Study Team

(1) MOT's Response for the Modernization Plan

In the official Letter No. 2740/GTVT-KHCN to VRA dated May 10, 2005 regarding "Modernization of tollbooth network along national highways", MOT stated below opinion:

- Semi-automatic toll collection: Barcode technology is applied for one-stop collection.
- Automatic toll collection: Data communication by WL technology will be applied for non-stop collection. The prepaid account will be deducted after every passing time of vehicle through toll booth with speed approximately 30 km/h.
- To explain on selected technology among Microwaves and Infrared, the combination of both technologies is recommendable.
- For the toll Station have less 6 lanes will applied one-stop technology only
- For the toll Station have 6 lane or more will applied none-stop technology in 2 middle lanes, the other lanes will applied one-stop technology"

Figure 5.36 Photos of One-Stop Toll Collection

Upper: Hanoi Highway
Middle: Binh Bridge
Lower: NR13 by BECAMEX

Source: Oriental Consultants Co.,Ltd

Figure 5.37 Tollgate Lanes and Monitor Screen at Binh Bridge in Hai Phong Province

Source: Oriental Consultants Co.,Ltd.

Figure 5.38 Tollgate Lanes and OBU with IC-card at Ha Noi Highway in HCMC

Source: VITRANSS 2 Study Team

ETC (Electronic Toll Collection) systems have been installed in the following tollgates described later.

- Binh Bridge Toll Plaza in Hai Phong Province (ETC installed in 2 lanes in 2006)
- Ha Noi Highway Toll Plaza in HCMC (ETC installed in 2 lanes in 2007)
- Kinh Duong Vuong Toll Plaza in HCMC (ETC installed in 2 lanes in 2007)
- Binh Duong Boulevard Toll Plaza in Binh Duong Province (ETC installed in 4 lanes in 2007 and additional 4 lanes in 2008)

These systems adopted IR (Infrared Ray) communication for the data exchange between roadside and the vehicle.

(2) Notices for the ETC lane for Gau Gie–Ninh Binh Expressway

There is a notice, 41/TB-BGTVT, on conclusions by vice minister, Mr. Ngo Thinh Duc, on implementation of package 10.1 under Gie–Ninh Binh expressway construction project and technology standard for ITS for Expressway System in Vietnam on 10th February, 2009. It said that the concept of installation for ETC booth as below.

For toll plaza with 6 gates or more (3 gates for each way), pilot application of 1 gate for ETC could be considered, for toll plaza with 2 gates for each way, pilot application of 1 gate for mixed and closed type between Touch & Go and ETC could be considered.

After this notice, another notice has issued as Reviewing Result of Basic Design for Expressway of Cau Gie–Ninh Binh, 347/TB-BGTVT on 6th August, 2009 as below.

As for toll collection systems, vice minister has basically agreed with planned number of lanes, toll collection method, which is “ETC at middle lane” + “semi-automatic (one-stop) collection” + “manual collection”, and the most outside lane is for super length and super weight vehicles.

2-pieces OBU is recommended and 1-piece OBU introduction should be considered for appropriate roads

IC card should be used for automatic and semi-automatic toll collection systems. Communication method between OBU and roadside equipments should be DRSC 5.8 GHz. Toll collection method should allow toll clearance among tollgates through banks.

2) Existing Framework for Toll Management

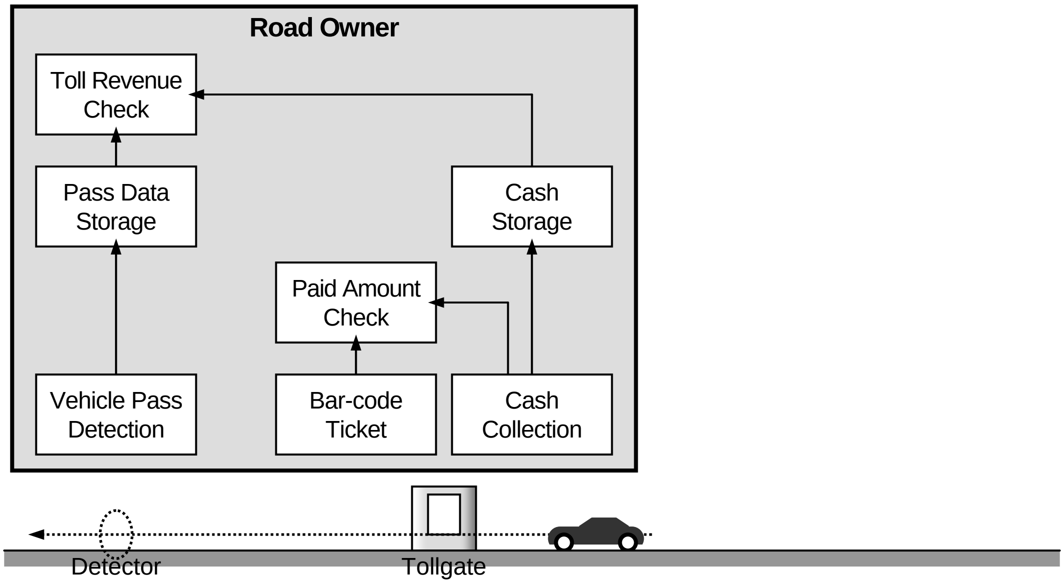
There exist three types of framework for toll management in Vietnam:

- Managed by the Government (as a road owner)
- Managed by a road owner
- Managed by a toll collection company.

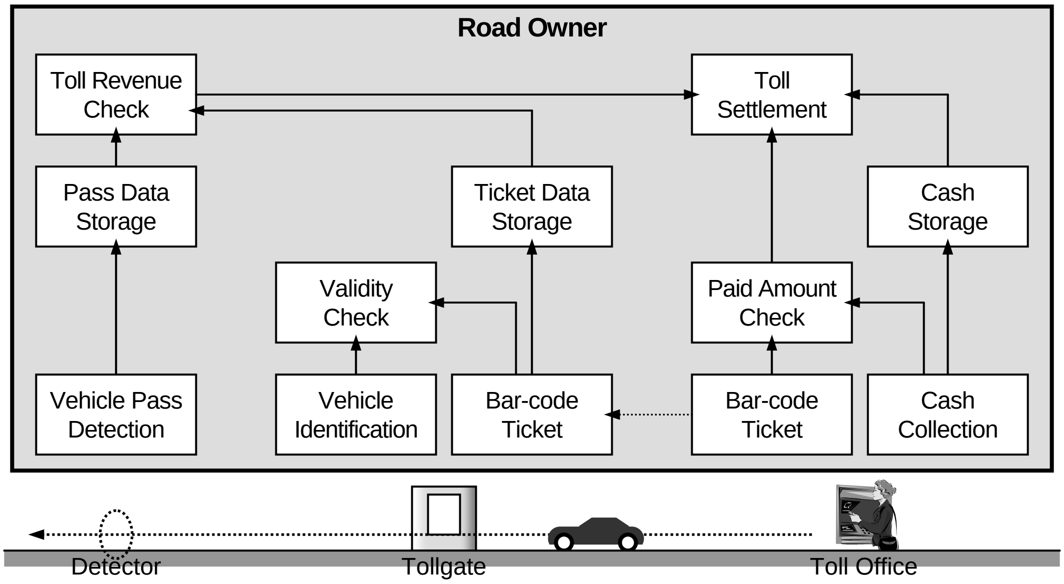
The first type of framework can be included in the second type and these two types are applied to toll collection by cash and bar-code ticket as shown in the following two figures. There can be many different types of framework for toll management; however, the process to check the toll revenue needs to be executed by the road owner in the all frameworks.

Figure 5.39 Existing Framework for Toll Management by Road Owner

Pay by Cash

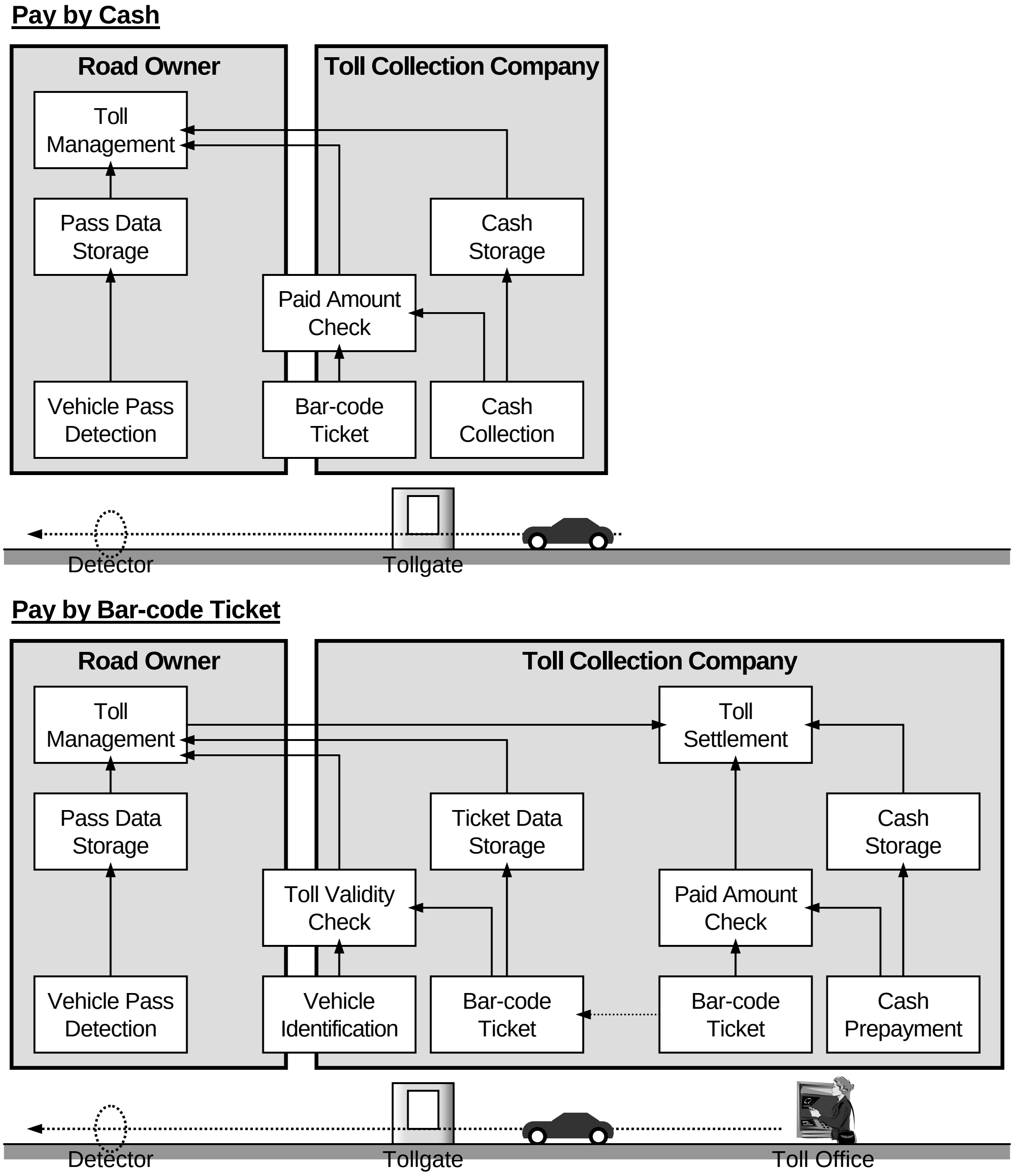


Pay by Bar-code Ticket



Source: ITS Integration Project (SAPI) Study Team

Figure 5.40 Existing Framework for Toll Management by Toll Collection Company



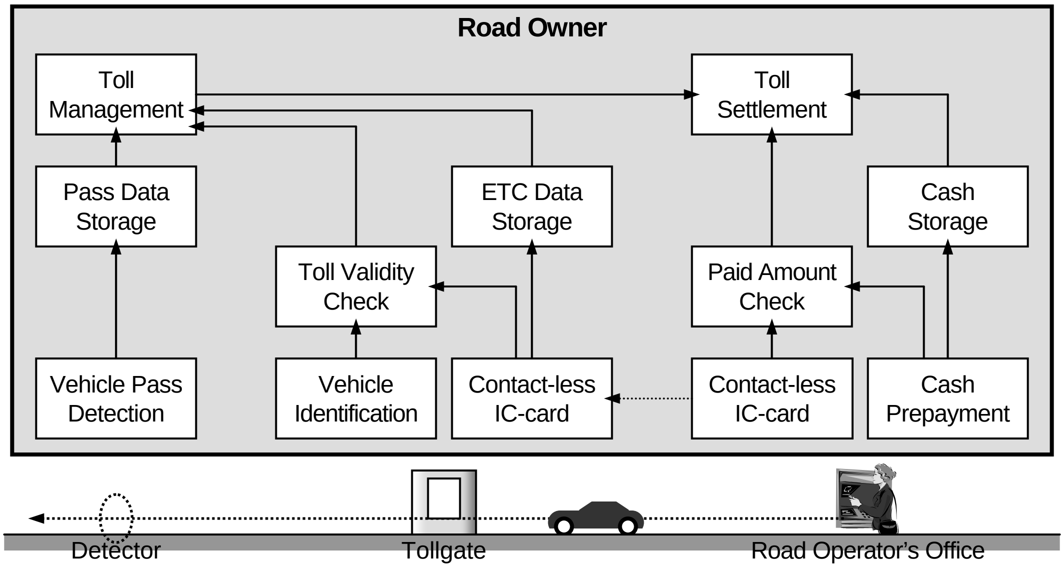
Source: ITS Integration Project (SAPI) Study Team

3) Applicable Framework for Toll Management using ETC

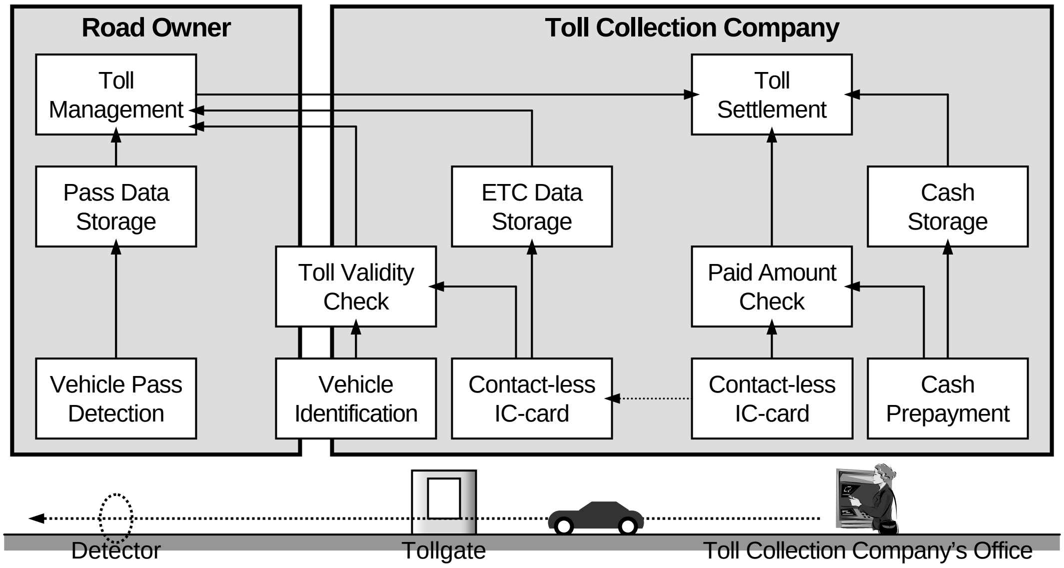
The traditional type of framework composed by the road owner and the toll collection company can be applied also to toll management using ETC as shown in the following figure. In this figure, only the bar-code ticket as a tool for checking paid amount in the previous figures is replaced to a contact-less IC-card.

Figure 5.41 Applicable Framework for Toll Management using ETC (1)

ETC Framework -0a



ETC Framework 0b



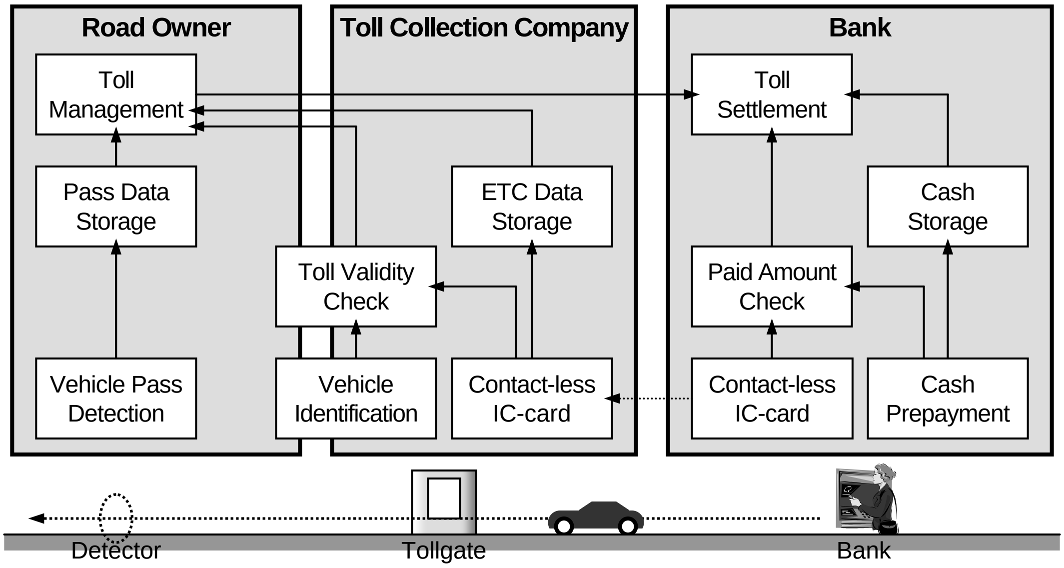
Source: ITS Integration Project (SAPI) Study Team

In addition, it is useful for road users that a contact-less IC-card is disseminated and available at ATMs in every branch office of a bank for recharging the prepaid balance recorded in it. For such benefit the processes of cash storage and toll settlement can be transferred to a bank as shown in the following figures. Accordingly, the "ETC Framework-1a" and "ETC Framework-1b" is recommended in the Study.

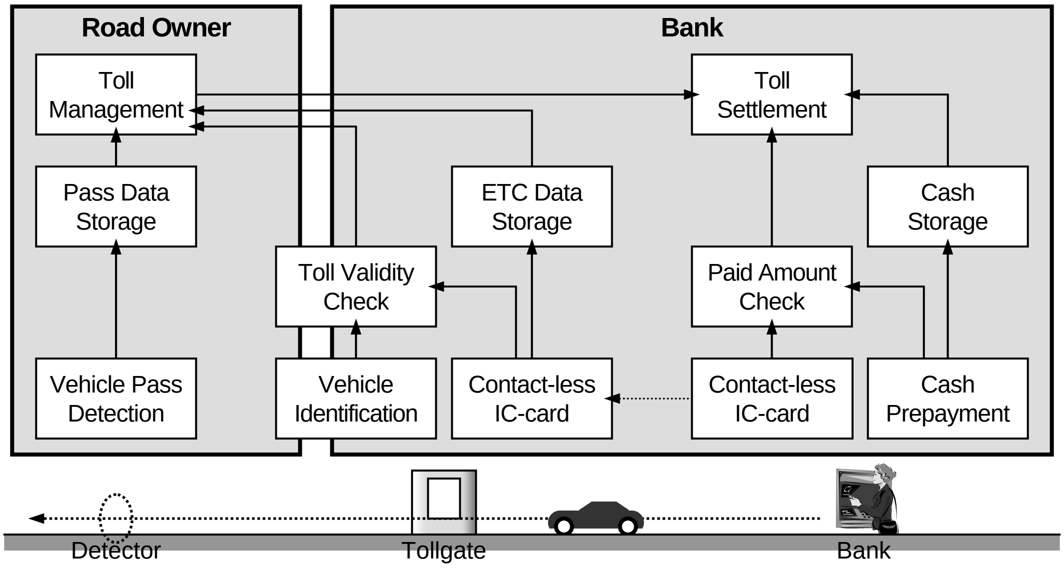
It is not a common framework for ETC in the world that the processes at the tollgate including vehicle identification and validity check are executed directly by a bank. Because, these processes need to be performed by a method with high reliability both for the road owner and the road user. Appropriate level of participation by a bank is to be determined by the Government of Vietnam.

Figure 5.42 Applicable Framework for Toll Management using ETC (2)

ETC Framework -1a



ETC Framework -1b



Source: ITS Integration Project (SAPI) Study Team

Table 5.8 Role Sharing on Toll Collection/Management

	Framework -0a,0b	Framework -1a	Framework -1b	Framework -2
Owner of Roadside Equipment	Road Owner, TCC	Road Owner, TCC	Road Owner, Bank	Bank
Owner of OBU **	Road Owner, TCC	Road Owner, TCC	Road Owner, Bank	Bank
Owner of IC-card ***	Road Owner, TCC	Bank	Bank	Bank
Cash Prepayment	Road Owner, TCC	Bank	Bank	Bank
Toll Collection (ETC)	Road Owner, TCC	Bank	Bank	Bank
Toll Validity Check	Road Owner	Road Owner	Road Owner	Bank
Toll Management	Road Owner	Road Owner	Road Owner	Bank
Toll Settlement	Road Owner	Road Owner	Road Owner	Bank
Grade	Not Suitable	Recommended (→ See Figure 5.45)	Recommended (→ See Figure 5.45)	Not Suitable

Note: TCC: Toll Collection Company, **: See Figure 5.58, ***: See Figures 5.50 and 5.51.

4) Road Owner's Offices Required for Toll Management

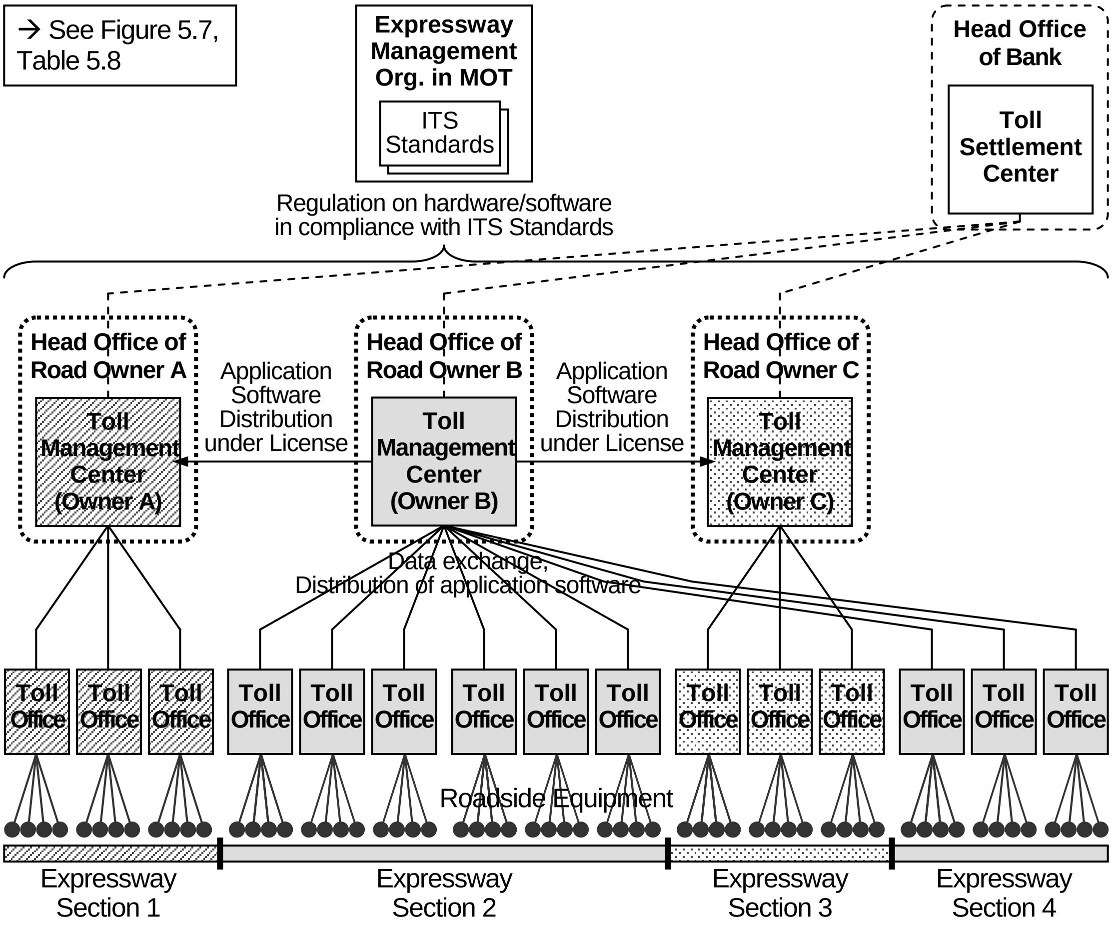
The expressway network in Vietnam will be shared among many different road owners; hence, the framework for toll management needs to be integrated based on separation for each operator.

- **Expressway Sections:** Road sections are shared among the road owners, and the road sections of different road owners are to be separated by barrier tollgates.
- **Toll Office:** Toll Office is to be established near the tollgate which include two or more tollbooths, and functions as toll collection.
- **Road Owner's Head Office:** Road Owner's Head Office means headquarters of road management offices and staffs under its organization, and includes a toll management center which manages toll offices. This office is to manage toll rate and toll revenue.

5) Recommended Framework for Toll Management of Expressway Network

The framework for toll management in the following figure, which includes many different road owners and a bank, is to be defined as a premise for discussion in the Study. The Standards on hardware/software is to be managed by the Expressway Management Organization in MOT and the application software is to distributed under license from the Regional Main Center.

Figure 5.43 Recommended Framework for Toll Management of Expressway Network



Note: ▍: Barrier tollgates between the expressway sections of different road operators

Source: ITS Integration Project (SAPI) Study Team

5.5.2 Framework for Toll Settlement

1) Recommended Payment Method

For introducing automated toll collection systems such as ETC and Touch&Go, toll settlement will be conducted by using contact-less IC-cards for prepayment. Comparison of various payment methods for toll collection is shown in the table below.

Table 5.9 Comparison of Various Payment Methods for ETC and Touch&Go

	Prepayment	Payment on Credit	Payment by Direct Debit
Outline	Toll fare is offset from the prepaid balance when OBU passes the tollgate. Deposit for prepayment ↓ OBU passes the tollgate ↓ Toll fare is offset from the prepaid balance	Toll fare is claimed later on to user's bank account by the credit company. Deposit in bank account ↓ Open a credit ↓ OBU passes the tollgate ↓ Passage data is sent to the credit company ↓ Toll fare is claimed later on by credit company	Toll fare is deducted later on from user's bank account by direct debit. Deposit in bank account ↓ OBU passes the tollgate ↓ Passage data is sent to the credit company ↓ Toll fare is deducted later on by direct debit
Available User	Unlimited	Limited to Credit Card Holder	Limited to Bank Account Holder
Suitability to Pay Small Amount	Good	Average	Average
Exclusive Means for Payment	Necessary	Not Necessary	Not Necessary
Good Quality Telecom.	Necessary	Indispensable	Indispensable
Familiarity in Vietnam	High	Not High	High
Grading	Recommended	Not Suitable	Average

Source: ITS Standards & Operation Plan Study Team

A single IC-card needs to be shared by many different road owners, and issue/recharge of the IC-card needs to be used conveniently in the city as well as the roadside. Adequate data exchange needs to be conducted for toll settlement between the toll management center of the road owner and the toll settlement center in the bank.

2) Expected Toll Settlement Frameworks

The following frameworks are compared for executing the toll settlement:

- Toll Settlement Framework -0 : unshared IC-cards issued by road owners
- Toll Settlement Framework -1': shared IC-cards issued by a bank
- Toll Settlement Framework -1 : of shared IC-cards issued by banks
- Toll Settlement Framework -2 : operated all by a bank.

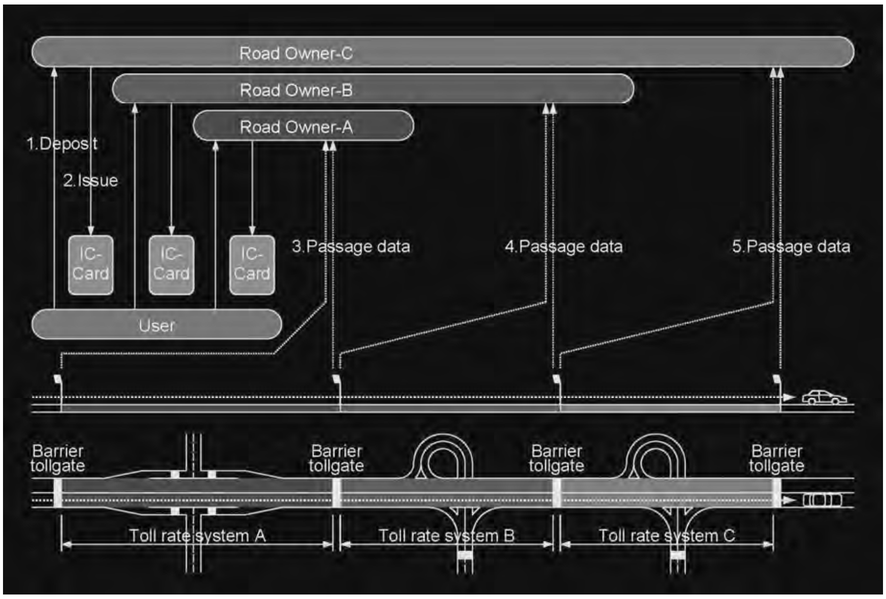
Toll settlement among different road owners is to be operated a bank or an organization permitted by the State Bank (as the case of Decision No.5190/NHNN-TT). The following discussion on above four is premised on the distance proportional tariff system for toll rate.

(1) Toll Settlement Framework -0 : Unshared IC-cards Issued by Road Owners

This framework for toll settlement is based on many kinds of unshared IC-cards issued by different road owners and has the following problems:

- Users need to prepare many IC-cards for passing continuously through the expressway sections shared by different road owners.
- Users can receive issue/recharge service of the IC-cards only at the roadside of the expressways.
- Road owners need to prepare all the equipment for IC-card issue/recharge and car parks for convenience of the users who intend to use the issue/recharge service.
- Measures against congestion are necessary for access roads to car parks for IC-card issue/recharge service.
- Diffusion of OBU and IC-card tends to be slow.

Figure 5.44 Toll Settlement Framework-0 : Unshared IC-cards Issued by Road Owners



Source: VITRANSS2 Study Team

(2) Toll Settlement Framework -1 : Shared IC-card Issued by Banks

To resolve the problems, a staged implementation of framework is to be defined as a premise for discussion in the Study. Issue/recharge service for IC-cards is provided by a single bank in the 1st stage and by several different banks in later stages. These frameworks for toll settlement are based on utilization of a single kind of IC-card shared by different road owners. The staged implementation of framework achieves the following advantages:

<in the 1st stage>

- Users can use a single IC-card through the whole expressway sections.
- Users can receive issue/recharge service of the IC-card at many places in urban area using the equipment prepared by the bank.
- Road owners need not prepare the equipment for IC-card issue/recharge service and the relevant car parks.
- OBU and IC-card tends to be diffused rapidly.

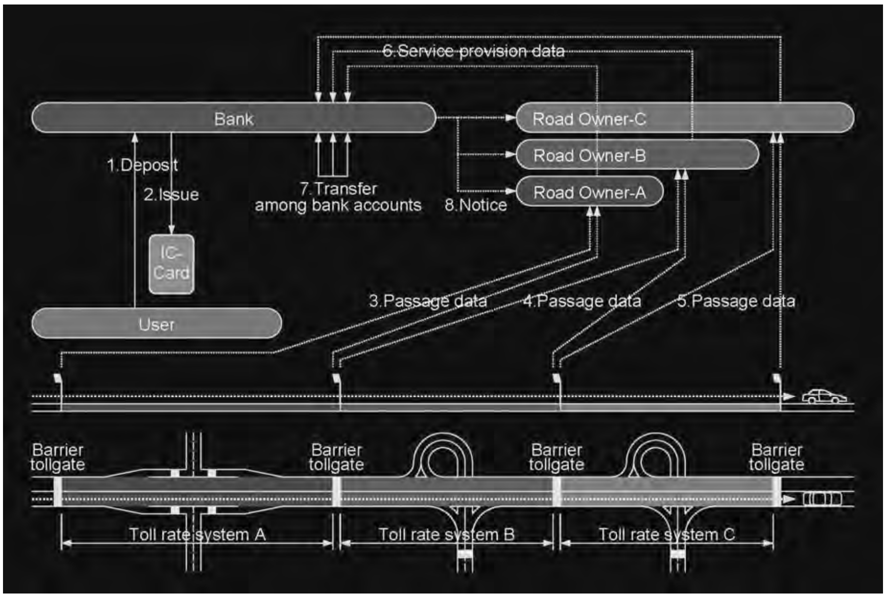
<in later stages>

- Users can receive the IC-card issue/recharge service more conveniently.

- Driver needs not stop the vehicle many times on the expressway to get the IC-card issue/recharge service.
- Congestion to access the IC-card issue/recharge service can be removed.

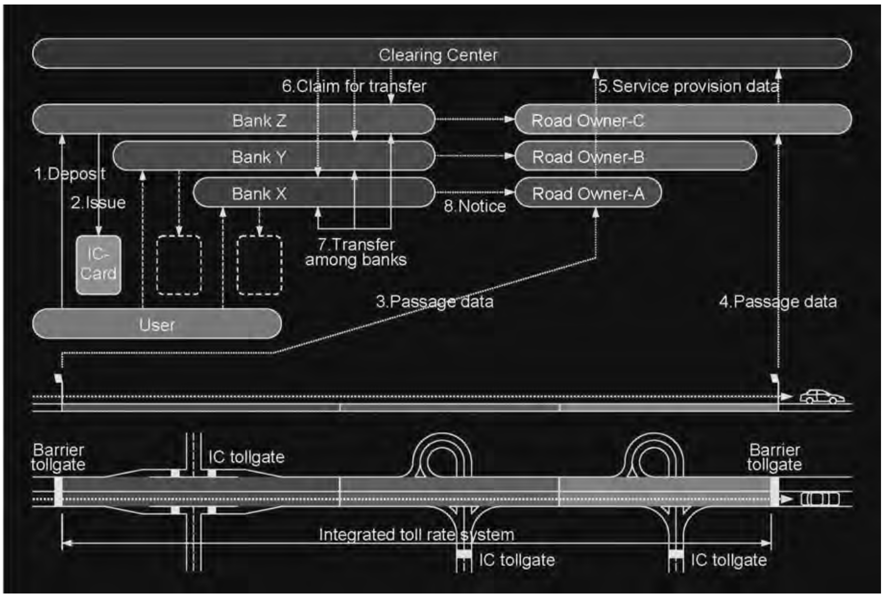
However, for integrating the road owners and the banks, a clearing center needs to be discussed to establish it in a later stage.

Figure 5.45 Toll Settlement Framework-1' : Shared IC-card Issued by a Bank (in 1st Stage)



Source: VITRANSS2 Study Team

Figure 5.46 Toll Settlement Framework-1 : Shared IC-card Issued by Banks (in Later Stages)

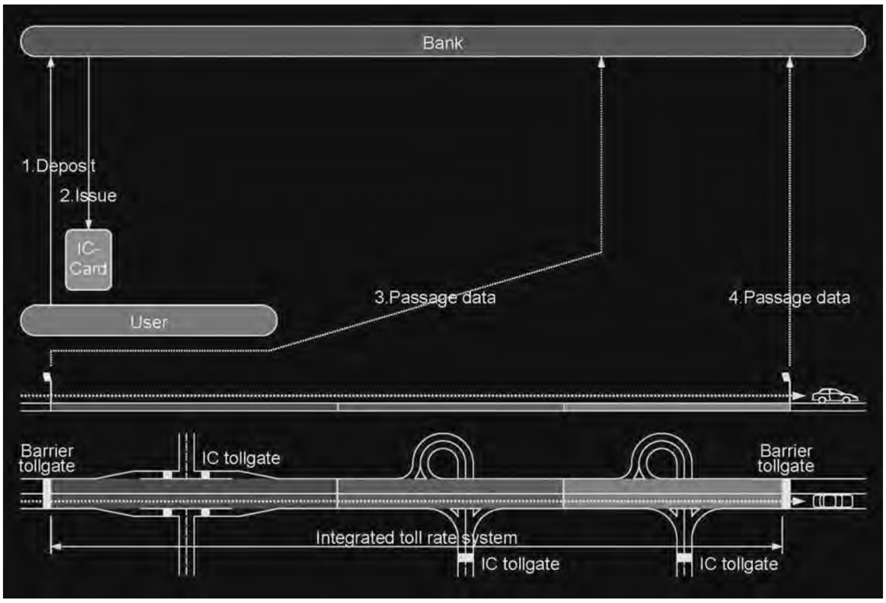


Source: VITRANSS2 Study Team

(3) Toll Settlement Framework -2 : Operated All by a Bank

In this framework, all processes including passage data collection and toll settlement are operated by a single bank and advantages on the toll settlement can be achieved as well as Framework-1. However, it is difficult to control/secure the reliability of this framework, because a single organization occupies processing of both passage data collection and toll settlement for many expressway sections without any benefit and duty on the road operation. For this reason, this framework is not suitable.

Figure 5.47 Toll Settlement Framework-2 : Operated All by a Bank



3) Recommended Toll Settlement Framework for Expressway Network

The Framework-1 is recommended as a premise for discussion in the Study based on the comparison on toll settlement frameworks summarized below.

Table 5.10 Selection of Toll Settlement Framework

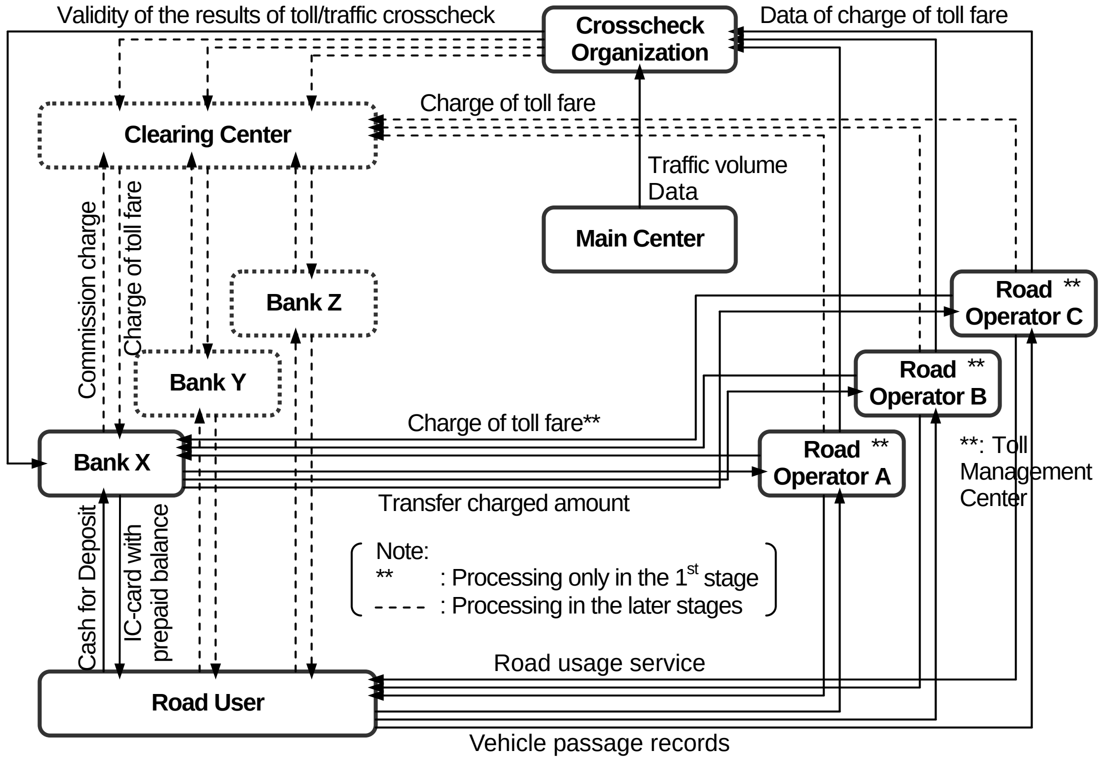
	Framework-0	Framework -1’	Framework -1	Framework -2
IC-card Issue Organization	Road operators	A bank	Banks	A bank
Cost-cutting on IC-card Operation for Road Operator	Incapable	Capable	Capable	Capable
Tollgate-to-center Cash Delivery by Road Operator	Necessary	Not necessary	Not necessary	Not necessary
Number of IC-cards Necessary for a User	2 or more	1	1	1
Clearing Center	Not necessary	Not necessary	Necessary	Not necessary
Convenience of IC-card Recharge for the User	Average	High	Very high	High
Control/Securing of Reliability of the Framework	Average	Average	Average	Difficult
Grading	Not suitable	Useful in 1st Stage	Recommended	Not suitable

Note: →See Table 5.8, Figures 5.44, 5.45, 5.46 and 5.47

Source: ITS Standards & Operation Plan Study Team

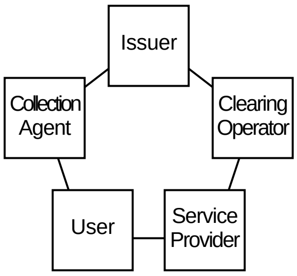
The toll settlement framework shown in the following figure is to be built up by the staged implementation of Framework-1’ and Framework-1. The toll fare is directly charged to a bank in the 1st stage; however, a clearing center needs to be set up in the later stage to allocate charged amount of toll fare to two or more banks. Additionally, a crosscheck organization needs to be set up to check the charged amounts by road owners against traffic volumes.

Figure 5.48 Recommended Toll Settlement Framework for Expressway Network



Source: ITS Standards & Operation Plan Study Team

Table 5.11 Correspondence to the Basic Conceptual Model in ISO 14904

ISO 14904: "EFC Interface Specification for Clearing between Operators"			Case of Toll Settlement Framework-1
 Basic Conceptual Model for EFC	Issuer	The entity responsible for the payment system and responsible for issuing the payment means (IC-card) to the User.	Bank
	Collection Agent	The entity responsible for selling, reloading or delivering the payment means to the User.	Bank
	Clearing Operator	The entity that collects and possibly aggregates transactions from one or more Service Providers for delivery to the Issuers. The Clearing Operator can also handle the apportionment between the Service Providers.	Clearing-house
	Service Provider	The entity that accepts the User's payment means and in return provides the service to the User.	Road Owners
	User	The entity that uses services provided by the Service Provider according to the terms of the Contract expressed by the payment means. The user receives and reloads the electronic payment means through the Collection Agent.	Road Users

Note: EFC: Electronic fee collection.

Source: ITS Standards & Operation Plan Study Team

5.5.3 Framework for IC-card Issuance/Operation

1) Existing Conditions of Bank IC-card Issuance/Operation

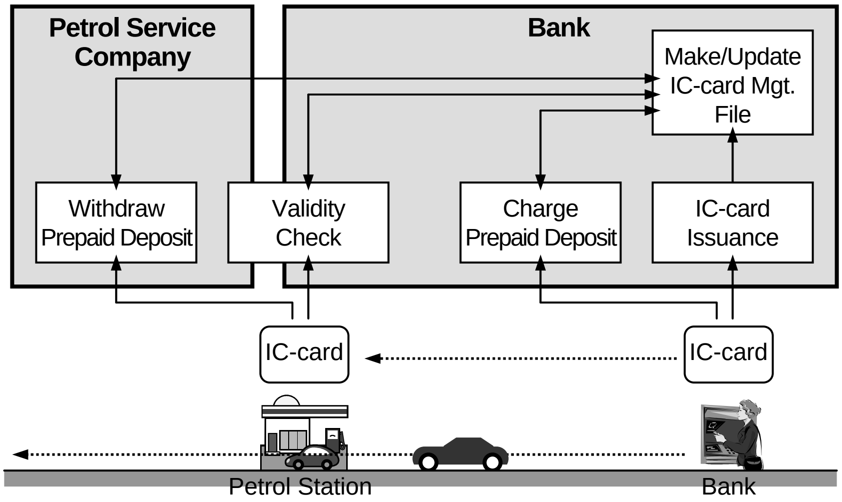
According to the Decision No: 20/2007/QD-NHNN, which is ”Promulgating the regulation on issuance, payment, use of bank cards and provision of bank card operation support services (May 15, 2007. "Bank card" is a tool issued by a card-issuing organization for conducting card transactions under the conditions and terms agreed upon by the involved parties.

Pre-paid card is a card permitting its holder to conduct card transactions within the value limit loaded on the card corresponding to the amount of money already prepaid by its holder to the card-issuing organization. Pre-paid cards include bearer pre-paid card and non-bearer pre-paid card (anonymous prepaid cards).

After this decision, there are decision of the governor of the state bank of Vietnam No.32/ 2007/QD-NHNN (July 3, 2007) which shows the “Balance Limit of bearer pre-paid cards” regulated, it is regulated to be not in excess of 5,000,000 VND.

A kind of prepaid IC-card issued by bank is can be applied to the payment of petrol as shown in the figure below.

Figure 5.49 Existing Framework for IC-card Issuance/Operation



Source: ITS Integration Project (SAPI) Study Team

2) Applicable Framework of IC-card Issuance/Operation for ETC

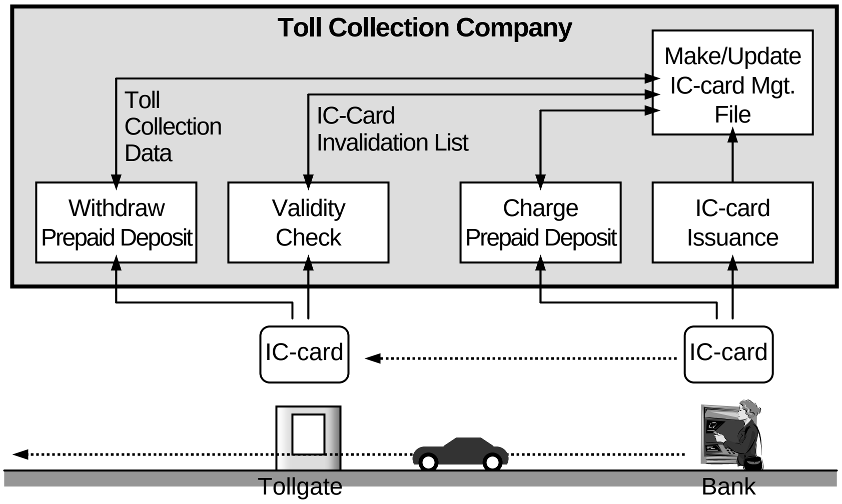
The VietinBank issues the contact-less IC-card. It can be used for toll payment at the Touch &go tollgates. However, this card cannot be used at the ETC tollgates because only 1-piece type OBUs are existing currently in Vietnam.

The card is available at every branch office of VietinBank nationwide or at toll office located near the tollgates where VietinBank equips Touch&go tollgate. The person who has the bank account in VietinBank is available to obtain the card. In the form of application of the card, there are options on type of pre-paid or post-paid, recharge options such as internet banking, request through mobile phone, or process at ATM. The card is able to issue on the basis of the options selected in the application form.

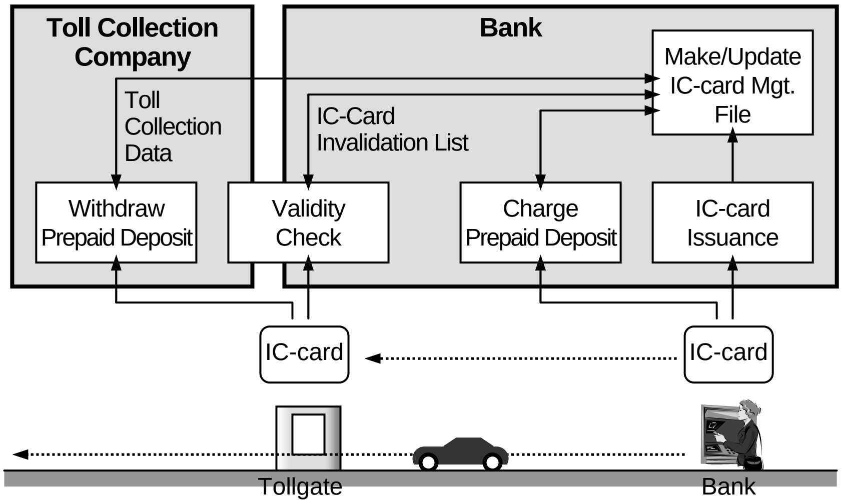
2-piece type OBU will be introduced In near future and it will become possible to use IC-card with OBU for passing through the ETC tollgate. In such stage, the frameworks shown below are applicable to IC-card issuance/operation for ETC.

Figure 5.50 Applicable Framework of IC-card Issuance/Operation for ETC

IC-card Framework -0



IC-card Framework -1



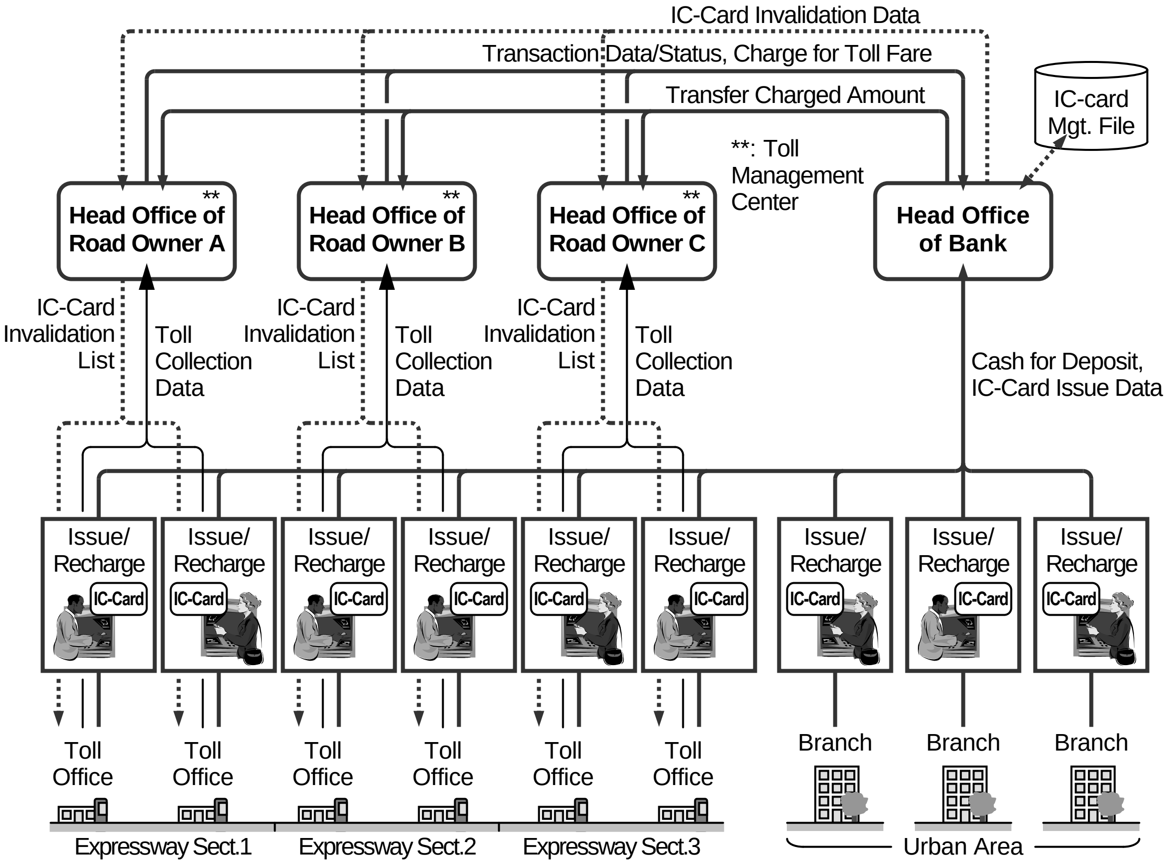
Source: ITS Integration Project (SAPI) Study Team

For a harmonization with the framework for ETC, the “IC-card Framework-1” is recommended and to be discussed and illustrated in more detail in the following.

2) Recommended Framework for IC-card Issuance/Operation

The framework for IC-card issuance/operation both of Touch&Go and ETC shown below is to be defined as a premise for discussion in the Study.

Figure 5.51 Recommended Framework for IC-Card Issuance/Operation



Source: ITS Standards & Operation Plan Study Team

For creating the framework, IC-card issuers/rechargers need to be installed in the branches of the bank in urban area and the toll offices along the expressway. Cash for deposit and IC-card Issue data are to be received by the issuers/rechargers and to be accumulated in the head office of the bank. The head office of the bank receives charge of toll fare from the road owners and transfers the charged amounts to the road operator’s bank account. Additionally, The head office of the bank generates an IC-card invalidation list and sends it to the road operators as well.

5.5.4 Framework for OBU Registration/Management

1) Existing Framework for Vehicle Registration

(1) Vehicle Registration System

Vehicle registration and issue of vehicle number plate is conducted by the Ministry of Public Security under the Circular 01/2002/TT-BCA and Circular No 12/2008/TT-BCA-C11, and Circular No 34/2003/TT-BTC of the Ministry of Finance for registration fee. The provincial land road police division is in charged for vehicle registration of normal passenger, private firm and government agency, and the land/railway road police department is in charged for diplomatic vehicle registration.

The procedure for vehicle registration is required to submit following documents in order to issue registration certificate. (Normally, it is required within 5 working days in Hanoi, 7 working days in HCMC)

- Owner's Identification Document
- Registration Form
- Vehicle's ownership transfer document
- Receipt of Registration Fee
- Documents showing the vehicle's original: imported as whole vehicle, domestic assembled vehicle, converted vehicles, etc. (included inspection certificate for domestic assembled vehicles)

In the registration certificate, name of owner, address, vehicle type (color), engine number, chassis number, number plate are described (the registration certificate for truck is also required to indicate the loading capacity (kg)). The figure below shows the sample of registration certification form.

Figure 5.52 Registration Certification (Left: Passenger Car, Right: Truck)

Tên chủ xe *(Owner's full name)*: [redacted]
Địa chỉ *(Address)*: [redacted]
Nhãn hiệu *(Brand)*: DAEWOO
Loại xe *(Type)*: Ôtô con
Màu sơn *(Color)*: Ghi
Năm sản xuất *(Year of manufacture)*:
Kích thước bao:-Dài*(Length)*: m;Rộng*(Width)*: m;Cao*(Height)*:
Overall dimension
Tải trọng: Số chỗ ngồi*(Sit)*: 05 đứng*(Stand)*: nằm*(Lie)*: Hàng hoá: *Goods*:
Gross weight: Seat capacity
Số máy *(Engine N⁰)*: 079923
Số khung *(Chassis N⁰)*: 009459
Tên động cơ *(B. of E.)*:
Dung tích *(Capacity)*:
Công suất *(Horsepower)*:
Tự trọng *(Empty weight)*:
Đăng ký xe có giá trị đến ngày tháng năm
Valid until date
Hà Nội, ngày *(date)* tháng 04 năm 2008
Trưởng phòng
Biển số đăng ký
(N⁰Plate)
[redacted]-[redacted]
Đăng ký lần đầu ngày:
Date of first registration
23/04/2008

CÔNG AN TP HÀ NỘI
Phòng CSGT
Số: 0060702
CÔNG HOÀ XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc
ĐĂNG KÝ XE Ô TÔ
Họ tên chủ xe: [redacted]
Nơi ĐKNK thường trú: [redacted]
CMND số: *cấp ngày*
Nhãn hiệu: Tr/Hải *Số loại*: *Loại xe*: Tải
Màu sơn: Trắng *Số máy*: 098950 *Số khung*: 00075
Tự trọng: *kg. Tải trọng*: - *Hàng hoá*: 13000 *kg*
- *Số chỗ ngồi*: 02 *(cả lái phụ*
Hà Nội, ngày 24 *tháng* 05 *năm* 200
Trưởng phòng
Biển số:
[redacted]-[redacted]
Đăng ký lần đầu
ngày 23/05/2005

Source: VITRANSS 2 Study Team

According to the vehicle classification under the Circular No60/2004/TT-BTC of Ministry of Finance, there are 7 types as below.

- Type 1: Motorbikes, motorbikes with 3 wheel and similar types
- Type 2: Lambretta, rudimentary trucks, tractors
- Type 3: Cars of under 12 seats, trucks of a tonnage of under 2 tons and mass transit buses

- Type 4: Cars of between 12 and 30 seats, trucks of a tonnage of between 2 tons and under 4 tons
- Type 5: Cars of 31 seats or more; trucks of a tonnage of between 4 and under 10 tons
- Type 6: Trucks of a tonnage of between 10 and under 18 tons and 20 ft-container lorries
- Type 7: Trucks of a tonnage of 18 tons or over and 40 ft-container lorries

(2) License Plate System

The vehicle number plate is issued same as vehicle registration, by the Ministry of Public and Security under Circular No 06/2009/TT-BCB (C11). The regulation of Number plate is as follows.

(a) Vehicles for Non-business Administrative Offices or Government Agencies
- Background of Plate: Blue
- Characters & number: White
- Region code: followed by Table 5.12
- Series no: Use 1 of 5 symbols below: A, B, C, D, E

(b) Vehicles for All Economic Sectors and Individuals
- Background of Plate : White
- Characters & number: Black
- Region code: followed by Table 5.12
- Series no: Use 1 of 5 symbols below: F, H, K, L, M, N, P, R, S, T, U, V, X, Y, Z (and some symbols for special cases

(c) Vehicles for Diplomatic Organizations, Consulates, Individuals of Foreigner
- Background of Plate: White
- Characters & number: Black
- Series no: “NG” in red

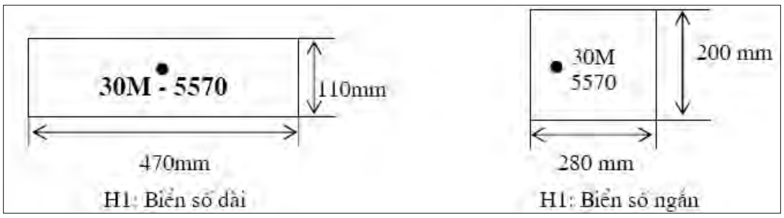
(d) Vehicles for International Organizations, Individuals of Foreigner:
- Background of Plate: White
- Characters & number: Black
- Series no: “QT” in red

(e) Vehicles for Representative Office, Representative Organizations, Individuals of Foreigner and Student learning abroad
- Background of Plate: White
- Characters & number: Black
- Series no: “NN” in red

The material of plate should be made by metal. And there are two type of size at one for front, the other is in behind of vehicle in the following figure.

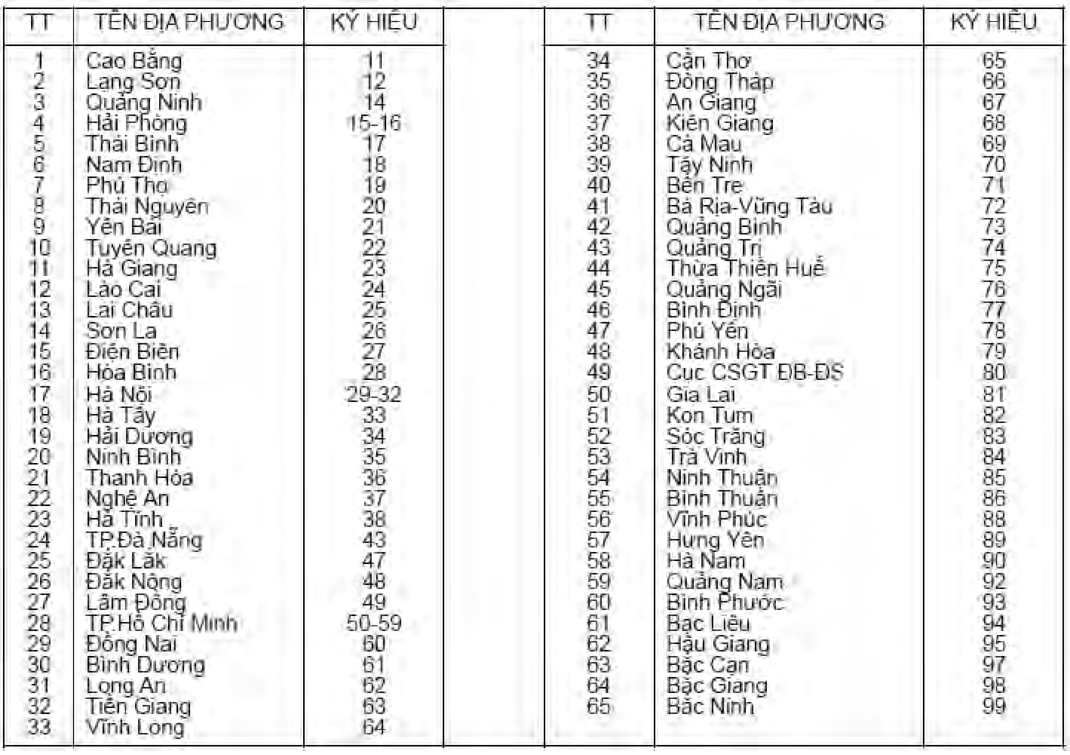
- Type 1 Short Plate: Height 200 mm, Length 280 mm,
- Type 2 Long Plate: Height 110 mm, Length 470 mm

Figure 5.53 Size and Dimension of Number Plate



Source: VITRANSS 2 Study Team

Table 5.12 Region Code List of Number Plate



TT	TÊN ĐỊA PHƯƠNG	KÝ HIỆU
1	Cao Bằng	11
2	Lạng Sơn	12
3	Quảng Ninh	14
4	Hải Phòng	15-16
5	Thái Bình	17
6	Nam Định	18
7	Phú Thọ	19
8	Thái Nguyên	20
9	Yên Bái	21
10	Tuyên Quang	22
11	Hà Giang	23
12	Lào Cai	24
13	Lai Châu	25
14	Sơn La	26
15	Điện Biên	27
16	Hòa Bình	28
17	Hà Nội	29-32
18	Hà Tây	33
19	Hải Dương	34
20	Ninh Bình	35
21	Thanh Hóa	36
22	Nghệ An	37
23	Hà Tĩnh	38
24	TP.Đà Nẵng	43
25	Đặk Lăk	47
26	Đăk Nộng	48
27	Lâm Đồng	49
28	TP.Hồ Chí Minh	50-59
29	Đồng Nai	60
30	Bình Dương	61
31	Long An	62
32	Tiền Giang	63
33	Vĩnh Long	64
34	Cần Thơ	65
35	Đồng Tháp	66
36	An Giang	67
37	Kiên Giang	68
38	Cà Mau	69
39	Tậy Ninh	70
40	Bến Tre	71
41	Bà Rịa-Vũng Tàu	72
42	Quảng Bình	73
43	Quảng Trị	74
44	Thừa Thiên Huế	75
45	Quảng Ngãi	76
46	Bình Định	77
47	Phú Yên	78
48	Khánh Hòa	79
49	Cục CSGT ĐB-ĐS	80
50	Gia Lai	81
51	Kon Tum	82
52	Sóc Trăng	83
53	Trà Vinh	84
54	Ninh Thuận	85
55	Bình Thuận	86
56	Vĩnh Phúc	88
57	Hưng Yên	89
58	Hà Nam	90
59	Quảng Nam	92
60	Bình Phước	93
61	Bạc Liêu	94
62	Hậu Giang	95
63	Bặc Cạn	97
64	Bặc Giang	98
65	Băc Ninh	99

Source: VITRANSS 2 Study Team

Figure 5.54 Example of Number Plate

Upper: Individuals

Lower Left: Government Agencies

Lower Right: Foreign

Source: VITRANSS 2 Study Team

Number plate for temporally registered vehicle is made by paper with the same design of above categories.

(3) Vehicle Inspection System

MOT has a responsibility for vehicle inspection as the function of vehicle technical safety environmental protection (VTSEP) since 1995. MOT assigned this inspection to the Vietnam Register (VR) and VA is the agency for conducting vehicle inspection with local TUPWS and DOT. Law and regulation for vehicle inspection are as follows.

- Decision No. 4105/2001/QĐ-BGTVT (December 04, 2001): Regulations on periodical inspection in terms of technical safety and environment protection for Motor Vehicles.
- Decision No. 39/2007/QD-BGTVT (August 22, 2007): Amending and Supplementing of Decision No. 4105/2001/QD-BGTVT: The Regulation on Periodical Inspection of Technical Safety and Environmental Protection of Motor Vehicles
- Decision 4134/2001/QD-BGTVT: Technical Standards for inspection based on 22TCN/224-2001: Technical safety and Environmental protection of land road motor vehicles dated 2001
- Decision 065/QD-DK (14 March 2006): Vietnam Register guiding the inspection on technical safety and environmental protection of land road motor vehicles.

Inspection is divided into the "Initial Inspection" conducted just after purchasing and "Periodical Inspection".

Initial Inspection

Following documents are required for issuing certification record of motor vehicle inspection.

- Original copy of "Registration Certificate" or the registration application receipt note, or copy of valid registration certificate certified by the lending Bank, or the valid confirmation note of leasing company
- Original copy of import certificate or original copy note of notification on inspection exemption for imported vehicle, or vehicle quality certificate manufacturer (domestic produced, assembled or converted vehicles)
- License for transportation business (for the case that the vehicle is registered for transportation business.)

Routine Inspection

Following documents are required for routine inspection.

- Certification record of periodical motor vehicle inspection
- Vehicle Registration Certificate
- Business Registration Certificate (for the case that the vehicle is registered for transportation business.)

The Table 6.2.2 shows the inspection item and its frequency. Items are regulated by Decision No.4134/QD-BGTVT, and there are 55 items for general passenger vehicle and 75 items for motor cycle. That table shows also the main items to be inspected.

Table 5.13 Vehicle Inspection Item and Frequency

Type of Vehicle	Period (month)	
	Initial	Periodic
Truck (cargo)		
• Brand-new imported vehicle; domestic manufactured or assembled vehicle	24	12
• Modified/repaired vehicle	12	06
Small car (including working car) up to 9 seats incl. driver		
• Brand-new imported vehicle; domestic manufactured or assembled vehicle		
(i) for transportation business	24	12
(ii) not for transportation business	30	18
• Modified/repaired vehicle		
(i) for transportation business	18	06
(ii) not for transportation business	24	12
Passenger car with more than 9 seats including driver		
• Brand-new imported vehicle; domestic manufactured or assembled vehicle		
(i) for transportation business	18	06
(ii) not for transportation business	24	12
• Modified/repaired vehicle		
(i) for transportation business	12	06
(ii) not for transportation business	18	12
Motorized three-wheelers vehicle		
• Brand-new imported vehicle; domestic manufactured or assembled vehicle		
(i) for transportation business	24	12
(ii) not for transportation business	30	24
• Modified/repaired vehicle		
(i) for transportation business	18	06
(ii) not for transportation business	24	12
All the vehicle after manufacture date more than 7 years		06

All passenger cars from 15 years and truck from 20 years since from manufacture date should have inspection every 3 months at the Inspection Center, where the inspection record of that car is recorded. All required items should be checked up as stipulated in Standards.

If the inspection result meets the Standard, the Inspection Certificate will be issued with 3 month effectuation.

If the inspection result doesn't meet the Standard, the vehicle should be repaired/ improved for re-inspection. If the second inspection result doesn't meet its standard again, such vehicle can't have further repairing for joining the traffic.

1. General Observation
    - Number plate, outside details
    - Number of engine and body
    - Form, general layout, size limit
    - Body, cap
    - Coach, boot
    - Drag hook
    - Drag disk and bolt
    - Container lock
    - Windscreens and door screen
    - Windscreen wiper, water spray
    - Mirrors
    - Driver seat, rear seats
    - Fire protection equipment
2. Engine and other systems for vehicle operation
3. Power train
4. Tire
5. Suspension system
6. Steering system
    - Flywheel
    - Steering column
    - Driving rod and arm
    - Coupling
    - Center shaft
    - Angle travel of flywheel
    - Power steering
    - Strike slip of guide wheels
7. Break system
8. Lighting and signalling system
    - Front lamps
    - Signalling lamps
    - Horn
9. Environment Standards: follows the current regulations of MOT.

Source: VITRANSS 2 Study Team

The sample shows the vehicle registration and inspection results. These registered information can be used for toll fare system based on different vehicle type if these data had been input in on board unit for ETC.

Figure 5.55 Sample of Vehicle Registration and Inspection Results

II.

ĐẶC ĐIỂM PHƯƠNG TIỆN
(VEHICLE DESCRIPTION)
No: B 0539841

Loại phương tiện *(Type)*:Ô tô con
Nhãn hiệu *(Mark)*: DAEWOO
Số loại *(Model code)* : LACETTI -SE
Số máy *(Engine Number)*: F16D3079923K
Số khung *(Chassis Number)*: RLLANF46D8H009459
Năm, nơi sản xuất: 2008, Việt Nam
(Manufactured Year and Country)
Năm hết niên hạn sử dụng *(Lifetime limit to)* :
Công thức bánh xe *(Wheel Formula)*: 4x2
Vết bánh trước/sau *(Front/Rear track)* : 1,480 / 1,480 (mm)
Kích thước bao: 4,500 x 1,725 x 1,445 (mm)
(Overall Dimension)
KT thùng: *(Cargo Dim.)* (mm)
Chiều dài cơ sở: 2,600 (mm)
(Wheel Base)
Trọng lượng bản thân *(Kerb Weight)*: 1,180 (kG)
Trọng tải thiết kế/ CP TGGT: (kG)
(Designed Loading Capacity/ Permissible Loading Capacity)
Số người cho phép chở: 5(ngồi)
(Permissible No. of Pers Carried)
Trọng lượng kéo theo *(Towed Weight)* : (kG)
T.lg t.bộ TK/CP TGGT: 1,665 (kG)
ned gross Weight/ Permissible gross Weight)

5

ĐẶC ĐIỂM PHƯƠNG TIỆN
(VEHICLE DESCRIPTION)
No: B 0539841

Kiểu động cơ *(Engine Model)* : X4I4
Loại nhiên liệu *(Fuel Used)* : Xăng
Thể tích làm việc của động cơ: 1,598 (cm3)
(Engine Displacement)
Công suất lớn nhất/tốc độ quay: 80.0(kW)/5800(v/ph)
(Max. output/rpm)
Hệ thống lái *(Steering system)* :Có trợ lực
Phanh chính *(Service Brake)* :Thuỷ lực trợ lực chân không
Phanh đỗ *(Parking)* :Cơ khí tác động trên bánh xe trục 02
Lốp sử dụng *(Tires Used)*
-Trục 1*(Axle No.1)*: 2; 185/65R14
-Trục 2*(Axle No.2)*: 2; 185/65R14
-Trục 3*(Axle No.3)*:
[redacted]
-Trục 6*(Axle No.6)*:
-Trục 7*(Axle No.7)*:
-Trục 8*(Axle No.8)*:
Hà Nội, ngày 23-tháng 4 năm 2008
(Date)
ĐƠN VỊ KIỂM ĐỊNH
(INSPECTION CENTER)
Số QL:2903V/043261
Biển ĐK: **30L-4545**
K55754823399

0539841 6

V. 1. KẾT QUẢ KIỂM ĐỊNH *(INSPECTION RESULT)*

BỘ GIAO THÔNG VẬN TẢI
CỤC ĐĂNG KIỂM VIỆT NAM

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

PERIODICAL MOTOR VEHICLE INSPECTION CERTIFICATE
FOR TECHNICAL SAFETY AND ENVIRONMENTAL PROTECTION
No: AE 0278872

Biển đăng ký: **30L-4545** KDVT: Không
(Registration Number) *(Commercial Use)*
Số máy: F16D3079923K
(Engine Number)
Số khung: RLLANF46D8H009459
(Chassis Number)
Phương tiện đạt tiêu chuẩn hiện hành về An toàn kỹ thuật và bảo vệ môi trường.
(The motor vehicle is in compliance with the applicable requirements of Technical Safety and Environmental Protection Standards)
Ngày kiểm định lần tới: **23/10/2010**
(Next Periodical Inspection Date)
Ngày 23 tháng 4 năm 2008
(Issued Date: day, month, year)
Số phiếu kiểm định
(Inspection Report No.)
2903V-13519/08
ĐƠN VỊ KIỂM ĐỊNH
(INSPECTION CENTER)
Chú ý: Khi tham gia giao thông, tổng trọng tải và số người chuyên chở của phương tiện không được vượt quá các giá trị ghi trong Sổ chứng nhận kiểm định.

1

2. KẾT QUẢ KIỂM ĐỊNH *(INSPECTION RESULT)*

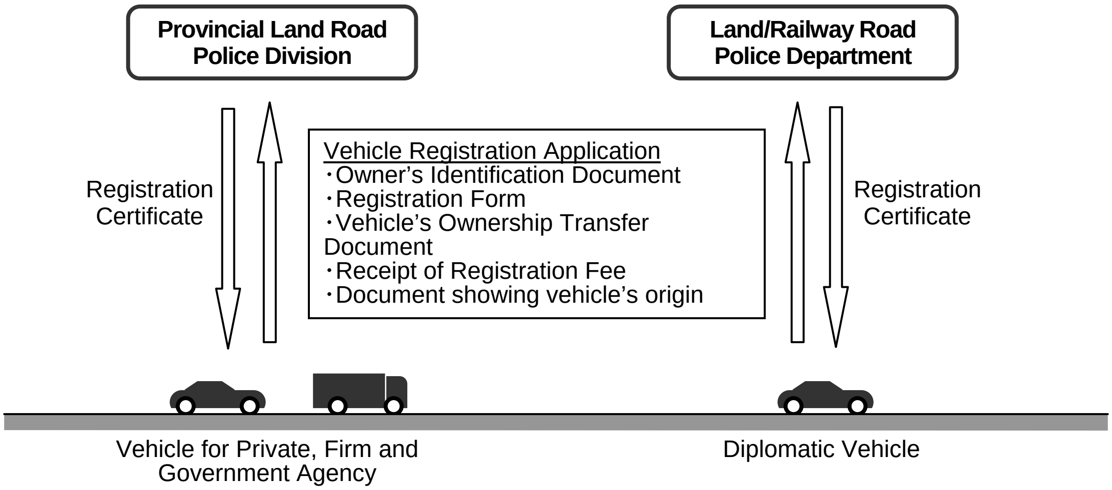
Ngày KĐ	Số phiếu KĐ	Hạng mục không đạt	Đơn vị KĐ

0539841 14

Source: VITRANSS 2 Study Team

The following figure shows the vehicle registration system. There are two different procedures are existing on the basis of the vehicle ownership. Except for the diplomatic vehicle, the same procedure is taken.

Figure 5.56 Existing Framework for Vehicle Registration



Source: ITS Integration Project (SAPI) Study Team

2) Existing Framework for OBU Registration/Management

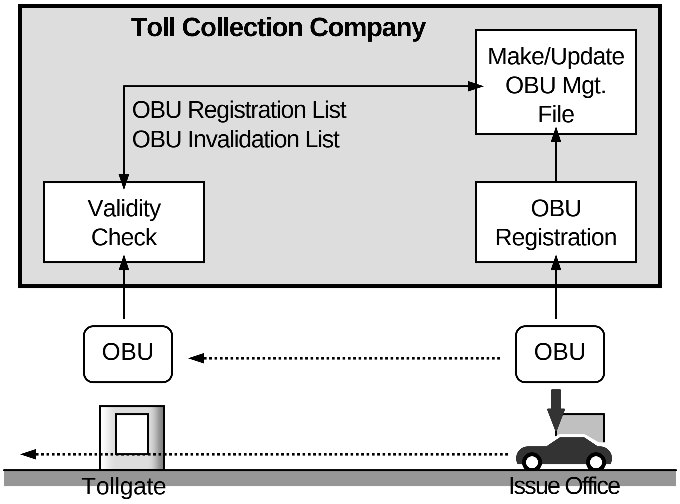
The OBU is sold by VietinBank. The OBU is available at every branch office of VietinBank nationwide or at toll office located near the tollgates where VietinBank equips ETC.

The procedure to obtain the OBU is simple. Necessary documents are copies of ID card/ passport and automobile registration certificate. If the customer belongs to some organization, certificate of registry and business registration form is required additionally.

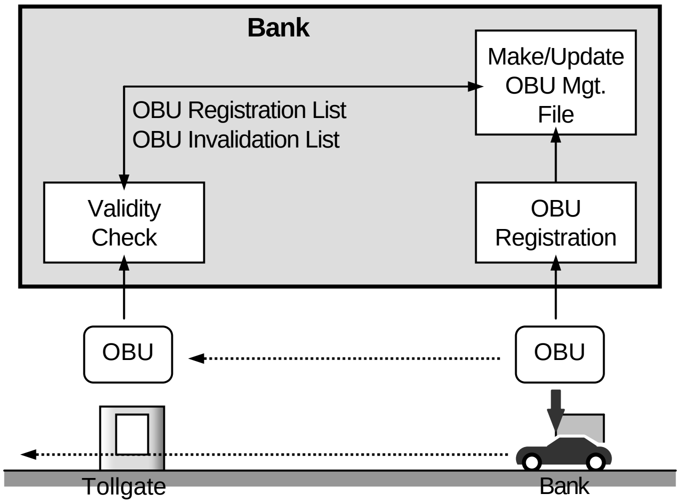
Currently 1-piece type OBU is available, and two kinds of payment methods :pre-paid and pre-payment by direct debit are available on the basis of the contract conditions. The OBU is registered and managed by two types of existing framework for each tollgate as shown below.

Figure 5.57 Existing Framework for OBU Registration/Management

OBU Framework –1
(For Each Tollgate)



OBU Framework –2
(For Each Tollgate)

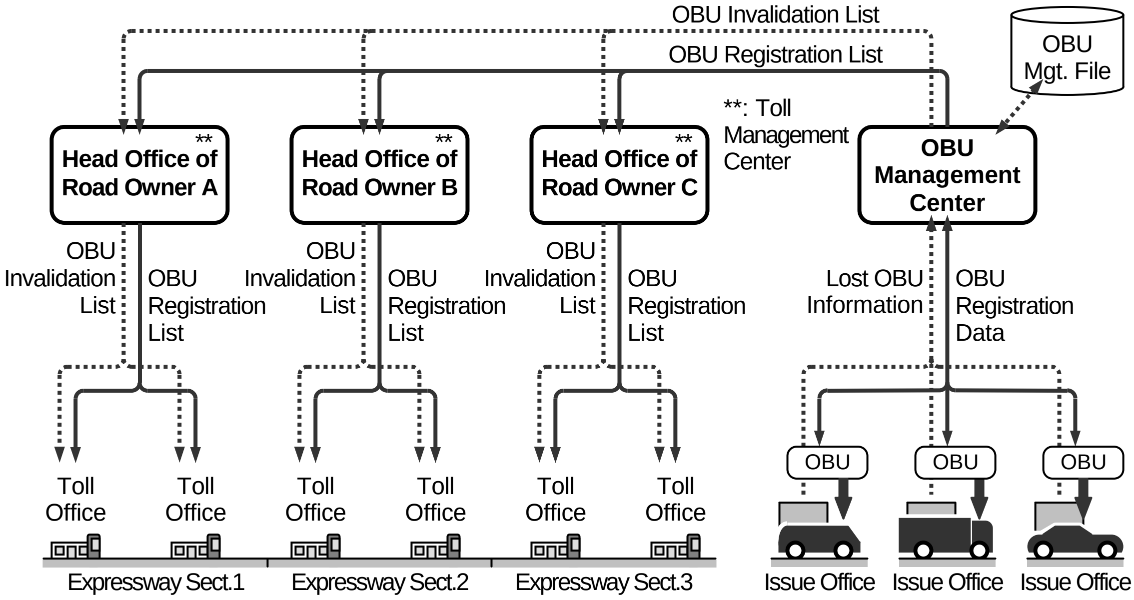


Source: ITS Integration Project (SAPI) Study Team

3) Recommended Framework for OBU Registration/Management

The framework below needs to be prepared for OBU registration/management, in which an OBU management center is operated by a unified organization for many different road owners and banks.

Figure 5.58 Recommended Framework for OBU Registration/Management



Source: ITS Standards & Operation Plan Study Team

For creating the framework, OBU management center needs to be set up to integrate offices for OBU issuance. The center compiles an OBU registration list responding to issuance of OBUs to users at regular intervals, and the list is to be delivered to toll offices through the head offices of road owners. Additionally, lost OBU information is compiled into an OBU invalidation list at the OBU management center and the list is to be distributed to toll offices as well.

5.5.5 Framework for Toll Enforcement

1) Existing Conditions of Enforcement on Road Traffic

(1) Penalty for Illegal Parking

This is regulated in Decree No.146/2007/ND-CP, which has warning notice, monetary penalty and supplementary sanctions (expropriating the permit, license, certificate forever or for a certain period; to confiscate exhibits, means which were used for such violations), for administrative violation. Followings are fine rate for penalty of illegal stopping and/or parking.

Table 5.14 Fine Rates for Illegal Stopping/Parking

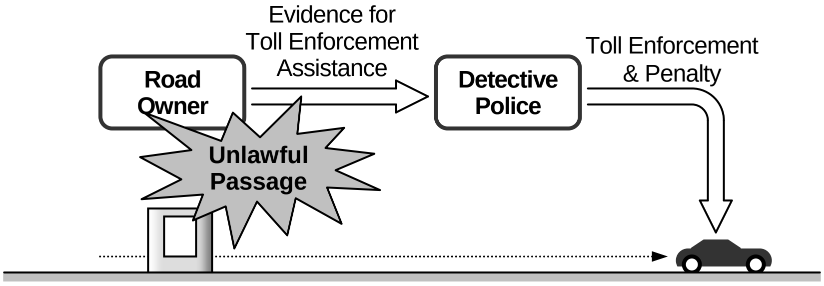
Fine Rate	100,000–200,000 VND	200,000–600,000 VND	600,000–1,000,000 VND
Case	• stopping, parking the vehicle without giving signals to operators of other means en route; • stopping, parking vehicles on the carriageway of non-urban roads, which have with broad roadsides; temporary stopping, parking the vehicle not closely to roadside on the right along to running direction where the roadsides are narrow or not available; stopping, parking the vehicle in inappropriate places on the road where car stops and/or are available; parking the vehicle on the slope without chocking the wheels. • stopping, parking the vehicle at the sports: on the left side of one-way road, on winding road sections and near slope heads where visibility is restricted; on bridges, under flyovers, in parallel with other stopping or parking vehicles; at cross-sections; at bus stops; on road wide enough only for one lane; covering the road signboards; • steeping down from the car when stopping the car; opening car door or leaving the door open without safety conditions. • illegal stopping, parking vehicles urban road; on the electric railways • If all above violations cause accidents but not at serious level supplementary penalty would be given, i.e. expropriating driving licenses for 90 days, at serious level – timeless revoking driving licenses.	• illegal stopping, parking vehicles on the road bed and roadside • If above violations cause accidents but not at serious level supplementary penalty would be given, i.e. expropriating driving licenses for 90 days, at serious level – timeless revoking driving licenses.	• Stopping, parking vehicles causing traffic congestions . • stopping, parking vehicles, opening car doors causing accident (If violations cause accidents but not at serious level supplementary penalty would be given, i.e. expropriating driving licenses for 90 days, at serious level – timeless revoking driving licenses)

Source: VITRANSS 2 Study Team

(2) Penalty for Unlawful Passage at Tollgate

Penalty for unlawful passage at tollgate is to be processed by detective police as shown in the following figure.

Figure 5.59 Existing Framework for Toll Enforcement



Source: ITS Standards & Operation Plan Study Team

2) Typical Policy of Toll Enforcement

Policies of toll enforcement can be broadly classified into the two types below. Policy 1 is adopted in many Asian countries, and Policy 2 is adopted in many European/American countries. In the Study, toll enforcement shall be discussed based on Policy 1 regarding common penalty systems in Vietnam.

Policy 1: Enforcement giving greater importance to fairness among the users

- Introduction of a relatively small penalty system aiming at a fixed deterrent effect
- Introduction of a highly reliable system intending a high exposure ratio for unlawful passages.

Policy 2: Enforcement giving greater importance to save manpower and cost

- Introduction of a heavy penalty system aiming at a large deterrent effect
- Introduction of a simple system intending a fixed exposure ratio for unlawful passages.

3) Conceivable Conditions of Toll Enforcement

(1) Legal Preconditions

It is assumed that the following legal definitions are prepared in advance of introducing ETC to complete the framework of toll enforcement:

- Legal Toll Payer: The IC-card owner shall be assumed as the legal toll payer when the intention to use the road service becomes apparent when IC-card is put in OBU. In the case of vehicle passage without IC-card put in OBU, the vehicle owner shall be assumed as the legal toll payer, because he has the obligation to put IC-card in OBU.
- Back Tax: Back tax shall be introduced for deterring mistakes and failures (e.g. 3-fold the regular toll amount).
- Penalty: Penalty shall be introduced for deterring unlawful passages (e.g. 3 million VND penalty charge for a violation).

(2) Assumed Cases of Unlawful Passage

Procedure of toll enforcement assistance is to be prepared for the following assumed cases:

- Mistake: Passage not turning on OBU, not putting IC-card into OBU, or not preparing enough prepaid balance of IC-card
- Failure: Passage under function failure of OBU or IC-card

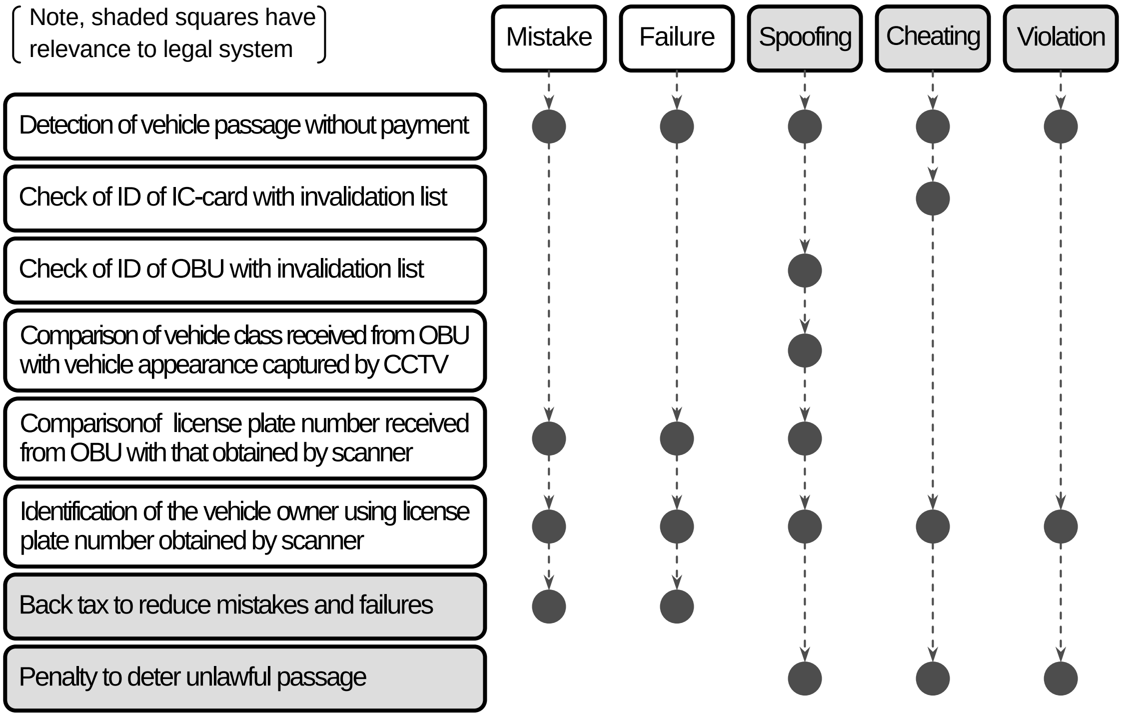
- Spoofing: Unlawful passage re-installing OBU to other vehicle or tampering with the vehicle class data in OBU
- Cheating: Unlawful passage tampering with the prepaid balance data or the bank account data in IC-card
- Violation: Unlawful passage without making available toll payment methods.

(3) Procedure of Toll Enforcement Assistance for ETC

In the case of ETC, some kinds of spoofing can be detected automatically by sensors; however, it is difficult to distinguish cheating and violation from mistake or failure without manpower. The following contorl measures including legal ones shall be taken for toll enforcement.

- Detection of vehicle passage without payment
- Check of ID of IC-card and OBU with invalidation list
- Comparison of vehicle class received from OBU with vehicle appearance captured by CCTV
- Comparison of license plate number received from OBU with that obtained by scanner
- Identification of the vehicle owner using license plate number obtained by scanner
- Back tax to reduce mistakes and failures
- Penalty to deter unlawful passage

Figure 5.60 Procedure of Toll Enforcement Assistance for ETC

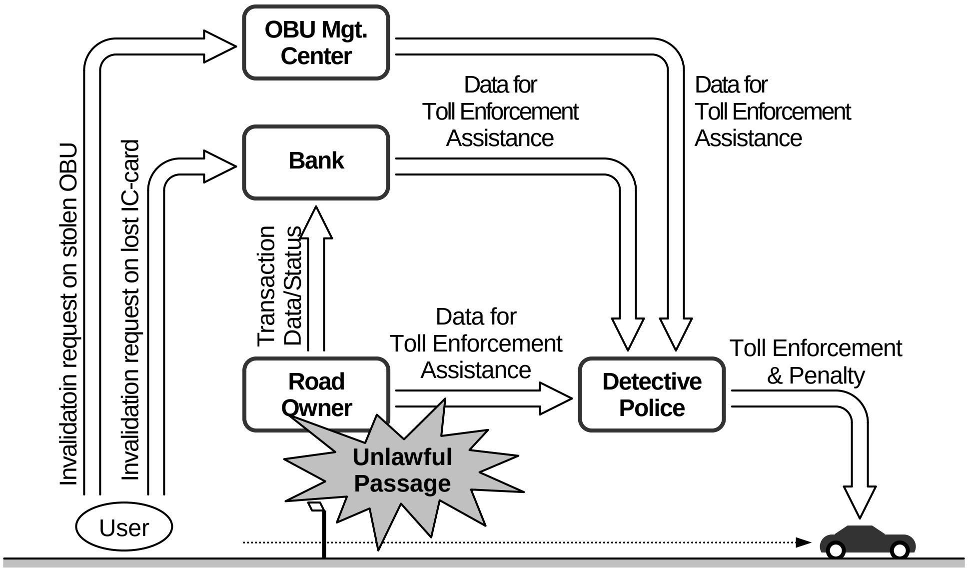


Source: ITS Standards & Operation Plan Study Team

4) Recommended Framework for Toll Enforcement (including Invalidation)

The recommended framework for toll enforcement and invalidation is shown in the figure below. In the framework, invalidation of IC-card or OBU is to be claimed by the user and the enforcement process is to be performed in cooperation between the road owner and the detective police through the bank and OBU management center.

Figure 5.61 Recommended Framework for Tol Enforcement (including Invalidation)



Source: ITS Standards & Operation Plan Study Team

5.6 Framework for Overloading Regulation

1) Existing Conditions of Overloading Regulation

According to the Study on "Vietnam Road Safety Phase 2 and Load Control (CONSIA)" shows that all trucks tend to carry overload. The data shows that

- On National Highway Route 3, the rate of overloaded trucked varies from 28% to 90%.
- On Notational Highway Route 5 (surveyed in May 2006), 30% overloaded trucks with overloaded rate of 200% in terms of weight.

(1) Law and Regulation for Vehicle Weight Control

There are law and regulations for vehicle weight control as below.

- Circular, No.07/2010/TT-BGTVT, dated 11/02/2010, Regulation on loading and limit size of vehicles on the road, issues on over-loading or over-size vehicles, issues on special or over-loaded/over-sized goods loaded on vehicles in the highway network
- Decree, No.146/2007/NĐ-CP, dated 14/09/2007
- Decision, No.20/2008/QĐ-BGTVT, dated 02/10/2008
- Circular, No.21/2001/TT-BGTVT, dated 10/12/2001
- Decision, No.05/2007/QĐ-BGTVT, dated 02/02/2007 (replaced Decision, No 42/2005/QĐ-BGTVT, dated 16/9/2005)

The Decree No.146/2007/NĐ-CP specifies the types of violation, penalty and procedures against violators.

(2) Historical and Current Enforcement Method

In 2003, Prime Minister gave the decision to establish 27 vehicle weight stations on national highways (according to decision No 455/TTg dated 04/09/2003), this is static weight stations and some portable weight equipments. At the each weight station included 3 forces, such as (i) Traffic Inspectors (staffs of Ministry of Transport), (ii) Traffic Polices and (iii) Military Inspectors. After some years, the traffic polices and military inspectors were no longer work in the weight stations. Then, all of 27 vehicle weight stations had been stopped their works since October, 2003. Table 5.15 shows the location of 27 weight stations.

The Vietnam Government issued in the document No 1882/TTg-CN, dated 03/12/2007, that the pilot project will be conducted by modernize and restore of 2 weight stations in Dong Nai Province & Quang Ninh Province.

(3) Pilot Project for Weight Control (Weigh-in-Motion) at Dau Giay

According to Invitation Letter of VRA, No 38/CĐBVN-KHCN & HTQT, the general requirements of pilot project for weight control at Dau Giay are as follows;

- Ability to control load on each lane separately
- The vehicle must be tested at WIM System before the inspection at static weight system.
- The system must have CCTV System to record images, number plate, time, images of staff in the operation static weight system.
- The system must connect to the data system of VRA

- This pilot project has been started since March, 2009 at Dau Giay on national highway route No 1, and planning another implementation at national highway rout 13. The purpose of this project aims to find the suitable procedure and technical requirements for modern weigh control and to apply to develop 27 weigh station described above.

Table 5.15 List of 27 Weight Stations on National Highway

	Station Name	Location
1	Pho Huong Station	Km57, QL3, Thai Nguyen
2	Bac Ninh Station	Km138+70057, QL1, Bac Ninh Town
3	QUANG NINH Station	Km103+800, QL18, Hoanh Bo
4	Vinh Phuc Station	Km47, QL2, Vinh Phuc
5	Ky son station	Km63, QL6, Hoa Binh
6	Quan Toan Station	Km87, QL5, Hai Phong
7	Phu thuy Station	Km15, QL5, Gai Lam, Ha noi
8	Phu Ly Station	Km231, QL1, Ha Nam Town
9	Hong Linh Station	Km481, QL1, Ha Tinh
10	Nam Gianh Station	Km657, QL1, South of Pha Gianh (Quang Binh)
11	Cam lo Station	Km15, QL9, Quang Tri
12	Que Son Station	Km965+500, QL1, Quang Nam
13	Ba To Station	Km18+250, QL24, Quang Ngai
14	Tru A Station	Km159+750, QL19, Gia Lai
15	Ba Di Station	Km1214+500, QL1, Binh Dinh
16	Phu Yen Station	Km1537+500, QL1, TX Tuy Hoa
17	Madrak Station	Km62+900, QL26, Dac Lac
18	Kien Duc Station	Km871+089, QL14, Dac Nong
19	Ca Du Station	Km1551, QL1, Ninh Thuan
20	Chon Thanh Station	Km68+800, QL13, Binh Phuoc
21	Suoi Sau Station	Km31, QL22, Tay Ninh
22	Dau Giay Station	Km1846+700, QL1, Dong Nai
23	Binh Phuoc Station	Km1888+600, QL1, Tp.HCMC
24	Ben Luc Station	Km1934, QL1, Long an
25	My thuan Station	Km2028, QL1, Vinh Long
26	Hau Giang Station	Km2068, QL1, Can tho
27	My Tu Station	Km2126, QL1, Soc Trang

Source: VITRANSS 2 Study Team

It is operated by 4 officers who belong to different organization (i.e. VRA-RRMU, PDOT-Traffic Inspector, Military Control and Provincial Traffic Police) based on the agreement with MOT and People's Committee. The technical requirements of this system which has "Static Weigh System" and "Weigh-in-Motion (WIM) System" are described in table below. The procedure of this system which is installed in Gau Diay is following steps. The photo of WIM and static weigh system is shown below.

- A vehicles go to the WIM System, it will activity and measure parameters such as: weight, the distance of axle, Number plate, image of vehicle, parameters are calculated and transmitted to the control center at Static Weight System.
- If the vehicle is overloaded, the system with lamps and will display alerts for the stations. Overloaded Vehicles need go to the Static Weight System to check again.
- If the vehicle is not overloaded, passing to the system without stop.
- When vehicle is overload for second check at Static Weight System: If overload, staff will penalty and require drivers remove of goods.
- All data, pictures, will be displayed on the monitor in Control center, restored, processed

Table 5.16 Technical Requirements of Static Weight System and WIM System

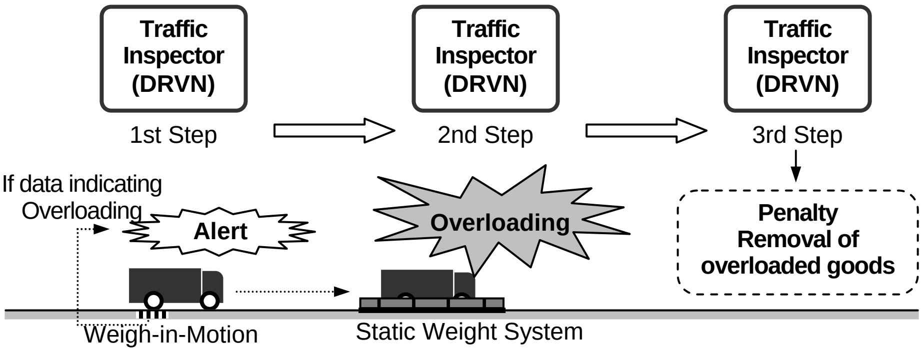
System	Static Weight System	Weigh-in-Motion (WIM) System
Technical Requirements	- Measure the load of each vehicle axles - Maximum load allowed: Not more than 30 tons - Accuracy: 3 tons - Software can record all information and calculate the weight of the vehicle. - Allows setting up and changing the threshold for the overloaded: axles, group of axles and vehicle. - Entry and store data of vehicle in the inspection processing. - Statistics and general data, data connection between WIM and static weight system - The system must register with the measurement quality of Vietnam	- Measure the load of each vehicle axles - Maximum load of axle allowed: Not more than 20 tons - Speed of vehicle through WIM System: Not more than 50 km/h - Determine the speed run, the distance of axles, No. axles and total weight of vehicle - Allows setting up and changing the threshold for the overloaded: axles, group of axles and vehicle. - Automatically detect overloaded by axle weight and the total weight of the vehicle - System controls traffic alerts overloaded vehicles go to the static weight system - System statistics the volume and classification of vehicles go through the station - Data connection between WIM and static weight system - Accuracy: Not more than 10% for the weight of axle, 3% for speed, 0.2m for the distance of axle

Source: VITRANSS 2 Study Team

Figure 5.62 WIM System (Left) /Static Weigh System (Right) /Static Weighbridge (Below)

Source: VITRANSS 2 Study Team

Figure 5.63 Existing Procedure for Overloading Regulation

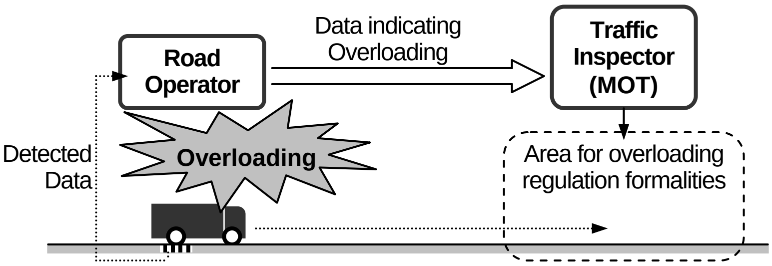


Source: ITS Integration Project (SAPI) Study Team

2) Recommended Framework for Overloading Regulation on Expressway Network

It is defined by the Decree 34/2010/ND-CP that actual procedure to enforce overloading regulation is a task to be conducted by the traffic inspectors. The role of road operator is to handover the inspector the information on the overloaded vehicle and the data from vehicle weighing system which indicates the fact of overloading.

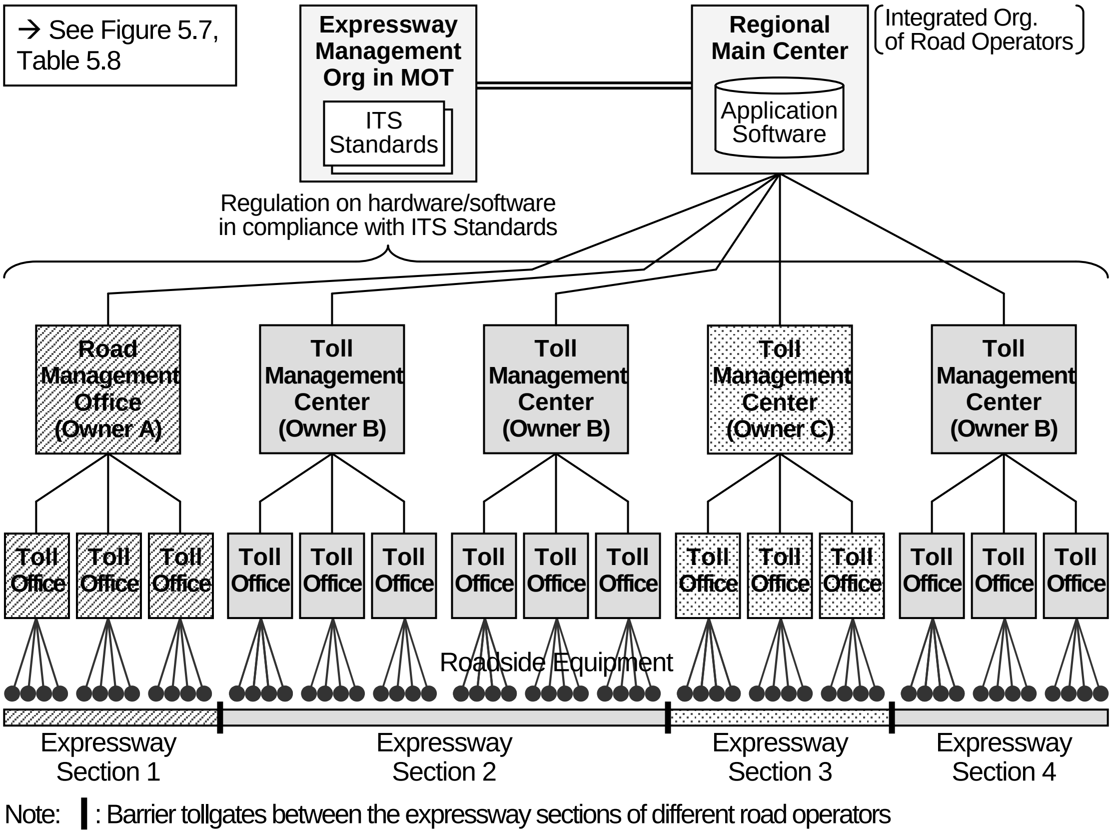
Figure 5.64 Recommended Procedure for Overloading Regulation on Expressway Network



Source: ITS Standards & Operation Plan Study Team

The framework for overloading regulation shown in the figure below is to be defined as a premise for discussion in the Study. This framework includes many different road owners, who own the expressway section and the vehicle weighing system, and the Regional Main Center. The Standards on hardware is to be managed by the Expressway Management Org. in MOT The application software is to be managed in the Regional Main Center and the part for roadside operation is to be distributed under license to each road owner.

Figure 5.65 Recommended Framework for Overloading Regulation on Expressway Network



Source: ITS Integration Project (SAPI) Study Team

5.7 Framework for Integrated Data Management

1) Necessities of Integrated Data Management for Operation of Expressway Network

Integrated data management system of expressway network is necessary and important for the expressway operation and maintenance by the following reasons:

- Utilization of acquired data such as traffic events, traffic volume, large vehicle ratio and measured axle loads of heavy trucks for developing inspection and budget plan of road maintenance
- Validity check on toll revenue data in comparison with traffic data.

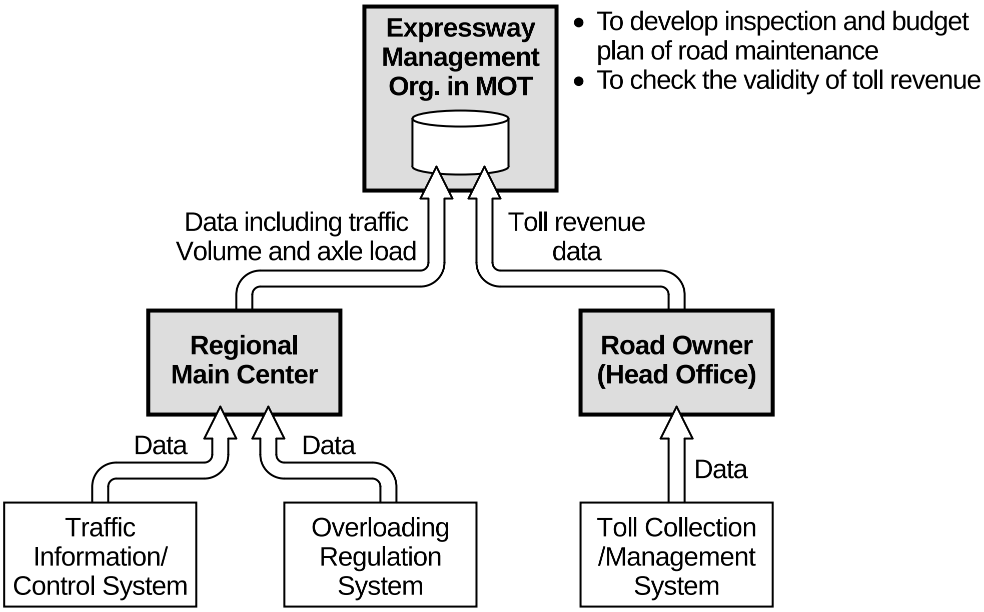
For establishing a sustainable system for maintenance of expressway network, it is necessary to develop the inspection and budget plan for road maintenance. For this purpose, measured data, such as the traffic volume and large vehicle ratio detected by traffic information/control system and the axle load measured by vehicle weighing system, are to be acquired and analysed for estimating the damage to the pavement or the bridges.

For establishing a sustainable concession system for expressway operation, it is necessary to secure appropriate and reliable apportionment of toll revenue among the road operators by prevention of unfair billings to the bank: the prepayment service center. For this purpose, the validity of toll revenue data of the road owners are to be checked in comparison with traffic data in the Regional Main Center.

2) Recommended Framework for Integrated Data Management

The framework shown below needs to be prepared for integrated data management. Traffic data, axle load data and toll revenue data are to be acquired and stored at the same place, and to be utilized for developing plans of inspection and budget for road maintenance and checking the validity of required toll revenue.

Figure 5.66 Recommended Framework for Integrated Data Management



Source: ITS Integration Project (SAPI) Study Team

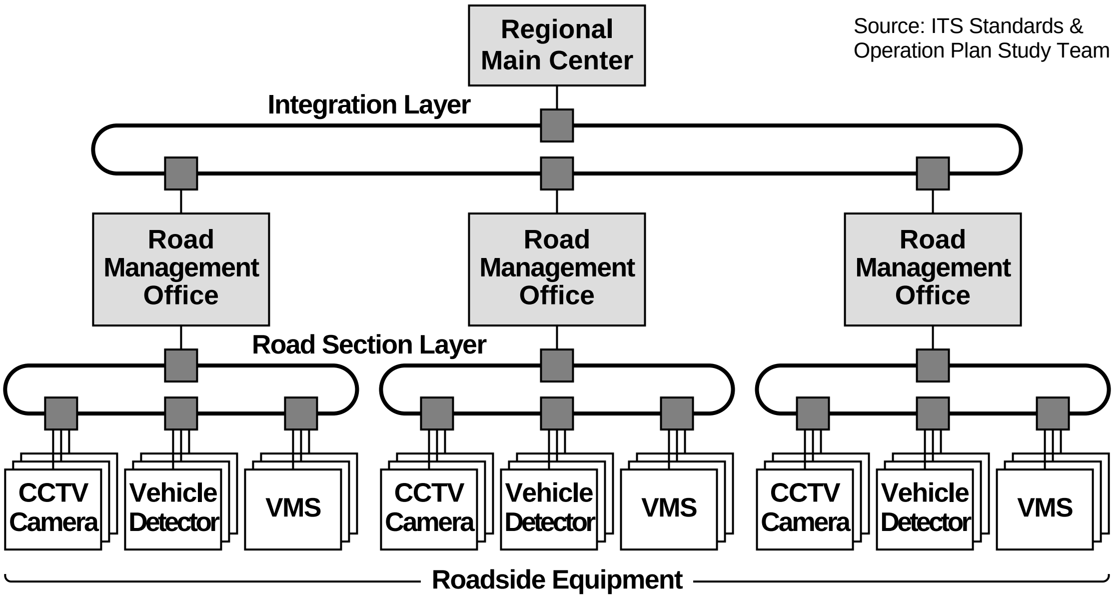
5.8 Framework for Communication Network Management

5.8.1 Key Framework

1) Hierarchical Network Structure for Road Operation

For road operation, a hierarchical communication network needs to be established. The reason is that fiber optic rings of road section layer for connecting a road management office and pieces of roadside equipment need to be installed section by section keeping pace with the road construction; however an integration layer is necessary for connecting the Regional Main Center and road management offices for total road operation.

Figure 5.67 Hierarchical Network Structure

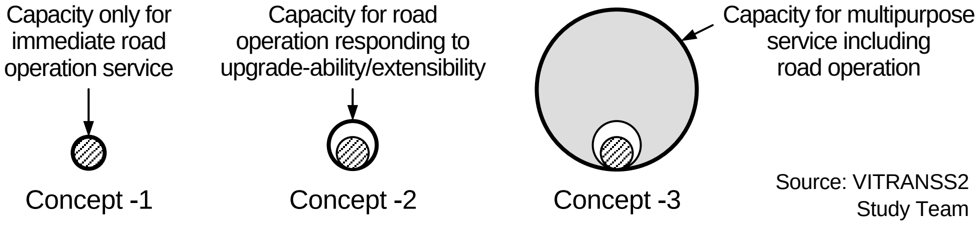


Source: ITS Standards & Operation Plan Study Team

In addition, transmission capacity is an important factor for discussing communication network management, which is to respond to the scope of services provided through it. Three typical concepts are proposed for setting target transmission capacity of the communication network:

- Concept -1: Capacity only for immediate road operation service
- Concept -2: Capacity for road operation service with upgrade-ability/extensibility
- Concept -3: Capacity for multi-purpose service including road operation.

Figure 5.68 Concepts of Target Transmission Capacity of Communication Network

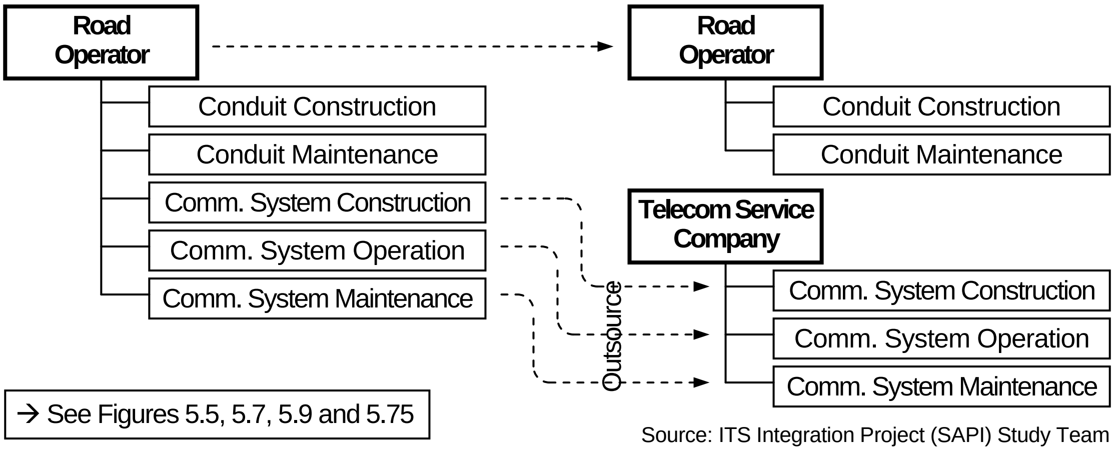


Source: VITRANSS2 Study Team

2) Applicable Framework for Communication Network Management

Several applicable frameworks for communication network management are compared in the table below, considering role/cost sharing among organizations and revenue increase for the road operator. From a viewpoint of role sharing, the system transfer & use of telecom service is to be selected as a suitable framework for communication network management for the expressways in Vietnam.

Figure 5.69 Role Sharing on Communication Network Management



Source: ITS Integration Project (SAPI) Study Team

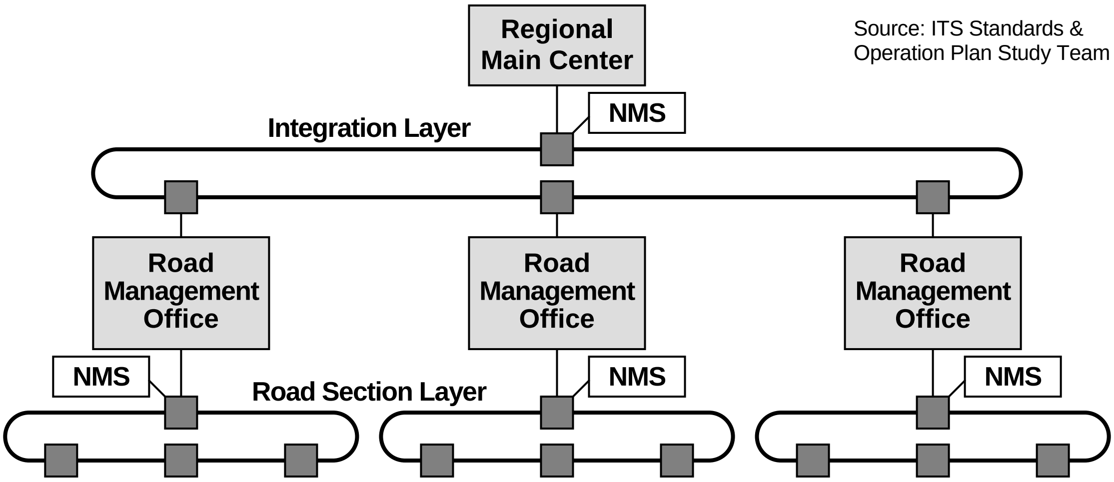
Table 5.17 Comparison on Frameworks for Communication Network Management

	Ownership & O/M	O/M Contract	Comm. System Lease Contract
Target Transmission Capacity	Concept-2	Concept-2	Concept-2
Owner of Duct	Road operator	Road operator	Road operator
Owner of Comm. System	Road operator	Road operator	Road operator
O/M of Comm. System	Road operator	Subcontractor	Road operator, Telecom service co.
Comm. System Engineer Employed by Road Operator	Necessary	Not necessary	Necessary
Cost for Road Operator	Construction cost, O/M cost	Construction cost, O/M service fee	Construction cost, Maintenance cost
Revenue for Road Operator	None	None	Lease charge paid by telecom service co.
Grade	Not Suitable	Not Suitable	Not Suitable
	System Transfer & Use of Telecom Service	Conduit Lease Contract	Use All of Telecom Service
Target Transmission Capacity	Concept-3	Concept-3	Concept-3
Owner of Duct	Road operator	Road operator	Telecom service co
Owner of Comm. System	Telecom service co	Telecom service co	Telecom service co
O/M of Comm. System	Telecom service co	Telecom service co	Telecom service co
Comm. System Engineer Employed by Road Operator	Not necessary	Not necessary	Not necessary
Cost for Road Operator	Construction cost, Conduit maintenance cost, Telecom service fee	Conduit construction cost, Conduit maintenance cost, Telecom service fee	Telecom service fee
Revenue for Road Operator	Transfer charge paid by telecom service co.	Lease charge paid by telecom service co.	None
Grade	Recommended (→ See Figure 5.7)	Average	Not Suitable

2) Typical Methods for Maintenance on Expressway Network

The network needs to be managed by using NMS (Network Management System). However, since there is no compatibility among NMSs supplied by different suppliers. An adequate organization needs to be set up to manage the hierarchical communication network for road operation.

Figure 5.70 Communication Network Management

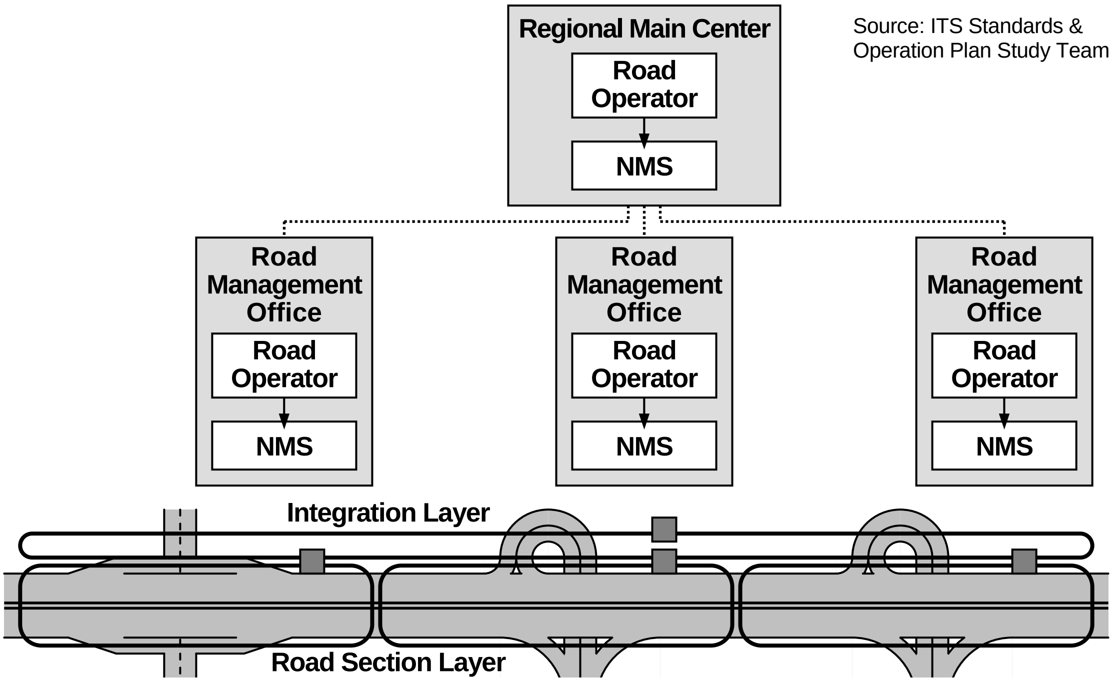


Source: ITS Standards & Operation Plan Study Team

(1) Method-1: Management Respectively by the Road Operators

Communication network consists of roadside layer and integration layer, and both layers are to be managed by the respective road operators.

Figure 5.71 Management by the Respective Road Operators



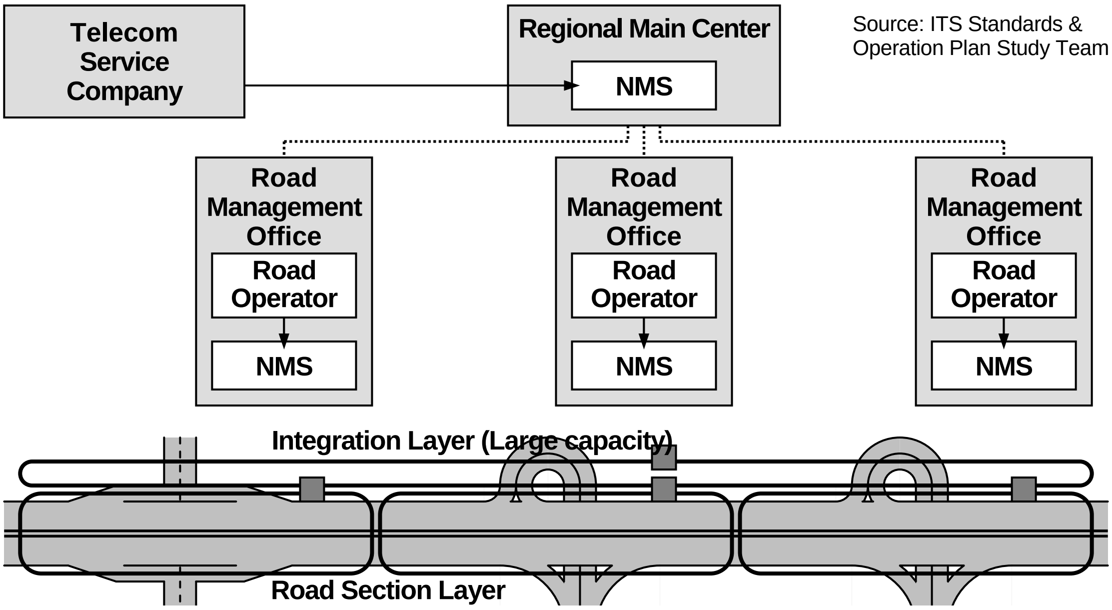
Source: ITS Standards & Operation Plan Study Team

Note: Roadside layer: for connecting a road management office and pieces of roadside equipment, Integration layer: for connecting the Regional Main Center and road management offices, NMS: Network Management System.

(2) Method-2: Management by the Road Operators with Integration by a Telecom Service Company

Communication network consists of roadside layer managed by the respective road operators and integration layer managed by a telecom service company.

Figure 5.72 Management by the Road Operators with Integration by a telecom service Company



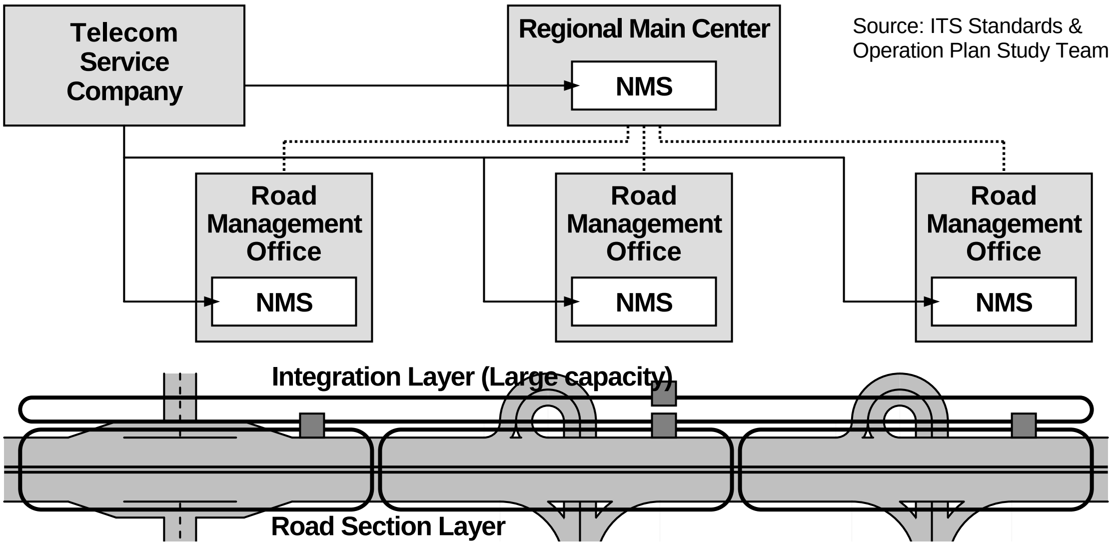
Source: ITS Standards & Operation Plan Study Team

Note: Roadside layer: for connecting a road management office and pieces of roadside equipment, Integration layer: for connecting the Regional Main Center and road management offices, NMS: Network Management System.

(3) Method-3: Operation Totally by a Telecom Service Company

Communication network consists of roadside layer and integration layer, and both layers are to be managed totally by a telecom service company.

Figure 5.73 Operation Totally by a Telecom Service Company



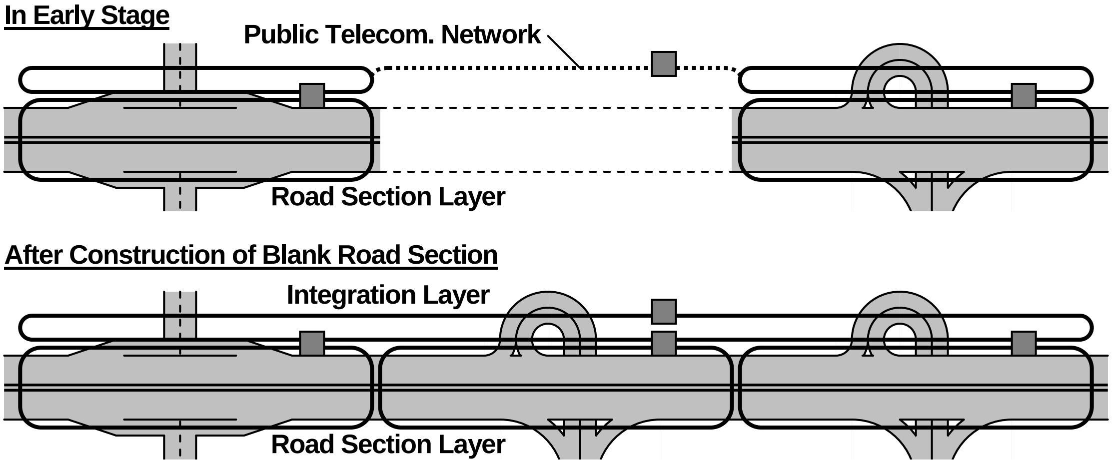
Source: ITS Standards & Operation Plan Study Team

Note: Roadside layer: for connecting a road management office and pieces of roadside equipment, Integration layer: for connecting the Regional Main Center and road management offices, NMS: Network Management System.

(4) Additional Case: Operation during Construction of Communication Network

In addition, a fiber optic cable network is to be installed by road sections. For any blank sections, a public telecommunication network is to be used as a complement in early stage as shown below; later, the fiber optic cable is to be installed to form linked loops after construction of the blank road section.

Figure 5.74 Stepwise Installation of Fiber Optic Cable

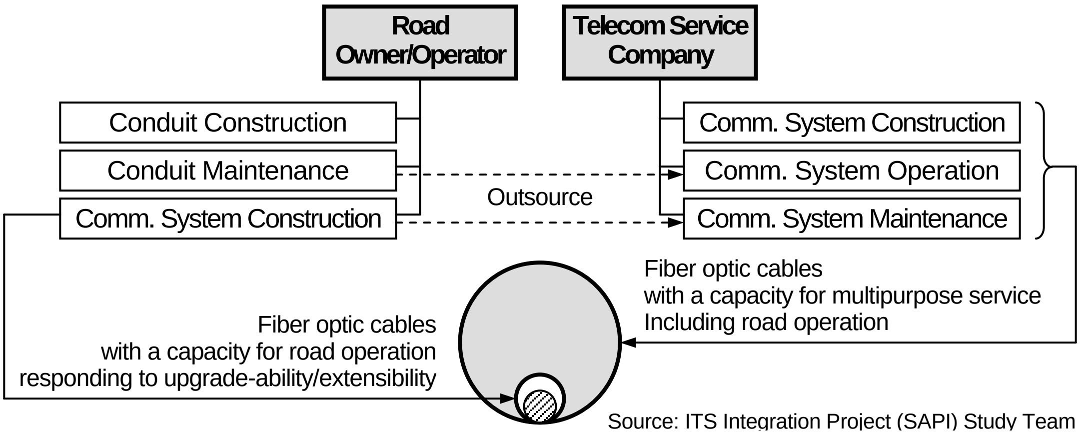


Source: ITS Standards & Operation Plan Study Team

3) Recommended Framework for Communication Network Management

The framework below is recommended communication network management from the results of comparison shown in Table 5.17. There are several different functions in the operation and maintenance of communication Network, such as resource management, network performance monitoring or fault detection. Those functions are realized by using Network Management System (NMS). It is recommended for road owners/operators to outsource the communication network management to a telecom service company, because telecom service companies have higher skills. Introduction of communication system/equipment also is to be outsourced to the telecom service companies in the future, as proposed in the Decision No.3569/VPCP-KTN VNPT, because they can select appropriate system, which will not be the hindrance of the operation and maintenance.

Figure 5.75 Recommended Framework for Communication Network Management



Source: ITS Integration Project (SAPI) Study Team

5.8.2 Framework for Radio Frequency Allocation

1) Necessities of Radio Frequency Allocation

In ITS, radio communication is to be used for exchanging information between patrol crews and road-to-vehicle data for ETC. However, for utilizing radio communication, it is necessary to allocate a specific radio frequency bandwidth for the intended purpose, to clear away usage for the other purpose and to prevent interference.

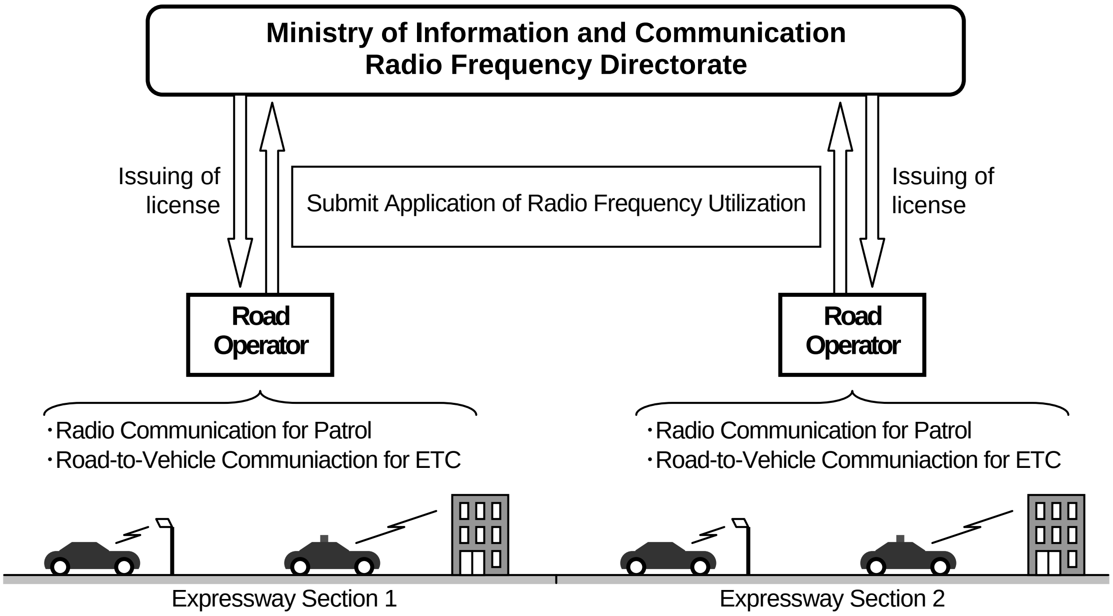
In the Draft ITS Standards prepared in the Study, the radio frequency bands and channels shown below are assumed to be allocated to communication for patrols and ETC. Toward that end, formalities for radio frequency allocation need to be conducted at the Radio Frequency Directorate in MIC (Ministry of Information and Communication) in advance.

• Radio communication for patrols:	UHF band (3 channels, available VHF band as well)
• RF-Tag for ETC:	UHF band (more than 2 channels at 865 MHz)
• DSRC for ETC:	Microwave band (more than 2 channels at 5.8 GHz)

2) Framework for Radio Frequency Allocation

Upon the utilization of radio frequency, there is a band necessary to obtain the license. The necessity of the license should be checked to Radio Frequency Directorate, if the frequency to be used is required to be licensed, the road operator in road management office should submit the application to Radio Frequency Directorate, and before installing the radio transmitter, the license shall be obtained. The information required for application of the license is name of applicant, objective of utilization, frequency band, location of transmitter, output power and other information required by Radio Frequency Directorate. The application should be submitted in accordance with Decree No. 24/2004/ND-CP, dated January 14, 2004. The necessary period from submit the application up to obtaining the license will be approximately 20 days. The maximum effective period of the license will be 5 years and it should be extended if it is necessary.

Figure 5.76 Framework for Radio Frequency Allocation



Source: ITS Integration Project (SAPI) Study Team

5.9 Framework for System Maintenance

1) Necessities of System Maintenance on Expressway Network

Once commencement of ITS operation, equipment components in the Regional Main Center, in road management offices, in roadside, and communication network related equipment components should be operated 24 hours a day 365 days in a year continuously. Should there be found failure or fault, the downtime shall be minimized.

In order to realize such operation conditions, the appropriate organization, capable technical staff, necessary spares and tools are required to be ready for maintenance. In addition, required budget should be allocated for the maintenance works.

The maintenance quality for the equipment component to be introduced should be the same level among the different expressway sections. The equipment components to be installed in the specific road management section is supposed to be maintained by the road operator in charge of that expressway section, and those equipment components should be maintained properly by each road operator.

As for communication network, it is composed of integration layer which connects between the Regional Main Center and the road management offices, and both road section and the terminal layers which connects between road management office and roadside equipment components.

Since it is supposed to be different management organization for the integration layer and the road section layer respectively, each network should be maintained properly by each maintenance organization in charge.

Should there be made improper maintenance, the following concern may arise:

- Delay of response to the incident (In the worst case, injured person will not be rescued)
- Due to no dissemination of the proper information with VMS, delay of arrival of the destination of the expressway users and economic loss induced by this.

So as not to become such situations, it is essentially required to ensure to establish necessary organization and to assign skillful staff including outsourcing possibility. It is noted that the required budget allocation for the maintenance is also essentially required.

2) Recommended Framework for System Maintenance on Expressway Network

The following equipment components are to be maintained for expressway operation:

(1) The equipment components related to ITS to be installed in the Regional Main Center and road management offices
(2) The equipment components related to ITS to be installed at Roadside
(3) The communication network related to ITS

In the foregoing discussion on the total framework of expressway operation, the following points are recommended for the operation of equipment components (1) and (2) above;

- Toll collection/management is recommended to be operated by the Road Owner
- Traffic information/control and overloading regulation is recommended to be operated

by the road operator

Taking the conditions above into consideration, In addition, equipment components included in functional packages are recommended to be maintained by the same organization respectively.

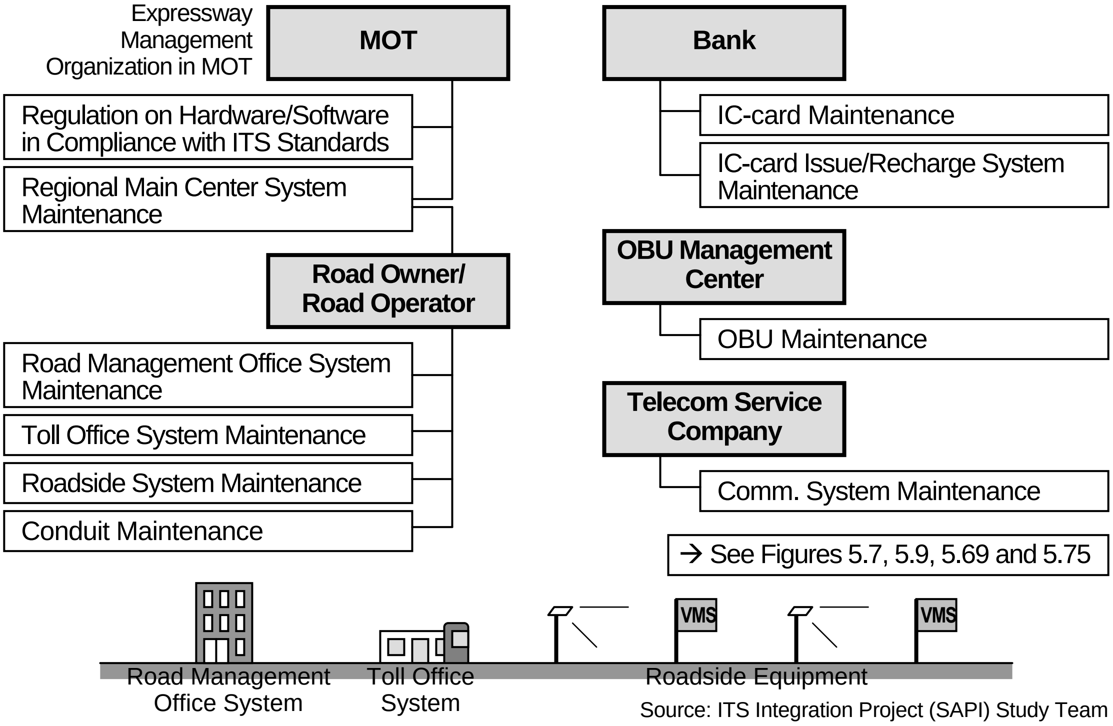
On the other hand, the equipment components of communication system is to be owned/ operated/maintained by the telecom service company in the future. As for the ducts, road operator is recommended to be owned.

After commencement of operation of communication network, it should be maintained 24 hours a day and 365days in a year. The fault occurrence and other monitoring should be made by the Network Management System and whenever required, the faulty parts shall be replaced with the spare parts. The communication network service provider provides such operation and maintenance services and deeply understands the technical know-how. Although the contract with the communication network service provider will be required, it is a merit for road operator to concentrate its own duty.

It is noted that in order to function whole system without failure or fault, each equipment component should function correctly as it is required. In order to identify the faulty parts promptly, maintenance demarcation shall be physically clarified among the parties concerned, and this condition shall be clearly shown in the contract document related to maintenance.

As shown below, the system maintenace is to be shared by the Expressway Management Organization in MOT, road owners, road operators, banks, the OBU management center and telecom service companies. The maintenance of the equipment components in the Regional Main Center requires cooperation between the Expressway Management Organization in MOT and the road owners/operators, because many system functions are actualized by the cooperation among the equipment components in the Regional Main Center and at roadside.

Figure 5.77 Recommended Framework for System Maintenance on Expressway Network



Source: ITS Integration Project (SAPI) Study Team

5.10 Listing of Recommended Frameworks

Discussed frameworks and conditions in building recommended frameworks for expressway operation using ITS are shown in the listing table below.

Table 5.69 Listing of Recommended Frameworks

Discussed Frameworks	Conditions in Building Recommended Frameworks
Total Framework of Expressway Operation	Consensus for project implementation is built in MOT based on the recommended frameworks shown in Table 5.1, Figures 5.7 and 5.9.
Framework for Service Level Control	Consensus for project implementation is built in MOT based on the recommended framework shown in Figure 5.12.
Framework for Traffic Control	Consensus for project implementation is built in MOT based on the recommended framework shown in Figure 5.14.
Framework for Police Car Dispatch	Recommended framework shown in Figure 5.16 has been built for the existing expressway.
Framework for Ambulance Dispatch	Recommended framework shown in Figure 5.19 has been built for the existing expressway.
Framework for Incident Notification to Road Operator	Recommended framework shown in Figure 5.23 has been built for the existing expressway, and the special call number is under discussion in MOT.
Framework for Traffic Restriction	Recommended framework shown in Figure 5.25 has been built for the existing expressway, and the special call number is under discussion in MOT.
Framework for Road/Traffic Monitoring	Recommended framework shown in Figure 5.27 is to be evolved simply from the existing framework.
Framework for Traffic Event Data Management	Consensus for project implementation is built in MOT based on the recommended framework shown in Figure 5.31.
Framework for Traffic Information Dissemination	Recommended framework shown in Figure 5.35 is to be evolved simply from the existing framework.
Framework for Toll Management	Consensus for project implementation is built in MOT based on the recommended framework shown in Table 5.8 and Figure 5.43.
Framework for Toll Settlement	Recommended framework shown in Table 5.10, Figures 5.45 and 5.46 is to be evolved from the framework for existing tollgates.
Framework for IC-card Issuance/Operation	A bank for IC-card issuance/operation is to be selected* to build the recommended framework shown in Figure 5.51.
Framework for OBU Registration/Management	A Center for OBU Registration/Management is to be set up* to build the recommended framework shown in Figure 5.58.
Framework for Toll Enforcement	Recommended framework shown in Figure 5.61 to be evolved from the existing framework by setting up of a bank* and a Center*.
Framework for Overloading Regulation	Consensus for project implementation is built in MOT based on the recommended framework shown in Figure 5.65.
Framework for Integrated Data Management	Consensus for project implementation is built in MOT based on the recommended framework shown in Figure 5.66.
Framework for Communication Network Management	Consensus for project implementation is built in MOT based on the recommended framework shown in Table 5.17 and Figure 5.75.
Framework for Radio Frequency Allocation	Recommended framework shown in Figure 5.76 is included in the existing framework.
Framework for System Maintenance	Consensus for project implementation is built in MOT based on the recommended framework shown in Figure 5.77.

Note: * : See Chapter 16 Required Conditions for Project Implementation.

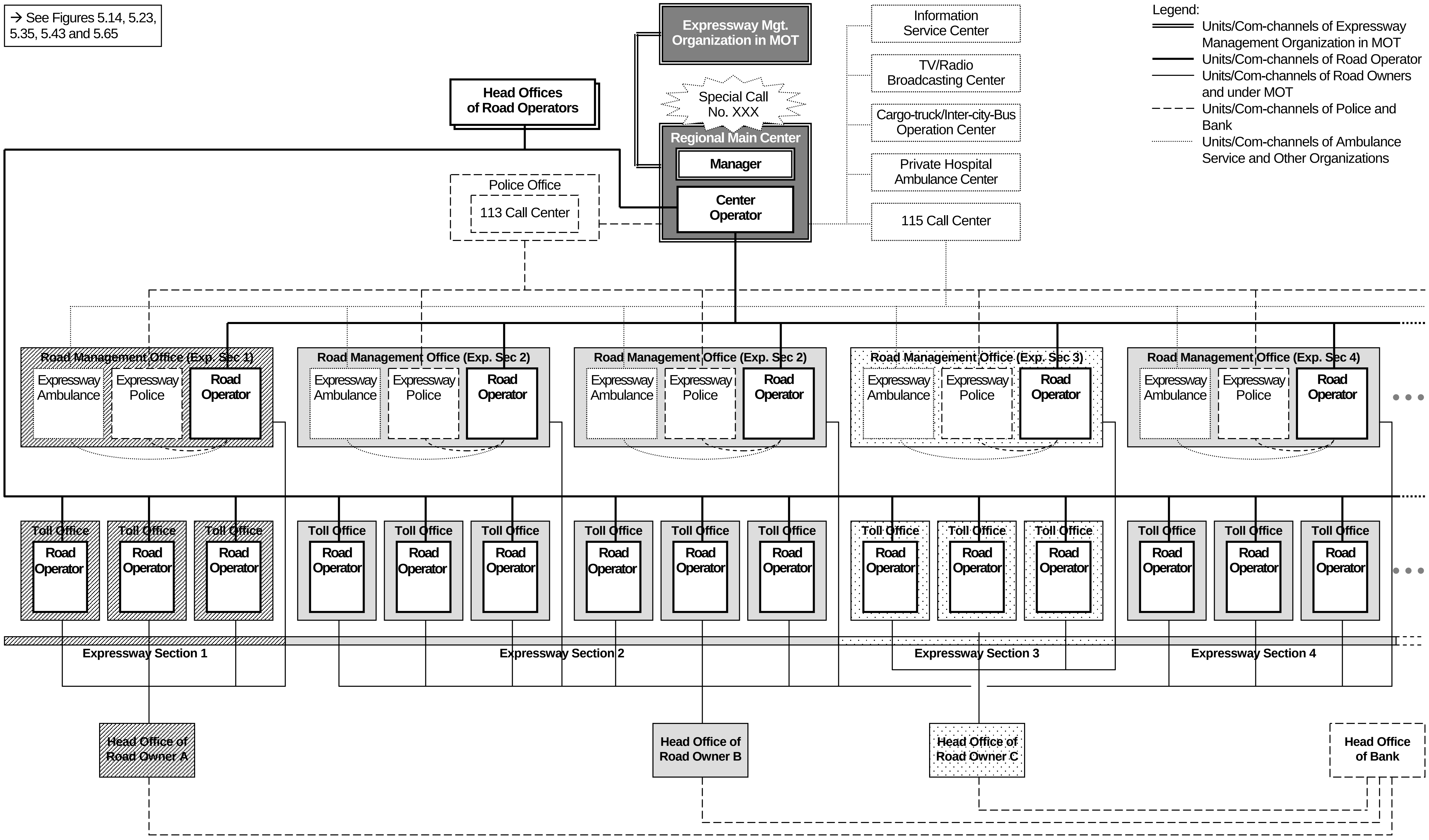
Source: ITS Integration Project (SAPI) Study Team

5.11 Organization of Road Owner/Operator

The discussion results foregoing can be integrated as the organization of road owner/operator as shown in the figure in the following page.

In this figure, the organization of the road operator is indicated by using heavy solid lines, the organizations and relationships of the road owners and under MOT are indicated by thin lines and other organizations and relations are indicated by dotted lines.

Figure 5.78 Organization of Road Owner/Operator and Relationships with Other Organizations



Source: ITS Integration Project (SAPI) Study Team

6. System Operation/Management Plan

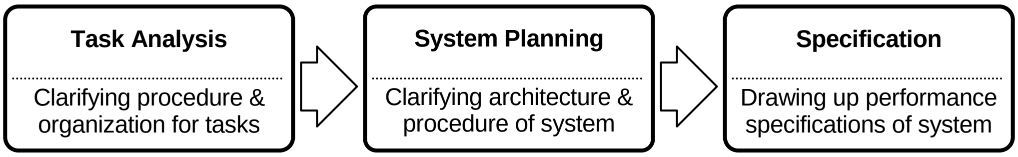
6.1 General

Operation and management of the system was discussed in this chapter and the following results were reasoned out from the discussion (see Appendix-2):

- Frameworks and role sharing for expressway operation
- Event trace diagrams of tasks for expressway operation
- Screen transition diagram.
- Operation/management plan for the traffic information/control system, the autometed toll collection system, the vehicle weighing system and the communication system
- Basic policy on training system operation/management
- Equipment operation manual lists.

Procedures and organizations for expressway operation were clarified by using task analysis, and based on its results, an appropriate architecture and procedure for implementing tasks were defined and performance specifications of the system were to be drawn up as outputs.

Figure 6.1 Procedure of Discussion based on Task Analysis

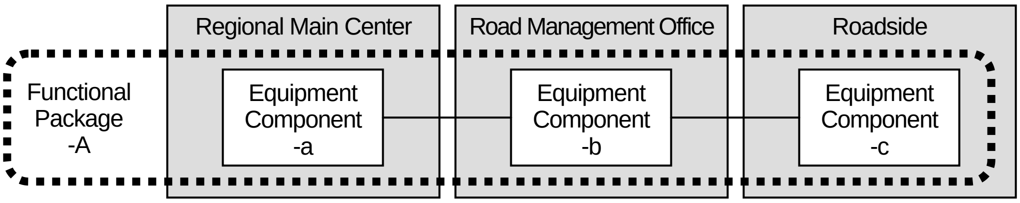


Source: ITS Integration Project (SAPI) Study Team

6.2 Role Sharing

ITS cosists of many functional packages and each functional package consists of several equipment components which can be installed separately in different locations as shown in the figure below. However, the centers and roadside are operated respectively by the different organizations. Accordingly, for discussing the sytem operation, the roles are to be detailed responding to the functional packages and the offices where equipment packages are installed.

Figure 6.2 Functional Package Consists of Equipment Components in Different Locations



Source: ITS Integration Project (SAPI) Study Team

In the following, the roles of exressway operation for the major organizations: the expressway management organization in MOT, the road owner, the road operator, the telecommunication service company, the OBU management center and the bank are shown in the form of matrix, which corresponds to the functional packages and the locations. These organizations shall share the roles and cooperate for operating and maintaining each functional package.

6.2.1 Roles of Expressway Management Organization in MOT

From the discussion on frameworks foregoing, roles of the expressway management organization in MOT are to be sort out as shown in the table below.

The Expressway Management Office is set up as the expressway management organization in MOT in 1st April 2011, is transferred to DRVN in 26th April 2012 and will be change into the Expressway Management Agency.

Table 6.1 Roles of Expressway Management Organization in MOT

Items		Center Subsystem			Roadside Subsystem	Onboard Subsystem	Mobile Subsystem	In-door Subsystem
		Regional Main Center	Road Management Office	Toll Office				
Functional Packages								
1	Voice Communication	O/F/Mgt						
2	CCTV Monitoring	O/F/Mgt						
3	Event Detection (by Image)	O/F/Mgt						
4	Vehicle Detection	O/F/Mgt						
5	Traffic Analysis	O/F/Mgt						
6	Weather Monitoring	O/F/Mgt						
7	Traffic Event Data Management	O/F/Mgt						
8	Traffic Supervision	O/F/Mgt						
9	VMS Indication	O/F/Mgt						
10	Mobile Radio Communication							
11	Traffic Information	O/F/Mgt						
12	Integrated Data Management	O/F/Mgt						
13	Tollgate Lane Monitoring							
14	Vehicle/Class Identification							
15	Lane Control							
16	Road-to-Vehicle Communication							
17	IC-card Recording							
18	Toll Data Management							
19	OBU Management							
20	Axle Load Measurement							
21	Measurement Lane Monitoring							
Communication System		O/F/Mgt						
Communication Ducts		O/F/Mgt						
Base Structures		O/F/Mgt						
Electric Power Supply		O/F/Mgt						

Note: O: Ownership, F: Funding, Mgt: Management.

Source: ITS Integration Project (SAPI) Study Team

6.2.2 Roles of Road Owner

From the discussion on frameworks foregoing, roles of the road owner are to be sort out as shown in the table below.

The road owners has been assigned respectively to the road sections in the Project Scope:

- VEC: Phap Van – Cau Gie – Ninh Binh
- RMU-2: Mai Dich – Thanh Tri, Ha Noi – Bac Ninh and Noi Bai – Bac Ninh
- HPC: Lang – Hoa Lac.

Table 6.2 Roles of Road Owner

Items		Center Subsystem			Roadside Subsystem	Onboard Subsystem	Mobile Subsystem	In-door Subsystem
		Regional Main Center	Road Management Office	Toll Office				
Functional Packages								
1	Voice Communication		O/F/Mgt	O/F/Mgt	O/F/Mgt			
2	CCTV Monitoring		O/F/Mgt		O/F/Mgt			
3	Event Detection (by Image)		O/F/Mgt		O/F/Mgt			
4	Vehicle Detection		O/F/Mgt		O/F/Mgt			
5	Traffic Analysis							
6	Weather Monitoring				O/F/Mgt			
7	Traffic Event Data Management		O/F/Mgt					
8	Traffic Supervision							
9	VMS Indication				O/F/Mgt			
10	Mobile Radio Communication		O/F/Mgt			O/F/Mgt	O/F/Mgt	
11	Traffic Information							
12	Integrated Data Management							
13	Tollgate Lane Monitoring			O/F/Mgt	O/F/Mgt			
14	Vehicle/Class Identification				O/F/Mgt			
15	Lane Control				O/F/Mgt			
16	Road-to-Vehicle Communication				O/F/Mgt			
17	IC-card Recording				O/F/Mgt			
18	Toll Data Management			O/F/Mgt				
19	OBU Management		O/F/Mgt					
20	Axle Load Measurement				O/F/Mgt			
21	Measurement Lane Monitoring			O/F/Mgt				
Communication System			O/F/Mgt	O/F/Mgt	O/F/Mgt			
Communication Ducts			O/F/Mgt	O/F/Mgt	O/F/Mgt			
Base Structures			O/F/Mgt	O/F/Mgt	O/F/Mgt			
Electric Power Supply			O/F/Mgt	O/F/Mgt	O/F/Mgt			

Note: O: Ownership, F: Funding, Mgt: Management.

Source: ITS Integration Project (SAPI) Study Team

6.2.3 Roles of Road Operator

From the discussion on frameworks foregoing, roles of the road operator are to be sort out as shown in the table below.

Road operators under road owners assigned to the road sections in the Project Scope:

- VEC O&M Company (under VEC): Phap Van – Cau Gie – Ninh Binh
- Road O&M company 248 (under RMU-2): Mai Dich – Thanh Tri, Ha Noi – Bac Ninh and Noi Bai – Bac Ninh
- Infrastructure Maintenance Project Management Unit (under HPC): Lang – Hoa Lac.

Table 6.3 Roles of Road Operator

Items		Center Subsystem			Roadside Subsystem	Onboard Subsystem	Mobile Subsystem	In-door Subsystem
		Regional Main Center	Road Management Office	Toll Office				
Functional Packages								
1	Voice Communication	Op/M *	Op/M	Op/M	Op/M			
2	CCTV Monitoring	Op/M *	Op/M		Op/M			
3	Event Detection (by Image)	Op/M *	Op/M		Op/M			
4	Vehicle Detection	Op/M *	Op/M		Op/M			
5	Traffic Analysis	Op/M *						
6	Weather Monitoring	Op/M *			Op/M			
7	Traffic Event Data Management	Op/M *	Op/M					
8	Traffic Supervision	Op/M *						
9	VMS Indication	Op/M *			Op/M			
10	Mobile Radio Communication		Op/M			Op/M	Op/M	
11	Traffic Information	Op/M *						
12	Integrated Data Management	Op/M *						
13	Tollgate Lane Monitoring			Op/M	Op/M			
14	Vehicle/Class Identification				Op/M			
15	Lane Control				Op/M			
16	Road-to-Vehicle Communication				Op/M			
17	IC-card Recording				Op/M			
18	Toll Data Management			Op/M				
19	OBU Management		Op/M					
20	Axle Load Measurement				Op/M			
21	Measurement Lane Monitoring			Op/M				
Communication System		Op/M *	Op/M	Op/M	Op/M			
Communication Ducts		Op/M *	Op/M	Op/M	Op/M			
Base Structures		Op/M *	Op/M	Op/M	Op/M			
Electric Power Supply		Op/M *	Op/M	Op/M	Op/M			

Note: Op: Operation, M: Maintenance, * : Operation by member dispatch to the Regional Main Center.

Source: ITS Integration Project (SAPI) Study Team

6.2.4 Roles of Telecommunication Service Company

From the discussion on frameworks foregoing, roles of the telecommunication service company are to be sort out as shown in the table below.

Introduction and O&M of communication system is to be outsourced to the telecom service companies for manpower saving in the later stage after the ITS Integration Project, that is proposed by the Decision No.3569/ VPCP-KTN VNPT.

Table 6.4 Roles of Telecommunication Service Company

Items		Center Subsystem			Roadside Subsystem	Onboard Subsystem	Mobile Subsystem	In-door Subsystem
		Regional Main Center	Road Management Office	Toll Office				
Functional Packages								
1	Voice Communication	(O/F) M	(O/F) M	(O/F) M	(O/F) M			
2	CCTV Monitoring							
3	Event Detection (by Image)							
4	Vehicle Detection							
5	Traffic Analysis							
6	Weather Monitoring							
7	Traffic Event Data Management							
8	Traffic Supervision							
9	VMS Indication							
10	Mobile Radio Communication		(O/F) M			(O/F) M	(O/F) M	
11	Traffic Information							
12	Integrated Data Management							
13	Tollgate Lane Monitoring							
14	Vehicle/Class Identification							
15	Lane Control							
16	Road-to-Vehicle Communication							
17	IC-card Recording							
18	Toll Data Management							
19	OBU Management							
20	Axle Load Measurement							
21	Measurement Lane Monitoring							
Communication System		(O/F) Op/M	(O/F) Op/M	(O/F) Op/M	(O/F) Op/M			
Communication Ducts								
Base Structures								
Electric Power Supply								

Note: O: Ownership, F: Funding, Op: Operation, M: Maintenance.

Source: ITS Integration Project (SAPI) Study Team

6.2.5 Roles of Other Organization

From the discussion on frameworks foregoing, roles of the bank and the OBU management center are to be sort out as shown in the table below.

IC-card recording, which is included prepayment strongly related to toll settlement among several different road owners, is to be operated a bank or an organization permitted by the State Bank (as the case of Decision No.5190/NHNN-TT). OBU Management is to be carried out independently by the Vietnam Register using the deposit and service charge for OBU.

Table 6.5 Roles of Other Organizations

Items		Center Subsystem			Roadside Subsystem	Onboard Subsystem	Mobile Subsystem	In-door Subsystem
		Regional Main Center	Road Management Office	Toll Office				
Functional Packages								
1	Voice Communication							
2	CCTV Monitoring							
3	Event Detection (by Image)							
4	Vehicle Detection							
5	Traffic Analysis							
6	Weather Monitoring							
7	Traffic Event Data Management							
8	Traffic Supervision							
9	VMS Indication							
10	Mobile Radio Communication							
11	Traffic Information							
12	Integrated Data Management							
13	Tollgate Lane Monitoring							
14	Vehicle/Class Identification							
15	Lane Control							
16	Road-to-Vehicle Communication						Bank	
17	IC-card Recording						(O/F) Op/M	O/F Op/M
18	Toll Data Management							
19	OBU Management					(O/F) Op/M		O/F Op/M
20	Axle Load Measurement							
21	Measurement Lane Monitoring					OBU Management Center		
Communication System								
Communication Ducts								
Base Structures								
Electric Power Supply								

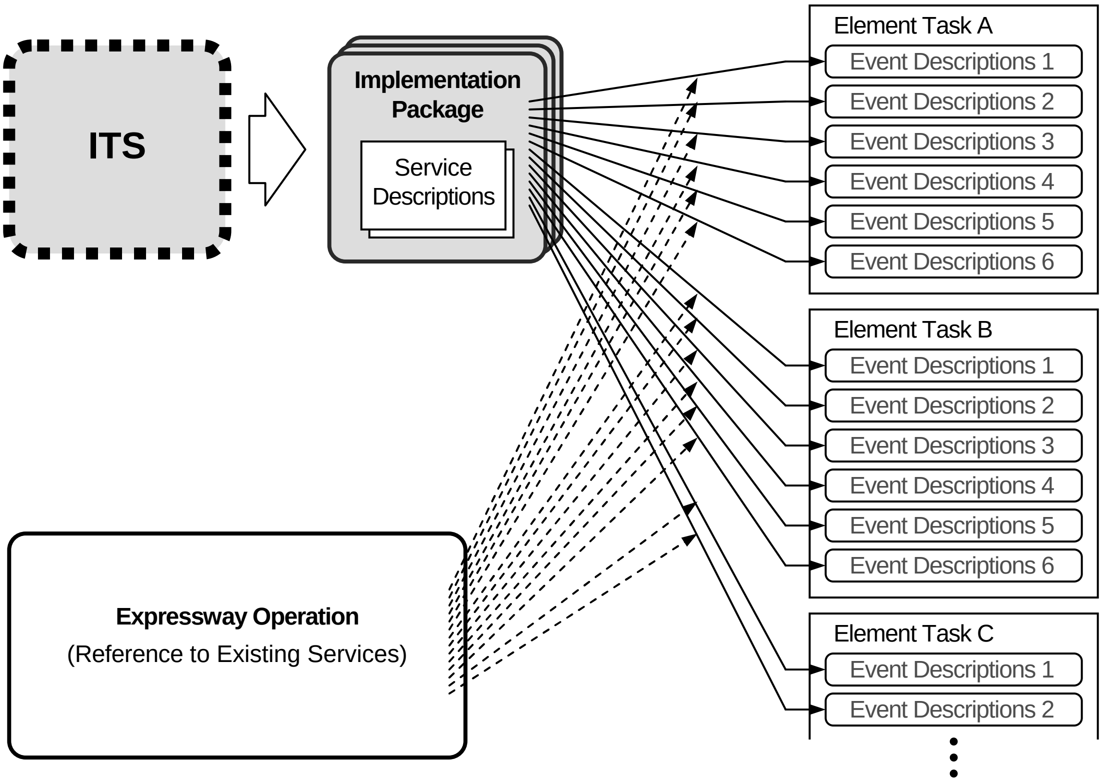
Note: O: Ownership, F: Funding, Op: Operation, M: Maintenance.

Source: ITS Integration Project (SAPI) Study Team

6.3 Event Trace Diagrams of Tasks for Expressway Operation

Applying the method of task analysis to examples of road operation in Vietnam and abroad, element tasks of expressway operation are to be picked out for actualizing service descriptions of the implementation packages. In addition, events included in an element task are to be organized in time sequence as an event tracing diagram.

Figure 6.3 Picking-out of Element Tasks and Events



Source: ITS Integration Project (SAPI) Study Team

The tasks for expressway operation are listed in the table below. In the Study, the discussion results on these tasks are shown by using the event trace diagrams in Appendix-2.

Table 6.6 Task List of Event Trace Diagrams

Name of System	No.	Task Procedures
Traffic Information/Control System	4.2	Routine Patrol
	4.3	Traffic Condition Monitoring
	4.4	Incident Reporting by Mobile Phone (113 Call)
	4.5	Incident Reporting by Mobile Phone (115 Call)
	4.6	Incident Reporting by Mobile Phone (to Private Hospital)
	4.7	Incident Reporting by Mobile Phone (to Regional Main Center)
	4.8	Incident Reporting from Patrol
	4.9	Incident Identification by Camera
	4.10	Ascertainment of Incident Situation
	4.11	Heavy Rain Identification
	4.12	High Wind Identification
	4.13	Dense Fog Identification
	4.14	High Temperature Identification
	4.15	Flood Identification
	4.16	Stopped Vehicle Identification
	4.17	Reverse Driving Identification
	4.18	Left Obstacle Reporting
	4.19	Vandalism Identification
	4.20	Road Damage Identification
	4.21	Construction Work Information Handling
	4.22	Road Traffic Supervision
	4.23	Decision of Traffic Restriction
	4.24	Entrance Closure
	4.25	Closure
	4.26	Exit Closure
	4.27	Lane Closure
	4.28	Speed Restriction
	4.29	Incident Handling
	4.30	Incident Clearance Reporting
	4.31	Restriction Removal
	4.32	Restriction Removal Reporting
	4.33	Traffic Event Management in Regional Main Center
	4.34	Traffic Event Management in Road Management Office
	4.35	Traffic Event Management by Patrol Crew
	4.36	Traffic Information by VMS
	4.37	Traffic Information by Internet
	4.38	Traffic Information by Broadcast
	4.39	Traffic Information Cancellation
	4.40	Traffic Data Management
	4.41	Integrated Data Management
	4.42	Routine Data Check in Regional Main Centre

Source: ITS Integration Project (SAPI) Study Team

Table 6.7 Task List of Event Trace Diagrams (2)

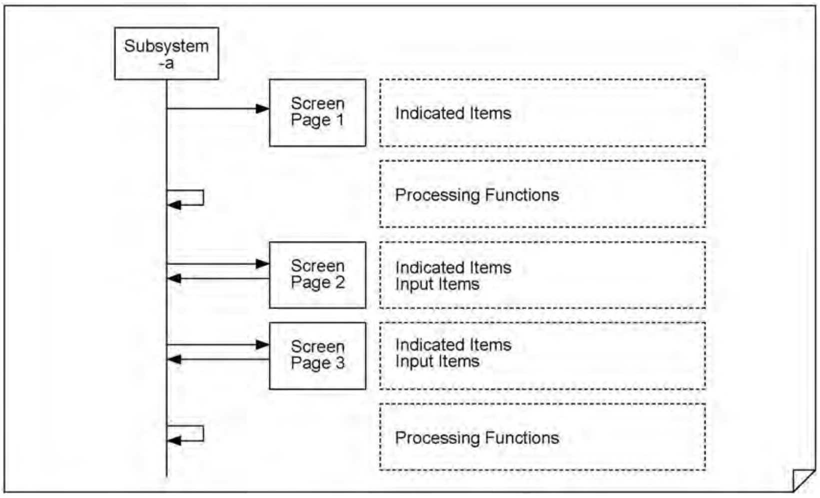
Name of System	No.	Task Procedures
Automated Toll Collection /Management System	4.43	Toll Collection by Manual
	4.44	Toll Collection by Touch & Go
	4.45	Toll Collection by ETC
	4.46	Handling of Balance Shortage Vehicle
	4.47	Toll Data Management
	4.48	Toll Settlement
	4.49	IC-card Issuance/Management
	4.50	Recharge of Prepaid Balance
	4.51	IC-card Data Management
	4.52	IC-card Negative List Management
	4.53	OBU Registration/Management
	4.54	OBU Negative List Management
	4.55	Toll Enforcement Assistance
Vehicle Weighing System	4.56	Axle Load Measurement
	4.57	Axle Load Data Management
	4.58	Overloading Regulation

Source: ITS Integration Project (SAPI) Study Team

6.4 Screen Transition Diagram

The screen transition diagram shows required function of processing and input/output in the form of time series as below. In this study, the screen transition diagrams shall be prepared and software components are to be discussed based on them.

Figure 6.4 Screen Transition Diagrams



Note: This diagram shows function of processing and input/output required for the software component in the form of time series. This need to be consistent with event tracing diagrams and message sequence diagrams.

Source: ITS Integration Project (SAPI) Study Team

7. Key System Policies

7.1 General

In this chapter, the following key policies of ITS are discussed from the perspective of appropriateness for applying to expressway operation.

- CCTV camera arrangement
- Event Detection by Image
- Vehicle detector arrangement
- Road-to-vehicle communication method for ETC
- Contact-less IC-Card type
- Axle load scale arrangement
- Network system for roadside equipment control
- Transmission method.

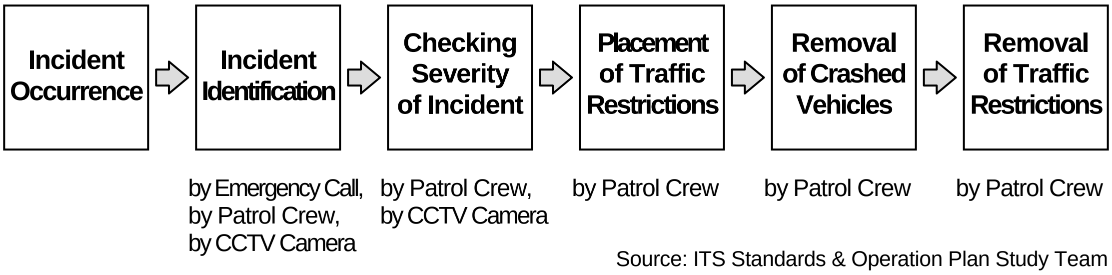
7.2 CCTV Camera Arrangement

1) Procedure to Address Incidents

CCTV camera can be used for various purposes on the expressway; however, the cameras need to be installed in different locations/conditions corresponding to the intended purpose. In this study, discussion focuses on the use of CCTV cameras for monitoring.

For example, the general procedure to address incidents is shown in the figure below.

Figure 7.1 General Procedure to Address Incidents



Source: ITS Standards & Operation Plan Study Team

As shown in the figure, CCTV cameras can be effective only for identifying incidents and checking severity of incidents. Placement/removal of traffic restrictions and removal of crashed vehicles need to be done by the patrol crews. Hence, even in the case CCTV cameras are installed on the expressway, sufficient number of crews and vehicles are necessary to address incidents.

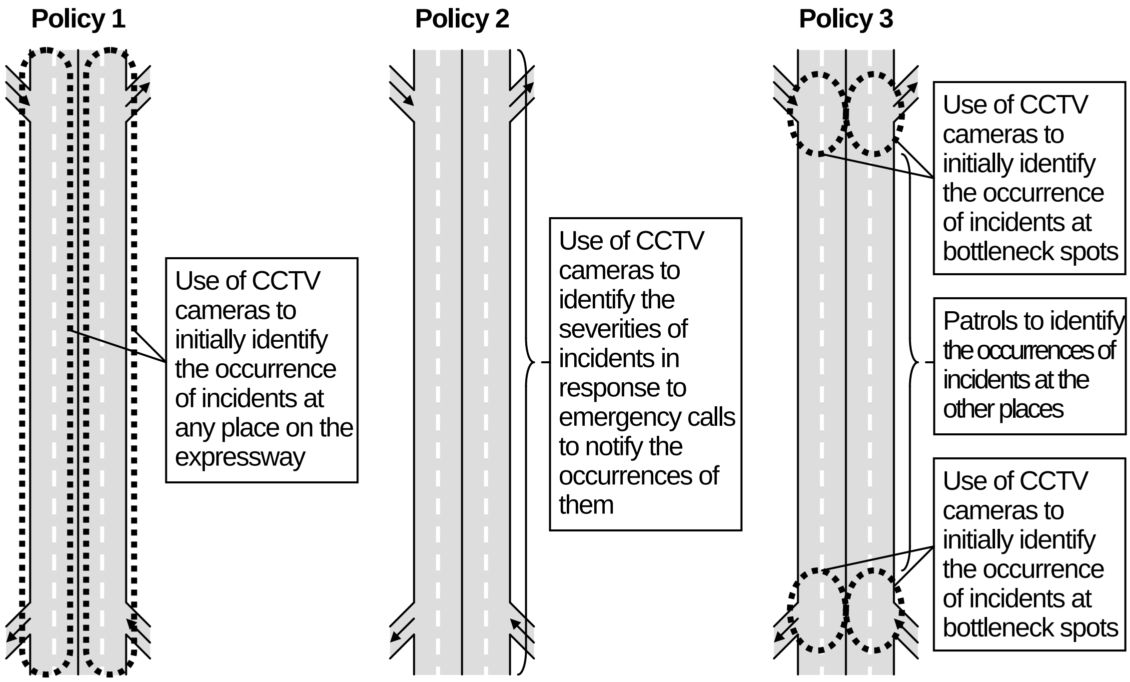
For this reason, effectiveness of CCTV camera is discussed in the following focusing on incident identification and checking of current situations.

2) Installation/Operation Policies of CCTV Camera

The following policies are considered for installation/operation of CCTV camera to provide incident information:

- **Policy 1:** Use of CCTV cameras to initially identify the occurrences of incidents at any place on the expressway without patrol or burdensome manual operation of panning/ zooming.
- **Policy 2:** Use of CCTV cameras, with manual operation of panning/zooming, to identify the severities of incidents at any place on the expressway in response to emergency calls to notify the occurrences of them.
- **Policy 3:** Use of CCTV cameras to initially identify the occurrences of incidents at bottleneck spots on the expressway where traffic can be stuck easily by the events without patrol or burdensome manual operation of panning/zooming in combination with patrols to identify the occurrences of incidents at the other places on the expressway.

Figure 7.2 Installation/Operation Policies of CCTV Camera



Source: ITS Standards & Operation Plan Study Team

3) Required Arrangement of CCTV Camera

Required arrangement of CCTV camera for each installation/operation policy is based on the following calculation elements.

Horizontal resolution: A man with normal eyesight can recognize a slit of 1.5 mm width of a Landolt Ring from a distance of 5 m. Hence, the required value of horizontal resolution is calculated by the following formula:

$$HR = \frac{0.75B}{1.5} \quad \frac{5}{d}$$

Where B: the width of monitoring screen (which is assumed as 406.4 mm for 20-inch display widely diffused or as 1016.0 mm for 50-inch display), 0.75: the aspect ratio of the monitoring screen (which needs to correspond with the aspect ratio of image sensor), d: the distance from the operator to the screen (which is assumed as 3 m).

Maximum range of surveillance: For a vehicle 1.5 m wide to be recognized by the operator, the vehicle needs to be displayed clearly on the screen using more than 4 lines (as large as 4.8 mm). Hence, the minimum size of a vehicle image on a 20-inch display in the Operator's Center is calculated by the following formula:

$$V' = 4 \ \frac{B}{HR}$$

The CCTV camera will provide the fine image of moving vehicles by using a wide-angle lens with a sufficient depth of field. For meeting this requirement, the maximum range of surveillance is calculated by the following formula:

$$L = f \ \frac{V}{V'} \ \frac{B}{0.95b}$$

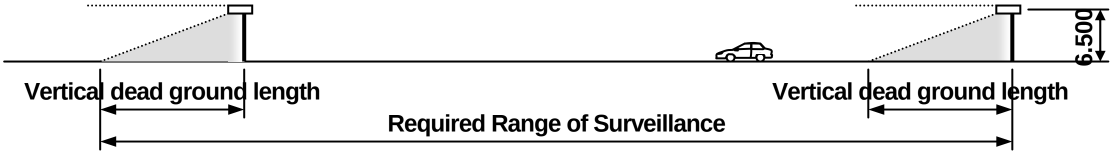
Where b: the size of image sensor (which is assumed as 6.5 mm for 1/2-inch image sensor), 0.95: over-scanning ratio, V: the width of an actual vehicle (which can be assumed as 1500 mm), V': the width of the displayed image of vehicle, and f: the focal length of lens of the CCTV camera (which is assumed as 3.8 mm to 8.0 mm).

Vertical dead ground length: On the same condition, the length of vertical dead ground is calculated by the following formula:

$$L = f \ \frac{H}{0.95h}$$

Where H: the height of camera installation (which is assumed as 6.5 m), and h: the vertical length of image sensor (which is assumed as 4.85 mm for 1/2-inch image sensor).

Table 7.1 Calculation Results of Maximum Range of Surveillance



Size of Monitoring Screen	Required Horizontal Resolution	Focal Length of Lens	Maximum Range of Surveillance	Vertical dead ground length
20 inches	339 lines	3.8 mm	78.2 m	5.3 m
		8.0 mm	164.5 m	11.2 m
		76.0 mm **	1563.1 m	--
		160.0 mm ***	3290.7 m	--
50 inches	847 lines	3.8 mm	195.4 m	5.3 m
		8.0 mm	411.3 m	11.2 m
		76.0 mm **	3907.7 m	--
		160.0 mm ***	8226.7 m	--
100 inches	847 lines	3.8 mm	390.8 m	5.3 m
		8.0 mm	833.7 m	11.2 m
		76.0 mm **	7815.4 m	--
		160.0 mm ***	16453.4 m	--

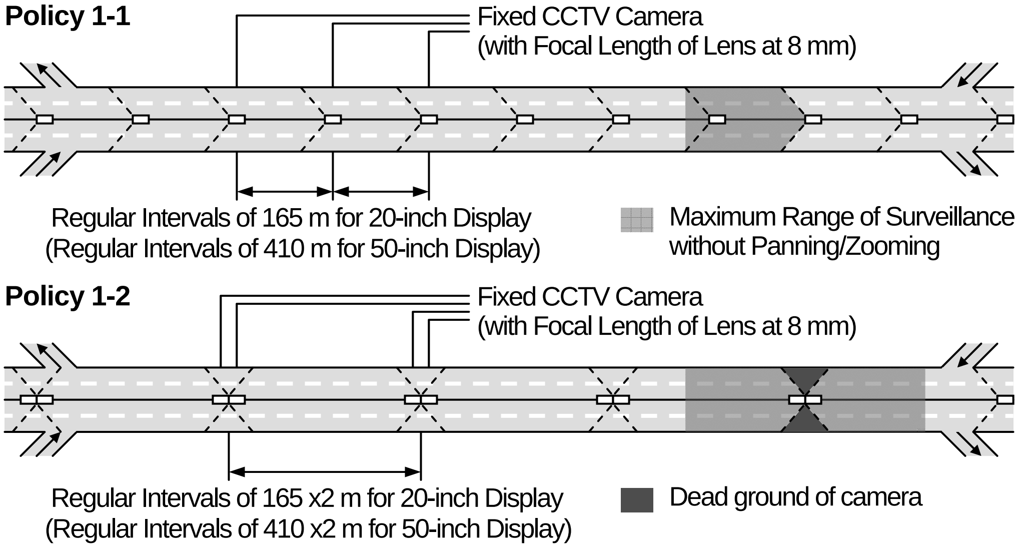
Note: ** : Focal length under 20 times zooming of 3.8 mm, *** : Focal length under 20 times zooming of 8.0 mm.

Source: ITS Standards & Operation Plan Study Team

(1) CCTV Camera Arrangement for Policy 1

In the case of Policy 1, CCTV cameras need to be installed continuously along the expressway for initially identifying the occurrences of incidents without manual panning/zooming of camera. Hence, if the expressway is monitored using 20-inch display and its alignment is assumed as completely straight, CCTV cameras with focal lengths of lenses at 8 mm need to be installed at regular intervals of 165 m. Even if 50-inch display is used, CCTV cameras need to be installed at regular intervals less than 410 m.

Figure 7.3 Installation at a Small Intervals Continuously along the Expressway



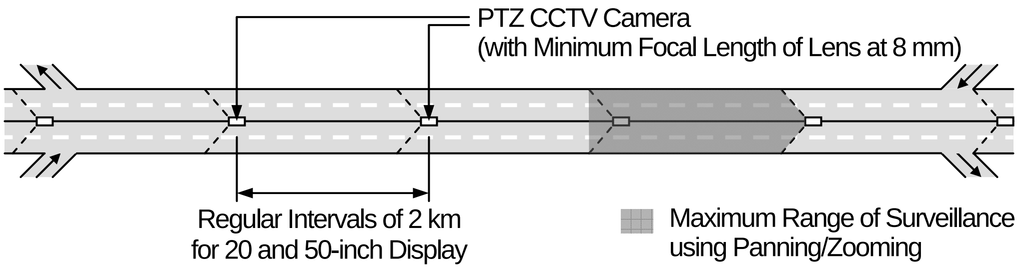
Source: ITS Integration Project (SAPI) Study Team

Difference between Policy1-1 and Policy 1-2 is only the direction of camera installation. In the case of Policy 1-2, a pair of cameras can be fixed on a single post for reducing installation cost; however, there exist dead ground behind of the cameras.

(2) CCTV Camera Arrangement for Policy 2

In the case of Policy 2, CCTV cameras need to be installed continuously along the expressway and utilized only for identifying the severities of incidents through manual panning/zooming of camera. As shown in the foregoing table, if alignment of the expressway is assumed as completely straight, 2 km intervals between two cameras can be monitored using 20-inch display by combination of panning/zooming of camera. If 50-inch display is used, 2 km intervals can be covered only by zooming.

Figure 7.4 Installation Continuously along the Expressway



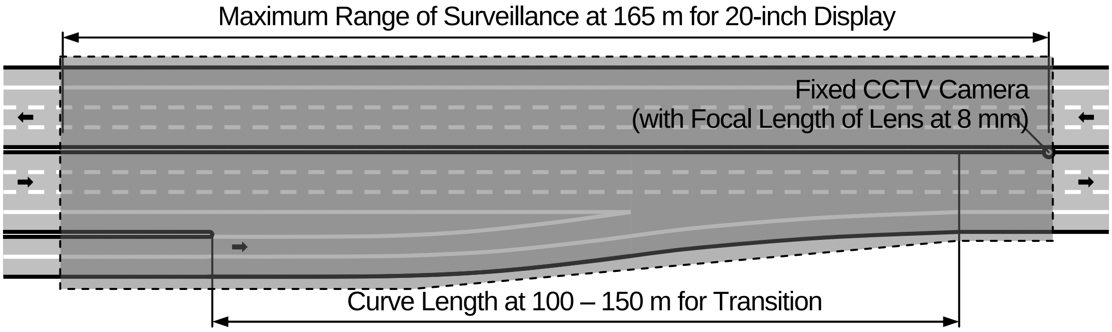
Source: ITS Standards & Operation Plan Study Team

(3) CCTV Camera Arrangement for Policy 3

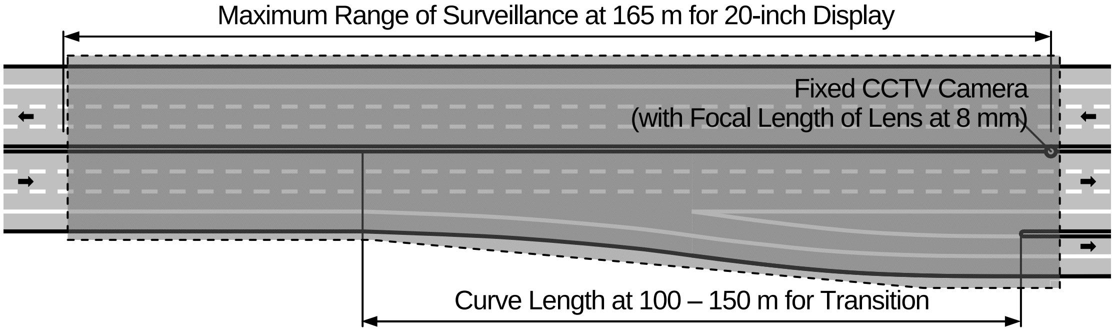
In the case of Policy 3, CCTV cameras need to be installed at bottleneck spots on the expressway and utilized for initially identifying the occurrences of incidents without manual panning/zooming of camera. As shown in the foregoing table, the maximum length of surveillance by the CCTV camera with focal lengths of lenses at 8 mm is around 165 m; hence, CCTV cameras are to be installed respectively for a merging point and a diverging point covering the transition curve lengths as shown in the following figure.

Figure 7.5 Installation at Bottleneck Spots on the Expressway

For Surveillance around Merging Point



For Surveillance around Diverging Point



Source: ITS Standards & Operation Plan Study Team

4) Comparison of Installation/Operation Policies

Advantages/disadvantages of the three installation/operation policies of CCTV camera are summarized in the table in the following page.

As shown in the table, Policy 1 requires very high cost of system implementation and is not suitable. Policy 3 allows reduction of implementation cost; however, the disadvantage of this policy is that no functions are prepared for occurrences of incidents at the places other than bottleneck spots.

Policy 2 has difficulty of identification in heavy rain or in darkness of the night, but is effective at identifying severities of incidents at any place on the expressway and at optimizing dispatch of patrol crew to be insufficient for estimated incident frequency rate. Hence, according to this comparison, Policy 2 is recommended for providing incident information.

Table 7.2 Comparison of Installation/Operation Policies of CCTV Camera

		Policy 1				Policy 2	Policy 3
		1-1	1-1w	1-2	1-2w		
Initial identification of the occurrences of incidents by CCTV cameras without patrol	At any place on the expressway	Capable	Capable	Capable	Capable	Impractical	Incapable
	At bottleneck spots on the expressway	Capable	Capable	Capable	Capable	Impractical	Capable
Identification of the severity of incidents by CCTV cameras in response to notification of the occurrences of incidents by emergency calls	At any place on the expressway	Capable	Capable	Capable	Capable	Capable	Incapable
	At bottleneck spots on the expressway	Capable	Capable	Capable	Capable	Capable	Capable
Applicability of image recognition for reducing human errors		Applicable	Applicable	Applicable	Applicable	Inapplicable	Applicable
Dead ground of cameras		None	None	Exist	Exist	None	None
Required number of monitoring displays in each road management office *		40 ***				8 ****	5 ****
Required cost of system implementation for 1000 km length of the expressway network (Unit: Million USD)	Roadside equipment including camera	17.81 ***				4.10 ****	1.96 ****
	Center equipment including displays **	1.82 ***				0.32 ****	0.18 ****
	Total	19.63				4.42	2.14
Actual Discussion in On-going Expressway Project in Vietnam		None	None	None	Phap Van – Cau Gie – Nonh Binh	HCMC – Trung Luong	HCMC – Long Thanh – Dau Giay
Grading		Not suitable	Not suitable	Not suitable	Not suitable	Recommended	Average

Note: * : It is assumed that five cameras can be monitored by a display by switching 5 times, ** : A Regional Main Center and 12.5 road management offices are to be constructed per 1000km, *** : Minimum cost by using 50-inch displays, **** : Minimum cost by using 20-inch displays.

Source: ITS Standards & Operation Plan Study Team

7.3 Event Detection by Image

1) Purpose and Outline of Event Detection

Event detection is realized by using the technology of image recognition. For the first step of this technology, moving objects, such as vehicles, are recognized by analysing the difference between a pair of serial frames in a video movie captured by CCTV camera. After that, changes in moving speed of the objects are recognized.

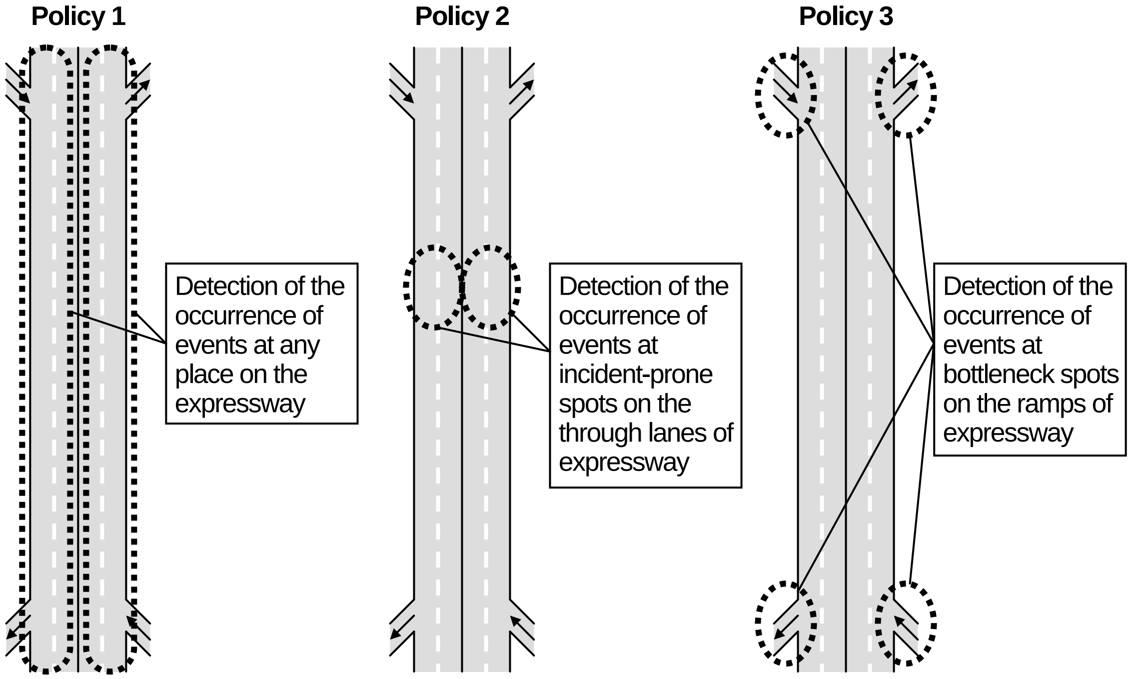
Event detection system recognize the Incidents, broken-down vehicles and traffic congestions usually only by the change in moving speed and give an alarm to the operators. Accordingly, even if a vehicle stops on the expressway only for taking a rest, the system will raise an alarm. In such a condition, it is very difficult for the operators to recognize which is the true alarm. This is the point of concern for introducing event detection to the expressways in Vietnam.

2) Installation Policies of Event Detection

The following installation policies are to be considered for event detection:

- **Policy 1:** Automatic detection and alarm at the occurrences of incidents at any place on the expressway
- **Policy 2:** Automatic detection and alarm at the occurrences of incidents at incident-prone spots on the through lanes of expressway
- **Policy 3:** Automatic detection and alarm at the occurrences of incidents at bottleneck spots on the ramps of expressway.

Figure 7.6 Installation Policies of Event Detection



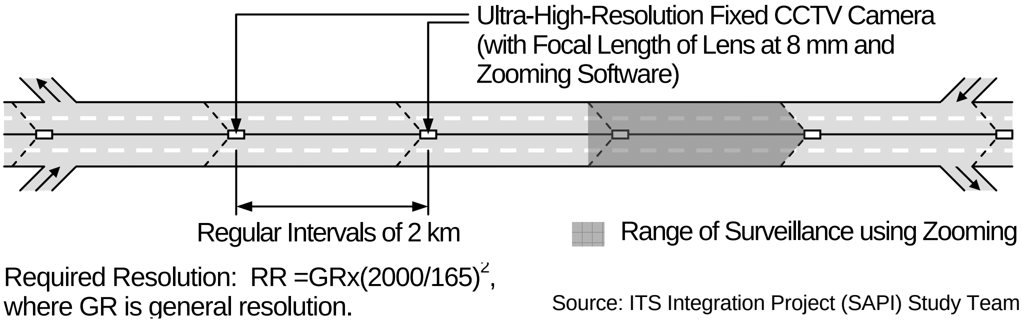
Source: ITS Integration Project (SAPI) Study Team

3) Required Arrangement of CCTV Camera

(1) CCTV Camera Arrangement for Policy 1

In the case of Policy 1, Fixed CCTV Cameras equipped with ultra-high-resolution image sensor and zooming software both for monitoring and image recognition need to be installed continuously along the expressway.

Figure 7.7 Ultra-High-Resolution Fixed CCTV Camera Installation for Event Detection

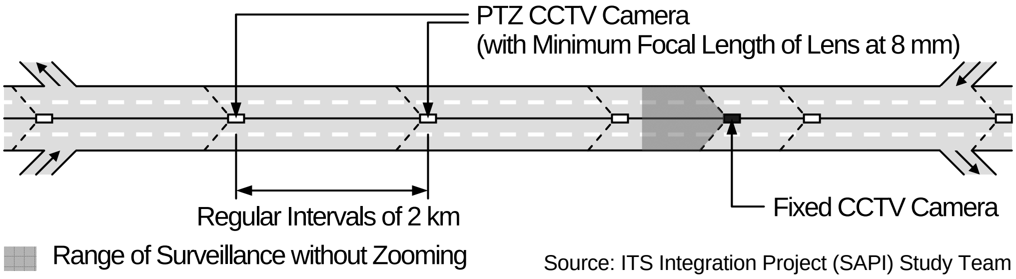


Source: ITS Integration Project (SAPI) Study Team

(2) CCTV Camera Arrangement for Policy 2

In the case of Policy 2, fixed CCTV cameras for event detection need to be installed on the through lane additionally to the PTZ CCTV Cameras for monitoring.

Figure 7.8 Additional Fixed CCTV Camera Installation for Event Detection

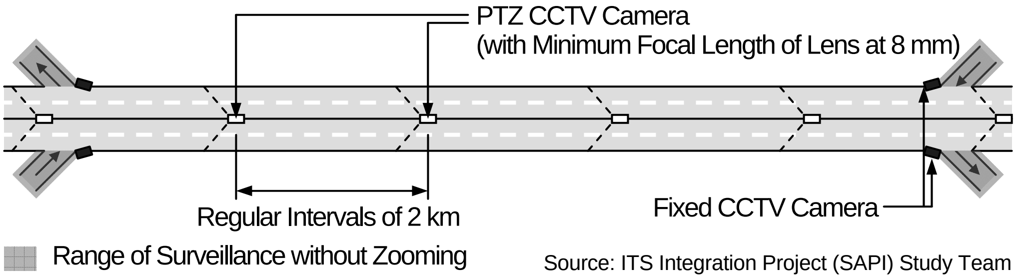


Source: ITS Integration Project (SAPI) Study Team

(3) CCTV Camera Arrangement for Policy 3

In the case of Policy 3, fixed CCTV cameras for event detection need to be installed on the ramps additionally to the PTZ CCTV cameras for monitoring.

Figure 7.9 Additional Fixed CCTV Camera Installation for Event Detection on Ramp



Source: ITS Integration Project (SAPI) Study Team

Policy 3 is recommended for event detection, because Policy 1 requires too much cost per 1000 km as shown in the comparison table below and congestion-prone spots for Policy 2 cannot be reasoned out from the data by actual observation.

Table 7.3 Comparison of CCTV Camera Arrangement Policies for Event Detection

		Policy 1	Policy 2	Policy 3
Reliability in bad weather conditions (e.g. heavy rain, heating of pavement, darkness in the night)		Low (in large distance)	High	High
Reliability in the condition many drivers take a rest on the through lanes of expressway		Low	Low	High
Urgency from the viewpoint of eliminating obstacles for vehicle passage		Not urgent	Urgent	Urgent
Required cost of system implementation for 1000 km length of the expressway network (Unit: Million USD)	Roadside Equipment including Camera	18.0	3.9	
	Software for Image Recognition including Zooming	270.0	2.1	
	Total	288.0	6.0	
Cost for Maintenance		Low	Average	Low
Grading		Not Suitable	Not Suitable	Recommended

Source: ITS Standards & Operation Plan Study Team

4) Upgrading to Next-generation System based on CCTV Camera for Multi-purpose

As mentioned foregoing in previous chapter and this chapter, CCTV camera is to be used for the following three purpose:

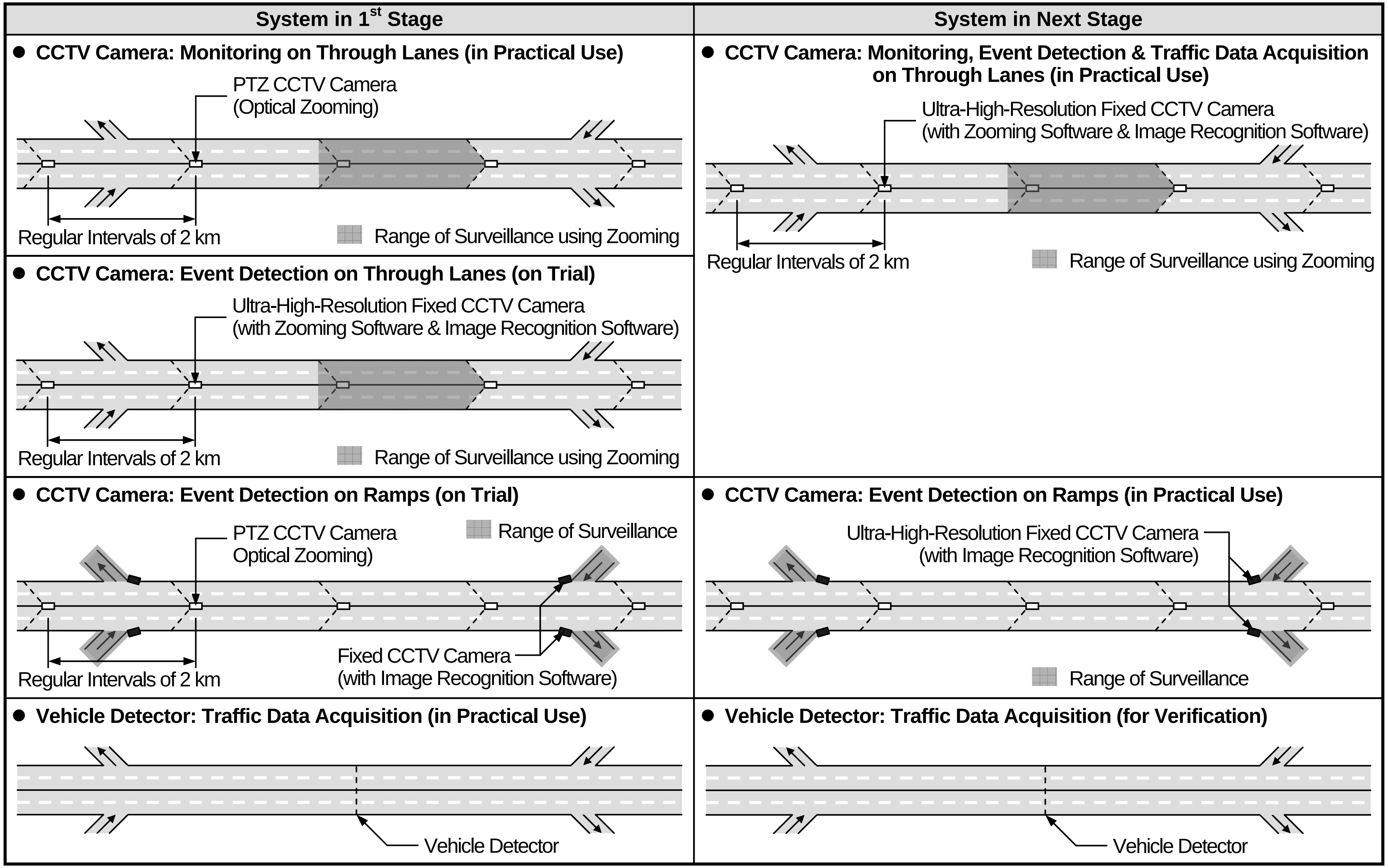
- Monitoring on the through lanes
- Event detection on through lanes
- Event detection on ramps

However, at the present moment, the resolution of IP-based CCTV camera is not sufficient for taking a view of 2 km range, which is the interval of installation of the camera. In addition there exists a disturbance against the technology of image recognition caused by many vehicles stop on the expressway only for taking a rest. Accordingly, the following types of camera need to be installed for each purpose in the 1st stage:

- Monitoring on the through lanes →PTZ CCTV camera
- Event detection on through lanes →Ultra-high-resolution fixed CCTV camera (on trial)
- Event detection on ramps →Fixed CCTV camera (on trial)

Toward the next stage, an upgrading to next-generation system can be proposed. These three purpose and traffic data acquisition will be accomplished by a single kind of ultra-high-resolution CCTV camera as shown in the table in the following page.

Figure 7.10 Upgrading to Next-generation System based on CCTV Camera for Multi-purpose



Source: ITS Integration Project (SAPI) Study Team

7.4 Vehicle Detector Arrangement

1) Objectives of Installing Vehicle Detector

Vehicle detector can be used for several different purposes on the expressway; however, the detectors need to be installed in different location and condition corresponding to the intended purpose.

In this study, discussion focuses on the usage of vehicle detectors for the following objectives:

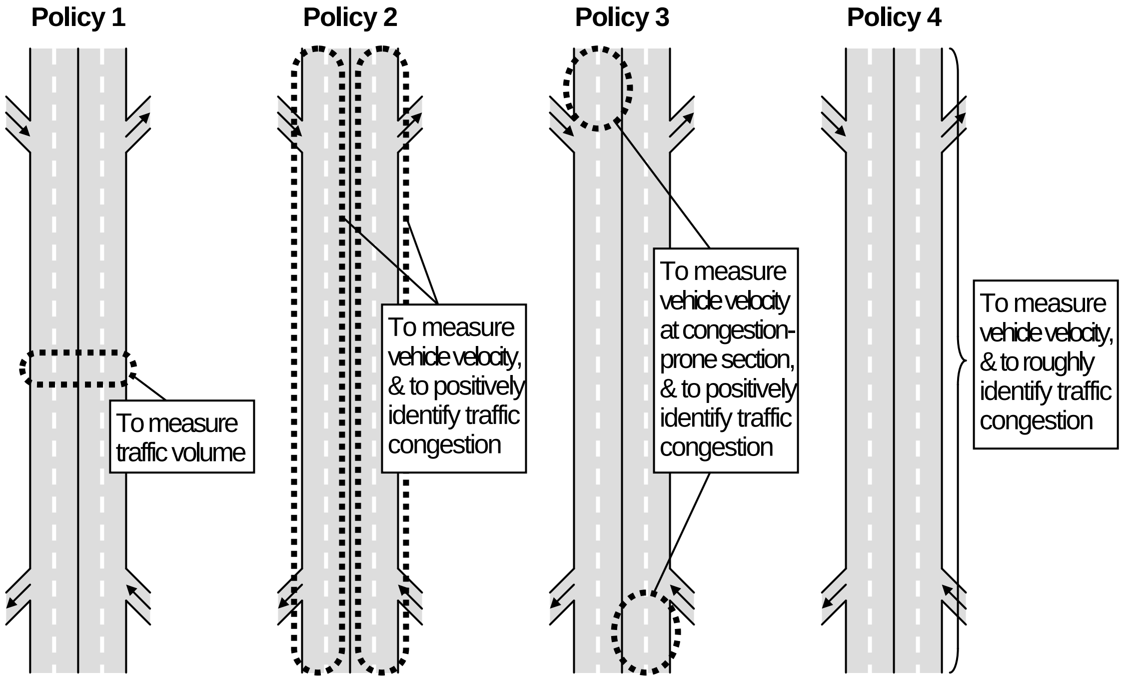
- Measurement of traffic volume
- Measurement of vehicle velocity
- Identification of traffic congestion
- Measurement of values of large vehicles.

2) Installation/Operation Policies of Vehicle Detector

The following operation/arrangement policies of vehicle detector for expressway operation are considered:

- **Policy 1:** To measure traffic volume on a section between a pair of interchanges on the expressway
- **Policy 2:** To measure vehicle velocity at any section on the expressway and to positively identify traffic congestion
- **Policy 3:** To measure vehicle velocity at congestion-prone sections on the expressway and to positively identify traffic congestion
- **Policy 4:** To measure vehicle velocity throughout the expressway and to roughly identify traffic congestion

Figure 7.11 Vehicle Detector Installation/Operation Policies



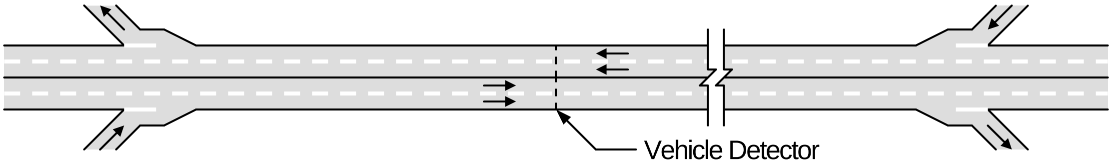
Source: ITS Standards & Operation Plan Study Team

2) Arrangement of Vehicle Detectors

(1) Vehicle Detector Arrangement for Policy 1

In the case of Policy 1, vehicle detectors need to be installed at a midway point between a pair of interchanges on the expressway in order to measure traffic volume on a section between them.

Figure 7.12 Installation at Midway between a Pair of Interchanges

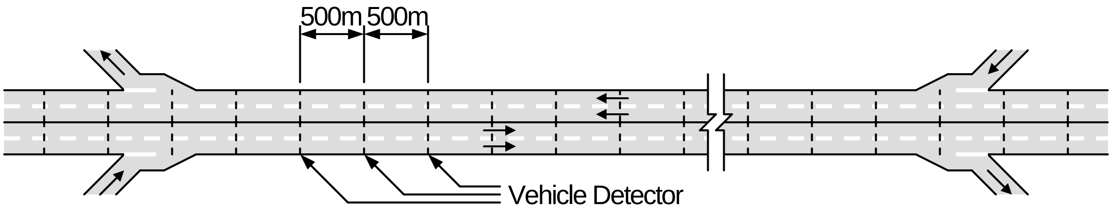


Source: ITS Standards & Operation Plan Study Team

(2) Vehicle Detector Arrangement for Policy 2

In the case of Policy 2, vehicle detectors need to be installed at small intervals (e.g. 500 m) continuously along the expressway in order to measure vehicle velocity at any section on the expressway and to positively identify traffic congestion.

Figure 7.13 Installation at a Small Intervals Continuously along the Expressway

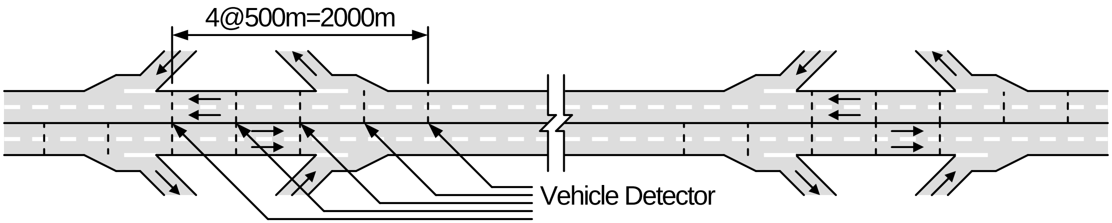


Source: ITS Standards & Operation Plan Study Team

(3) Vehicle Detector Arrangement for Policy 3

In the case of Policy 3, vehicle detectors need to be installed at small intervals (e.g. 500 m) in congestion-prone sections on the expressway in order to measure vehicle velocity at the sections and to positively identify traffic congestion.

Figure 7.14 Installation at Congestion-prone Sections on the Expressway

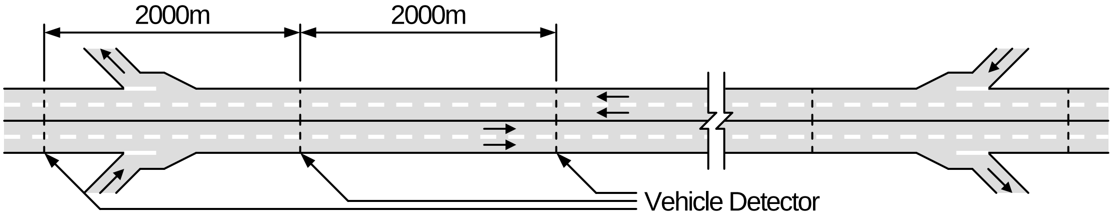


Source: ITS Standards & Operation Plan Study Team

(4) Vehicle Detector Arrangement for Policy 4

In the case of Policy 4, vehicle detectors need to be installed continuously along the expressway in order to measure vehicle velocity throughout the expressway and to roughly identify traffic congestion.

Figure 7.15 Installation Continuously along the Expressway



Source: ITS Standards & Operation Plan Study Team

3) Comparison of Installation/Operation Policies

Advantages/disadvantages of the four installation/operation policies of vehicle detector are summarized in the table below.

Table 7.4 Comparison of Installation/Operation Policies of Vehicle Detector

		Policy 1	Policy 2	Policy 3	Policy 4
Measurement of traffic volume on a section		Capable	Capable	Capable	Capable
Identification of traffic congestion	At any section on the expressway	Incapable	Capable (QL=0.5–1km)	Incapable	Capable (QL>2km)
	At congestion-prone sections on the expressway	Incapable	Capable (QL=0.5–1km)	Capable (QL=0.5–1km)	Capable (QL>2km)
Required cost of system implementation for 1000km length of the expressway network (Unit: Million USD)	Roadside equipment	0.8 **	120 **	3.8 **	30 **
	Center equipment	0.2	0.2	0.2	0.2
	Total	1.0	120.2	4.0	30.2
Actual Discussion in On-going Expressway Project in Vietnam		Many	None	Cau Gie – Ninh Binh	HCMC – Long Thanh – Dau Giay, HCMC – Trung Luong
Grading		Recommended	Not suitable	Useful for Congest-prone Section	Not suitable

Note: QL: Minimum detectable queue length, **: In the case of using image recognition type

Source: ITS Standards & Operation Plan Study Team

Policy 2 requires very high cost of system implementation and is not suitable. Policy 4 is also costly and can be applicable only to the road sections with large traffic over the length of them. As shown in the table above, Policy 3 is useful for congestion-prone sections on the expressway; however, this also requires rather high cost.

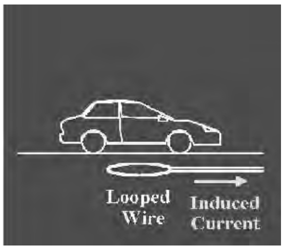
From the viewpoint that the next-generation system will be established using the technology of ultra-high-resolution CCTV camera for multi-purpose, Policy 1, which achieves measurement of traffic volume at low cost and can be applicable to any road sections, is recommended as the result of the Study.

4) Comparison of Vehicle Detectors

The following three types of vehicle detectors are compared:

- **Loop-coil Type:** Loop-coil type detects vehicles passing by using electromagnetic induction. Number of vehicles can be counted with relatively high accuracy. However, it is difficult to install in bridges with a slab densely reinforced because of difficulty to secure a sufficient distance from steel structures to the loop-coil.
- **Ultrasonic Type:** Ultrasonic type detects vehicles passing by using arrival time difference of ultrasonic waves reflected from objects on the road and from the road. Number of vehicles can be counted with relatively high accuracy. However, in this method, it is difficult to distinguish the vehicles from the other objects on the road.
- **Image Recognition Type:** Image recognition type detects moving objects in images captured from video cameras according to preset size/speed of the object. The image recognition can be conducted using higher quality images than for visual inspection. Number of detected vehicles also can be counted in the system.

Table 7.5 Comparison on Types of Vehicle Detectors

	a) Loop-coil type	b) Ultrasonic type	c) Image Recognition type
Outline			
Detection of Vehicle Class	Capable	Incapable	Capable
Installation	Buried at a sufficient distance from steels	Fixed on the structure securing road clearance	Fixed on a stable structure securing sight path
Unsuitable Location	Bridges with a slab densely reinforced	None	None
Implementation Cost	Low	Average	High
Applicability to Traffic Changing Lanes	Incapable	Incapable	Capable
Secondary Use for Visual Check	Incapable	Incapable	Capable
Endurance	Average	High	Average
Maintenance	Necessary to work on the pavement for mechanical trouble caused by heat	Very rare and not necessary to work on the pavement	Not necessary to work on the pavement
Grading	Useful for Verification	Not Suitable	Recommended

Source: ITS Standards & Operation Plan Study Team

7.5 Road-to-vehicle Communication Method for ETC

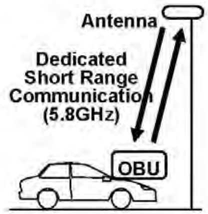
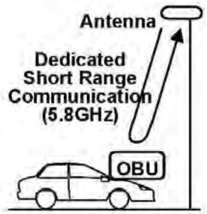
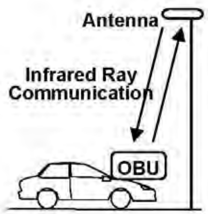
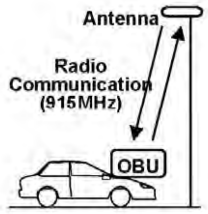
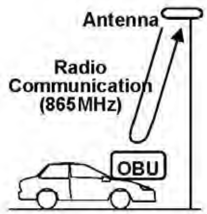
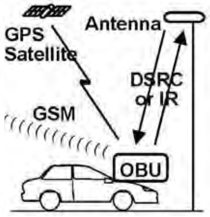
The advantage/disadvantages of the following six alternative road-to-vehicle communication methods for ETC are compared in the table on the next page.

- Active-DSRC
- Passive-DSRC
- DSRC/IR
- IR
- RF-Tag (Active)
- RF-Tag (Passive)
- GPS/GSM/IR,

Note:
DSRC: Dedicated Short Range Communication,
IR: Infrared ray, GPS: Global Positioning System,
GSM: Global System for Mobile Communications

According to the comparison, it is concluded that Active-DSRC, which has the largest number of advantages, is recommended, and Passive-DSRC is competitive mainly from the view point of equipment cost. RF-Tag (Passive) is to be followed up. The most appropriate road-to-vehicle communication for ETC will be selected from among these three methods through trial use.

Table 7.6 Comparison of Alternative Road-to-Vehicle Communication Methods for ETC

	Active-DSRC	Passive-DSRC	DSRC/IR	IR	RF-Tag (Active)	RF-Tag (Passive)	GPS/GSM
Outline							
Actual Use in Toll Collection	Many experiences	Many experiences	Many experiences	Many experiences	Many experiences	A few experiences	No experience
Shared Use of System among Different Operators	Many experiences	Many experiences	A few experiences	No experience	No experience	Few experience	No experience
Shared Suppliers in Actual Road Operation	12 (in Japan)	3 (in France)	7 (in Korea)	No experience	No experience	No experiences	No experience
Application to Distance Proportional Tariff	Many experiences	A few experiences	Many experiences	Many experiences	A few experiences	Not applicable under international std.	No experience
Applicability to ERP	Applicable	Applicable	Not applicable	Not applicable	Applicable	Applicable	Applicable
Recommendation in On-going Project in Vietnam	HCMC–Long Thanh –Dau Giay	HCMC–Trung Luong, Can Tho Bridge	None	None	Not Applicable (Conflict with GSM)	Cau Gie–Ninh Binh	None
Accuracy of Data Communication	High (99.9999%)	No regulation	Lowering by Sunlight	Lowering by Sunlight	Relatively low Fear of double charge	Relatively low Fear of double charge	No regulation
Vehicle Deceleration	Not necessary	Not necessary	Not necessary	Necessary	Not necessary	Not necessary	Not necessary
2-pice Type OBU (IC-card Business)	Many experiences	For trial	Many experiences	Many experiences	Not capable	Not capable	No experience
Required Cost of OBU	Average	Low (1-piece type)	Average	Average	Low (1-piece type)	Very low (1-piece type)	High (1-piece type)
Combined Use with Touch&Go	Capable	For trial	Capable	Capable	Capable	Capable	Not capable
Required Cost of Roadside Equipment	Low	Average	High	Average	Average	Average	Very low
International Standard	Established	Established	Established	Patented	Established	Established	None
Grading (The Number of Advantages)	Recommended (12)	Competitive (8)	Not suitable (7)	Not suitable (4)	Not suitable (6)	To be followed up (6)	Not suitable (3)

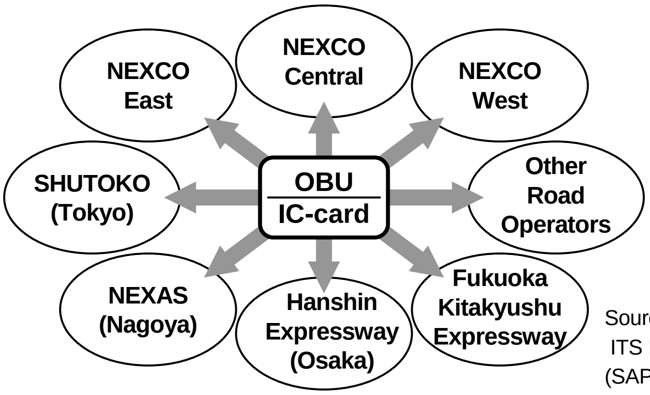
Note: ERP: ERP by multi-lane free-flow, OBU: OBU includes Tag, Underlined words: Fatal disadvantage

Source: ITS Standards & Operation Plan Study Team

1) Shared Use of System among Different Road Operators

Shared use of a single system among different road operator is necessary for convenience for road users. For example, an OBU for Active-DSRC and an IC-card is shared among all road operators in Japan as shown below. However, IR, Active RF-Tag and GPS/GSM has no experience and Passive RF-Tag has few experiences in shared use among road operators.

Figure 7.16 Shared Use of System among Different Road Operators in Japan



Source:
ITS Integration Project
(SAPI) Study Team

2) Shared Suppliers in Actual Road Operation

Present situation of shared suppliers of each road-to-vehicle communication method for ETC is mentioned below.

- **Active-DSRC in Japan:** In the case of Active-DSRC in Japan, even though OBUs are manufactured by six suppliers and the roadside antennas are manufactured by eight suppliers, OBUs manufactured by different suppliers are shared on the whole road network. In addition, the road network includes the sections operated by more than five different road operators.
- **Passive-DSRC in France:** In the case of Passive-DSRC in France, OBUs and the roadside antennas are manufactured totally by five suppliers, and OBUs manufactured by three different suppliers are shared on the specific road sections. However, OBUs manufactured by the other two suppliers are not shared and need to be used separately.
- **DSRC/IR in Korea:** In the case of DSRC/IR in Korea, two roadside antennas for DSRC and IR are installed together on the same toll island, and the antenna for use is selected by the OBU installed in the vehicle. OBUs of DSRC are manufactured by three suppliers, and OBUs manufactured by different suppliers are shared on the same road.
- **IR in Malaysia:** In the case of IR in Malaysia, OBUs and the roadside antennas are manufactured by only one supplier who holds the patent for IR system. There is no sharing and no competition of OBU among the suppliers.
- **Active RF-Tag in USA:** In the case of RF-Tag (Active, 915 MHz) in USA, primary track records of ETC installation are monopolistic as shown in the following table. The system in each state is manufactured exclusively by a single supplier that has some advantage in the target state. There is no sharing and no competition of OBU among the different suppliers. The track records of Active RF-Tag in USA is shown in the table below.

Table 7.7 Track Records of Active RF-Tag for Toll Collection in USA

Installed System	Installed Location	Supplier
EZ-Pass	Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Virginia	Kapsch
Fast Lane	Massachusetts	Kapsch
I-Pass	Illinois	TransCore
Smart Tag	Virginia	TransCore
Sun Pass	Florida	TransCore
K-Tag	Kansas	TransCore
Pike Pass	Oklahoma	TransCore
EZ TAG	Texas	TransCore
PAL PASS	South Carolina	SIRIT
FASTRAK	California	SIRIT

Source: ITS Integration Project (SAPI) Study Team

- **Passive RF-Tag in Europe and USA:** The technology of RF-Tag (Passive, 865 MHz) is developed and internationally standardized in Europe for the most part and is applied in USA. However, in every installation case of Passive RF-Tag, the system is manufactured exclusively by a single supplier, accordingly this technology has no experience of shared suppliers in actual road operation.
- **GPS/GSM/IR in Germany:** In the case of GPS/GSM/IR in Germany, vehicle passage at the tollgate is tracked by using GPS and the roadside antenna of IR. OBUs and the roadside antennas are manufactured by two suppliers; however, there is no sharing of OBU among the different suppliers.

3) Application to Distance Proportional Tariff System

Active-DSRC has been applied to the distance proportional tariff system on the expressway network more than 9800 km throughout the whole Japan. Passive-DSRC has only a few experiences in application to the distance proportional tariff system.

Passive RF-Tag is based on ISO 18000-6b and ISO 18000-6c. However, the Passive RF-Tag applied to distance proportional tariff system is modified several in features of ISO 18000-6c in order to realize the functions for distance proportional tariff. As a consequence of the modification, this type deviates from ISO 18000-6c. This type is installed only on three toll roads in USA, which are supplied exclusively by a manufacturer Transcore as shown in the table below.

Table 7.8 Application of Passive RF-Tag to Distance Proportional Tariff System in USA

Installed system	Sun Pass	K-Tag	Pike Pass
Installed Location	Florida	Kansas	Oklahoma
Road Operator	FL Turnpike, etc.	KTA	OTA
Toll Rate System	Sectional tariff + Distance proportional tariff	Distance proportional tariff	Distance proportional tariff
Toll Collection	Single lane free flow + Multi lane free flow	Single lane free flow	Single lane free flow
Radio Frequency	915 MHz	915 MHz	915 MHz
Battery for Tag	Equipped	None	None
International Std.	None (Deviated)	None (Deviated)	None (Deviated)
Supplier	Transcore	Transcore	Transcore

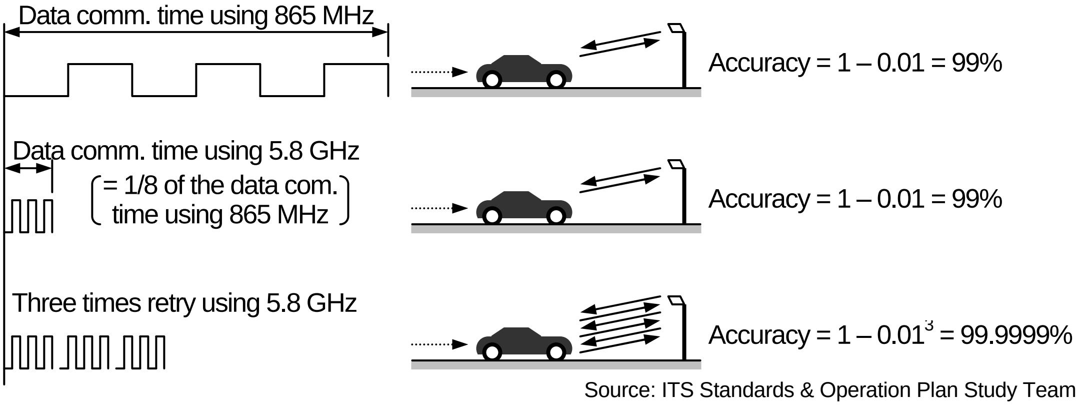
Source: ITS Integration Project (SAPI) Study Team

4) Accuracy of Data Communication

Accuracy Improvement by Retry of Data Communication

Accuracy of radio communication is around 99% in either cases of 5.8 GHz for DSRC or 865 MHz for RF-Tag. However, in the former case, a certain amount of data communication can be completed within one-eighth time of what required in the latter case. Based on this principle, the message exchange using 5.8 GHz radio frequency band can be retried three times within the duration for using 865 MHz, and this three times retry of message exchange achieves an accuracy of 99.9999%, which is defined as the general specification of Active-DSRC in Japan.

Figure 7.17 Accuracy Improvement by Retry of Data Communication



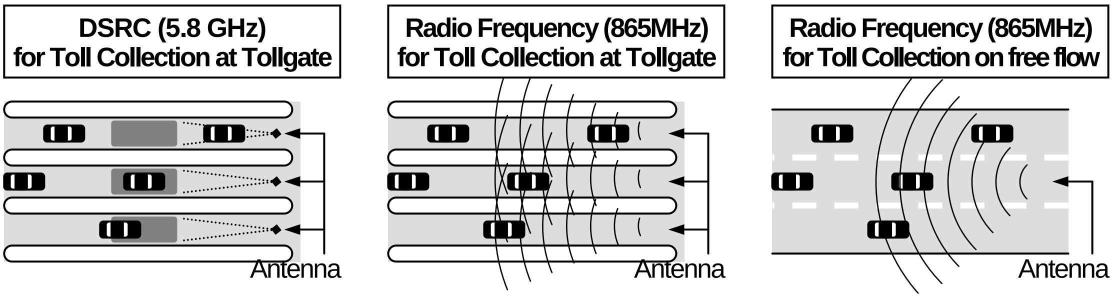
Source: ITS Standards & Operation Plan Study Team

A high accuracy of data communication is necessary for ETC, which deals with payment data; however, there is no specification on the accuracy of road-to-vehicle communication other than the case of Active-DSRC.

Additional Features Due to Diffraction of Radio Wave

Additional features on accuracy of communication due to diffraction of the radio waves of 5.8 GHz and 865 MHz, which may cause double toll charge, are shown the figure below.

Figure 7.18 Additional Features of DSRC (5.8GHz) and Radio Frequency (865 MHz)



- High accuracy of road-to-vehicle communication
- Ease in identifying unlawful passage by focused radio wave
- Reliable system at reasonable cost aiming at a high exposure rate for unlawful passage
- Necessity of a fixed deterrent effect by a small penalty system for unlawful passages.**

- Relatively low accuracy of road-to-vehicle communication
- Fear of double toll charge caused by diffraction of radio wave
- Difficulty in identifying unlawful passage by diffused radio wave
- Complicated system with difficulties in finding a solution to technical problems and enforcement.

- Relatively low accuracy of road-to-vehicle communication
- Difficulty in identifying unlawful passage by diffused radio wave
- Simple system at low cost aiming at a fixed exposure rate for unlawful passage
- Necessity of a large deterrent effect by a heavy penalty system for unlawful passages.**

Note: ** : See Section 6.13.

Source: ITS Standards & Operation Plan Study Team

5) Vehicle Deceleration

The capacity of each road-to-vehicle communication method for ETC is shown below. The methods with sufficient capacity for transmitting data volume allow the vehicles to pass through the tollgate without deceleration.

- Active-DSRC: 1.0 – 4.0 Mbps both for downlink and uplink
- Passive-DSRC: 1.0 Mbps for downlink and 0.25 Mbps for uplink
- IR: 0.5 Mbps for downlink and 0.125 Mbps uplink
- RF-Tag: 0.5 Mbps both for downlink and uplink.

Large communication capacity allows ERP (Electronic Road Pricing) on multi-lane free-flow as well.

6) 2-piece Type OBU (IC-card Business)

2-piece type OBU is adopted in many Asian countries, such as Active-DSRC in Japan, DSRC/IR in Korea and IR in Malaysia and Vietnam. 2-piece type OBU is suitable to ETC based on prepayment, because it allows prepaid-balance-in-card, which brings the following features as mentioned in Section 7.6.

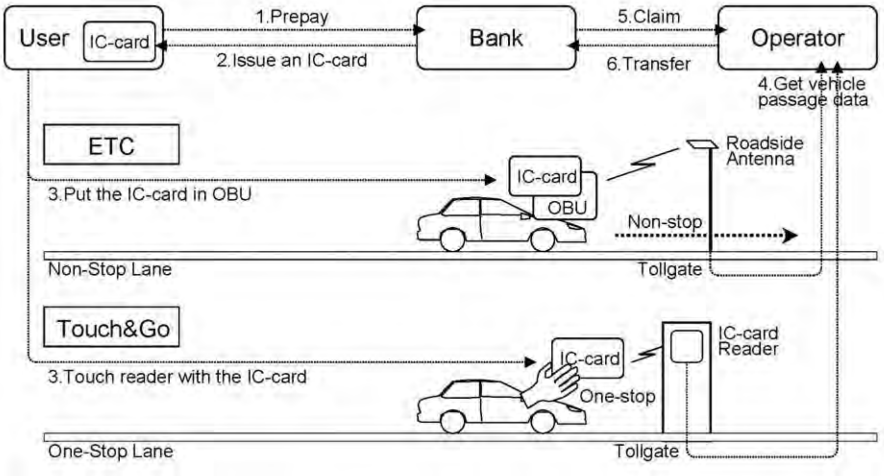
- Free from the difficulty in prepaid balance distribution to all tollgate lanes
- Free from the problem due to update interval of prepaid balance
- Free from the problems caused by low-quality telecommunication.

2-piece type OBU create a chance of IC-card business; however, Active RF-Tag and Passive RF-Tag does not utilize IC-cards and brings no chance for IC-card business.

7) Combined Use with Touch&Go

A single IC-card shall be shared for ETC as well as Touch&Go for the convenience of road users and road operators.

Figure 7.19 ETC Combined Use with Touch&Go

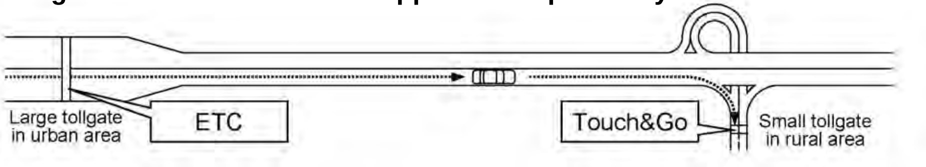


Source: VITRANSS2 Study Team

ETC combined use with Touch&Go provides the following advantages:

- Flexible operation by combined use of the toll collection methods: incoming by ETC and outgoing by Touch&Go, or incoming by Touch&Go and outgoing by ETC as well.

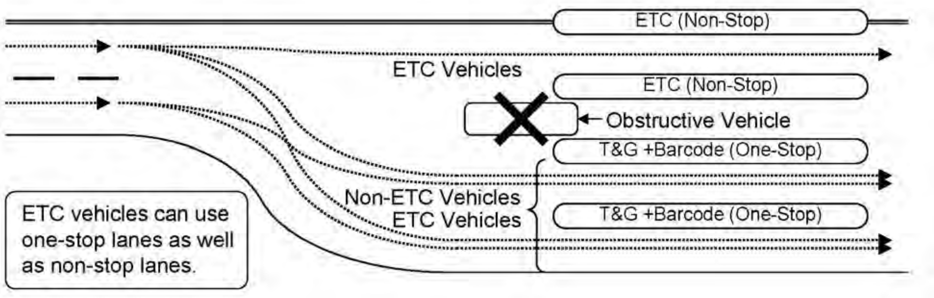
Figure 7.20 Combined Use Applied to Expressway Network



Source: VITRANSS2 Study Team

- Cost-cutting by excluding ETC installation at small tollgates in rural areas, and capability of stepwise ETC installation beginning with large tollgates in urban areas.
- Flexible tollgate lane operation that prevents mix-ups caused by inexperienced ETC vehicle drivers and/or accidents at ETC lanes.

Figure 7.21 Flexible Tollgate Lane Operation



Source: VITRANSS2 Study Team

ETC exclusive operation and ETC/manual mixed operation can be applied to an ETC lane operation at tollgate. The ETC exclusive operation is recommended by the comparison below.

Table 7.9 Comparison on Methods of ETC Lane Operation at Tollgate

	ETC Exclusive Operation	ETC/Manual Mixed Operation
Outline	Only the vehicles equipped with OBU can pass exclusively through ETC lanes at the tollgate. A human collector needs to deal with wrong tollgate lane selection by vehicles without OBU.	The vehicles without OBU can pass through ETC lanes at the tollgate as well as the vehicles equipped with OBU. A human collector needs to attend for toll collection of the vehicles without OBU.
Capacity	Vehicle processing design capacity: 800 vehicles/lane/hr.	Vehicle processing design capacity: 450–600 vehicles/lane/hr.
Advantages	- Attainment of large vehicle processing capacity in the ETC lane, - Large effects to relieve congestion at the tollgates, - Swift diffusion of OBU motivated by smooth passing through the ETC lane.	- Reduction of the possibility of congestion on the manual lanes caused by low diffusion rate of OBU in the early stage of ETC introduction.
Problems	- Possibility of congestion on the manual lanes caused by low diffusion rate of OBU in the early stage of ETC introduction.	- Lowering of vehicle processing capacity of the ETC lane due to longer processing time for the vehicles without OBU, - Small effect on relieving congestion at the tollgate, - Slow diffusion of OBU affected by delay in passing through the ETC lane.
Grading	Recommended	Not Suitable

Source: VITRANSS2 Study Team

8) Required Cost of Roadside Equipment

GPS/GSM is based on the vehicle location estimated by using GPS and requires only a small number of roadside antennas for enforcement and correction; hence, in the case of GPS/GSM, required cost of roadside equipment is very low. On the contrary, DSRC/IR needs combined roadside antenna for two types of road-to-vehicle communication and requires high cost.

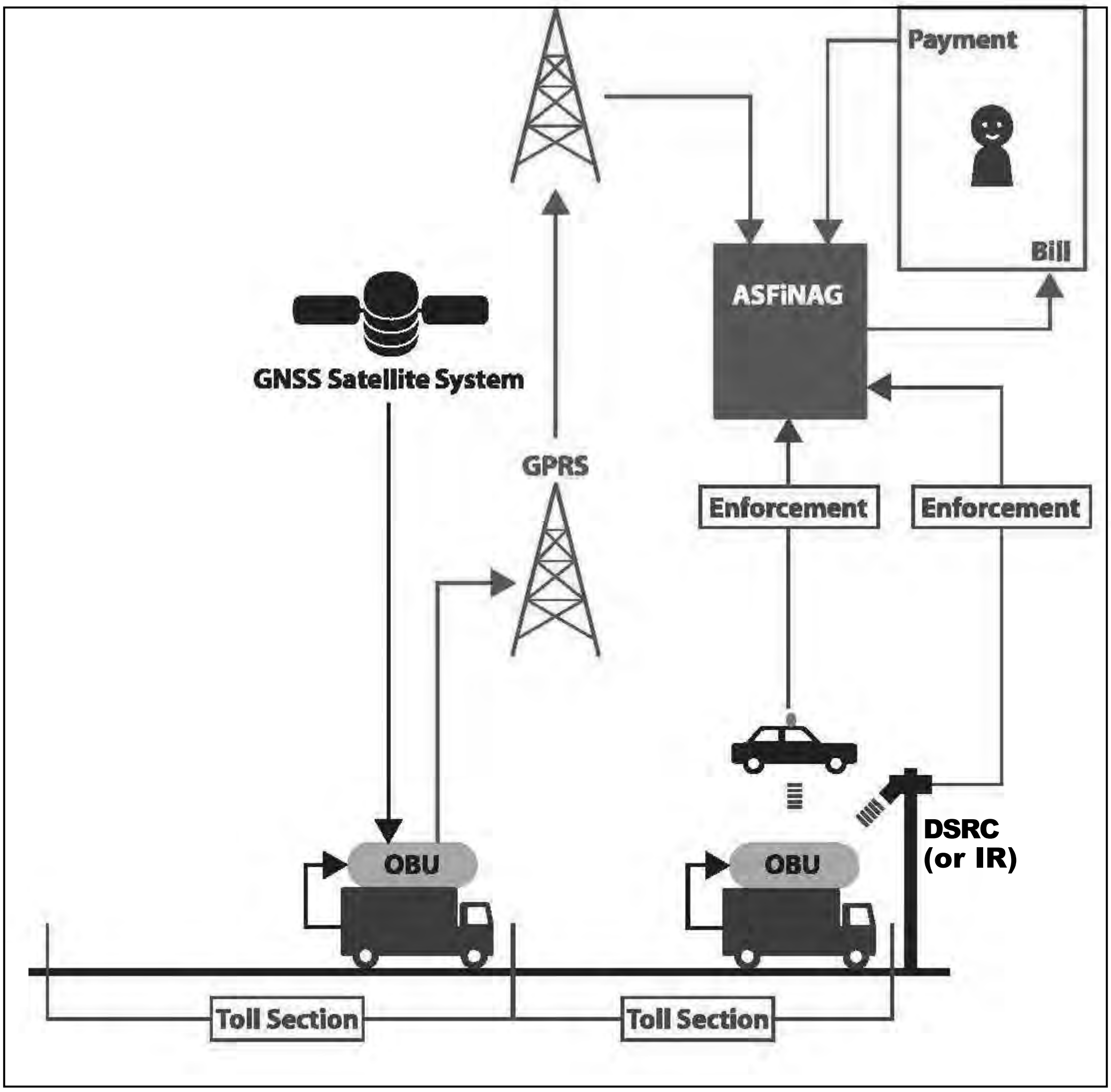
Roadside antenna for Passive-DSRC or Passive RF-Tag requires higher cost than that for Active-DSRC according to the following reasons:

- Roadside equipment of Touch&go at lower cost than that of ETC is not available in Passive RF-Tag
- Additional transmitting power is necessary for roadside equipment of Passive RF-Tag to store temporary data for distance proportional tariff in OBU.

9) International Trend to Next-generation ETC

In the ITS World Congress 2011 in USA, the technology of GPS/GSM for ETC is presented by many organizations as a next-generation ETC. This method realizes ETC by technologies of GPS (Global Positioning System) and GSM (Global System for Mobile Communications) generally without roadside equipment. In this method, DSRC or IR is used for enforcement

Figure 7.22 Next-generation ETC based on GPS and DSRC (or IR)



Source: ITS Integration Project (SAPI) Study Team

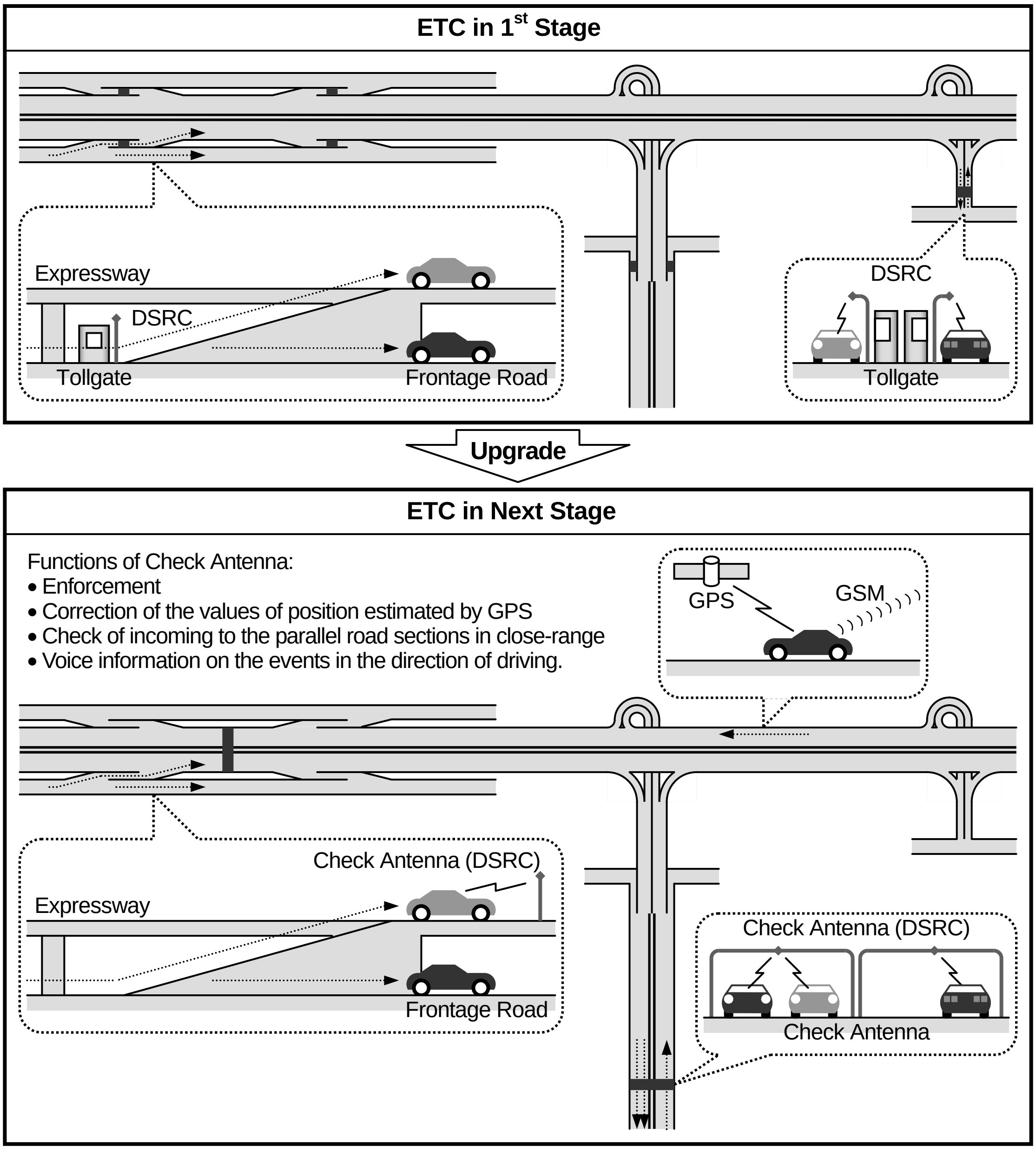
and check of incoming to the parallel road sections in close-range. However, Active and Passive RF-Tag is outside of the concept of the next-generation ETC.

10) Concept of Upgrading to Next-generation ETC

Toward the next stage, an upgrading to next-generation ETC can be proposed. Roadside equipment at tollgate and OBUs based on the technology of DSRC are to be installed for ETC in the 1st stage. The technology and roadside equipment can be utilized for the purposes below in the next stage as well as the technologies of GPS and GSM.

- Enforcement
- Correction of the values of position estimated by GPS
- Check of incoming to the parallel road sections in close-range
- Voice information on events in the direction of driving (→ only by Active-DSRC).

Figure 7.23 Upgrading to Next-generation ETC

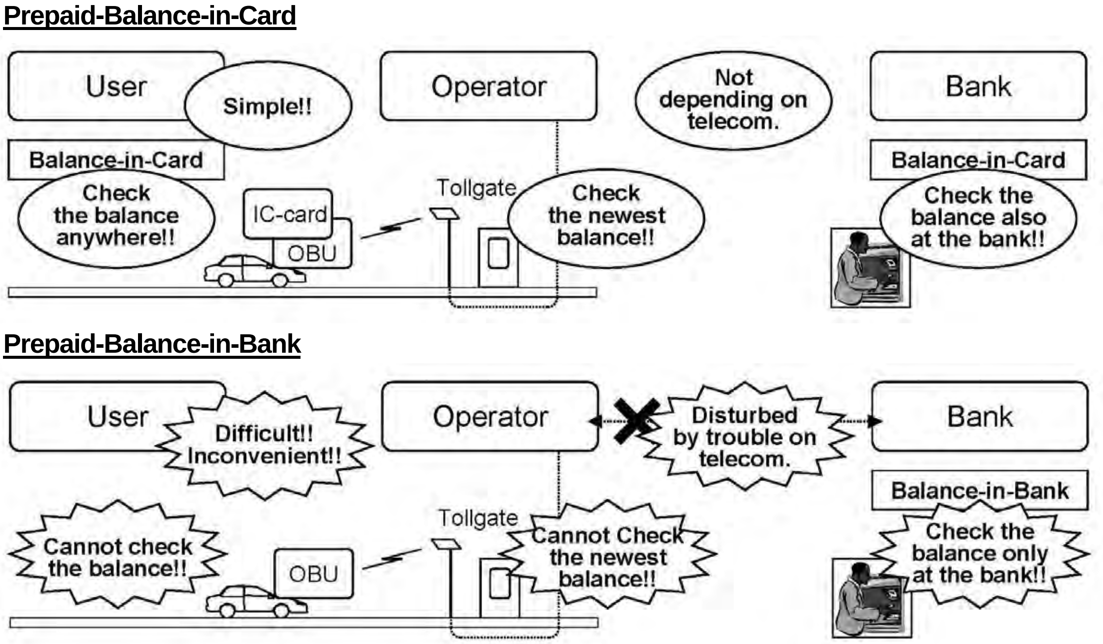


Source: ITS Integration Project (SAPI) Study Team

7.6 Method of Checking Prepaid Balance

Prepaid balance can be managed in two different ways: prepaid-balance-in-card and prepaid-balance-in-bank. Prepaid-balance-in-card allows users to check the prepaid balance anywhere, on the other hand, prepaid-balance-in-bank limits checking the prepaid balance only to a bank. For this reason, prepaid-balance-in-card is recommended for ETC and Touch&go.

Figure 7.24 Methods for Checking Prepaid Balance

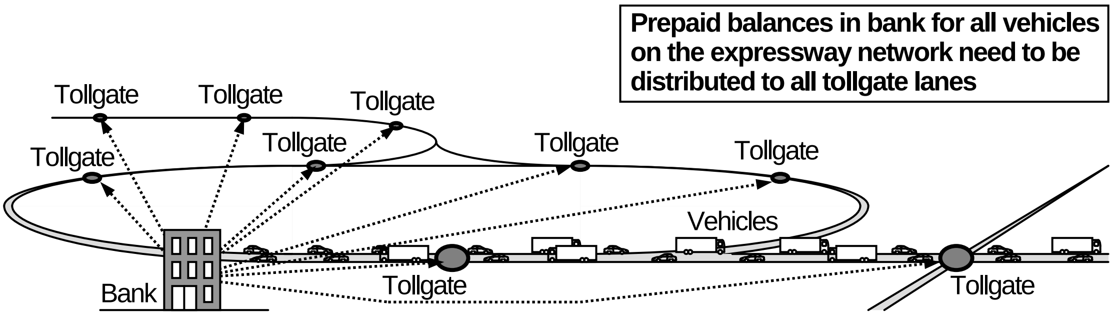


Source: VITRANSS2 Study Team

1) Difficulty in Prepaid Balance Distribution to All Tollgate Lanes

In the case of prepaid-balance-in-bank, the prepaid balance data (or the insufficient-balance-user-list) for all vehicles on the expressway network needs to be distributed from the bank to all tollgate lanes. However, in near future, the data volume of distribution will become very large corresponding to the increasing number of the vehicles on the expressway network; hence, the distribution cannot be done continuously but done only by batch processing in a certain time interval. In Europe, the delivery of insufficient-balance-user-list is generally done once a day or less.

Figure 7.25 Prepaid Balance Distribution to All Tollgate Lanes

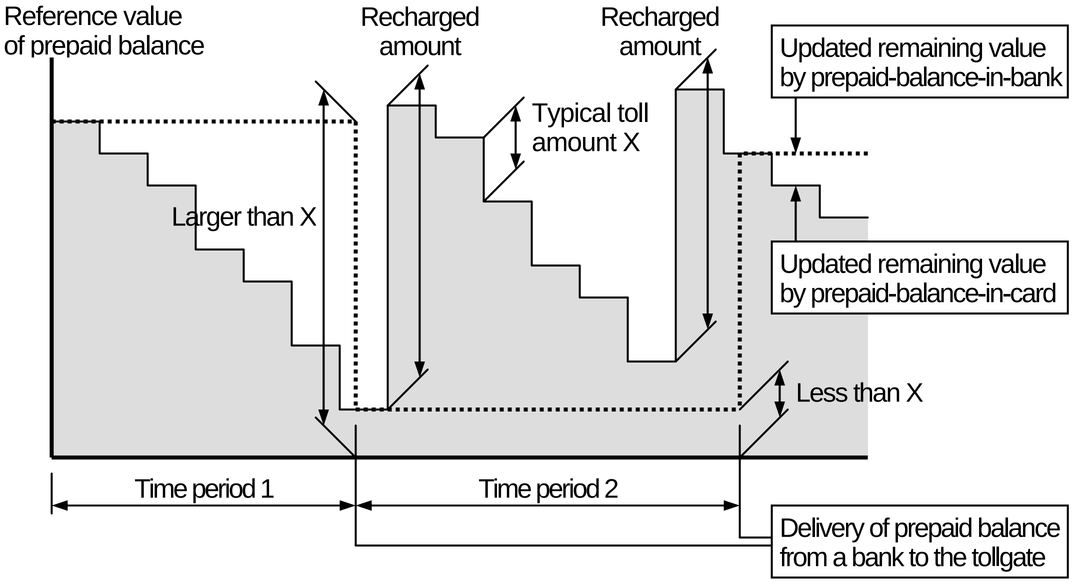


Source: ITS Standards & Operation Plan Study Team

2) Problem Due to Update Interval of Prepaid Balance

As shown in the figure below, remaining value of prepaid balance is updated every time the vehicle passes through the tollgates in the case of prepaid-balance-in-card. However, in the case of prepaid-balance-in-bank, remaining value is updated only at times the prepaid balance is distributed from the bank to the tollgate, accordingly remaining value is far lager than typical toll amount X throughout time period 1, but remaining value keeps less than X throughout time period 2.

Figure 7.26 Problem Due to Update Interval of Prepaid Balance



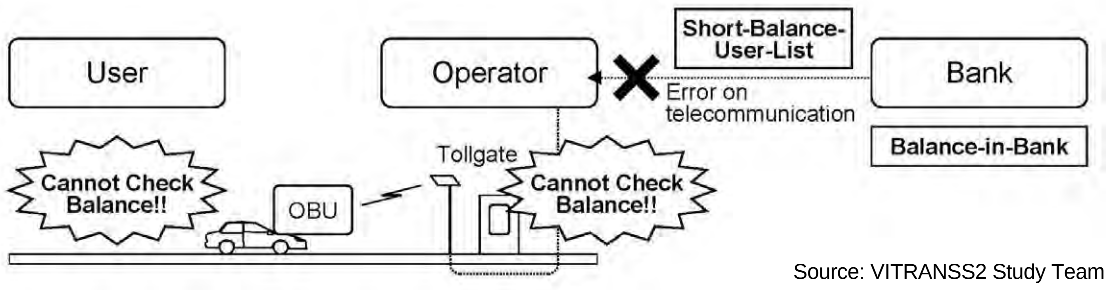
Source: ITS Standards & Operation Plan Study Team

3) Problems Caused by Low-quality Telecommunication

In the ETC trials in Malaysia, low-quality telecommunication interferes with the data exchange and causes the following problems:

- Even in the case a user's balance is not enough, the system cannot verify his balance and the operator cannot stop him,
- Even in the case a user recharged his balance, the system cannot check his balance and he cannot pass a tollgate.

Figure 7.27 Problems Caused by Low-quality Telecommunication



Source: VITRANSS2 Study Team

7.7 Contact-less IC-Card Type

There are three major types of contact-less IC-cards using 13.56MHz:

- TYPE-A (including some improved version such as TYPE A + Mifare)
- TYPE-B
- Felica

Advantages and disadvantages of each type of contact-less IC-card are summarized in the table below. TYPE-A (Mifare) and Felica are recommended for the use of ETC and Touch&Go in Vietnam.

Table 7.10 Comparison on Specification of Contact-less IC-card

		TYPE A (Mifare)	TYPE A	TYPE B	Felica
Transaction Speed		> 106kbps (depending on variety)	> 106kbps	106kbps	212kbps
International Standards	ISO 14443	Compliant	Compliant	Compliant	Not compliant
	ISO 18092	Compliant	Compliant	Not compliant	Compliant
Crypto-graphy	RSA	Applicable	Applicable	Applicable	Applicable
	AES	Applicable (depending on variety)	Applicable	Applicable	Not applicable
Multi-Reaction (Anti-Collision method)		Bit Collision /or/ Time Slot method	Bit Collision /or/ Time Slot method	Slot Marker method	Bit Collision /or/ Time Slot method
Usage Track Records for Transportation		Asia, Europe (e.g. fuel fee payment in Vietnam)	Asia, Europe	Europe	Asia (e.g. subway fare payment in Vietnam)
Usage Track Records in Vietnam		Many	None	A line of MRT (in near future)	Many lines of MRT (in near future)
Competitive Suppliers		Many	Many	Many	A few
Production Cost		Low	Low	Middle	High
Grading		Recommended	Not Suitable	Not Suitable	Recommended

Source: ITS Standards & Operation Plan Study Team

(1) Transaction Speed

“Felica” has more advantages than the others and has about twice the transaction speed as other systems.

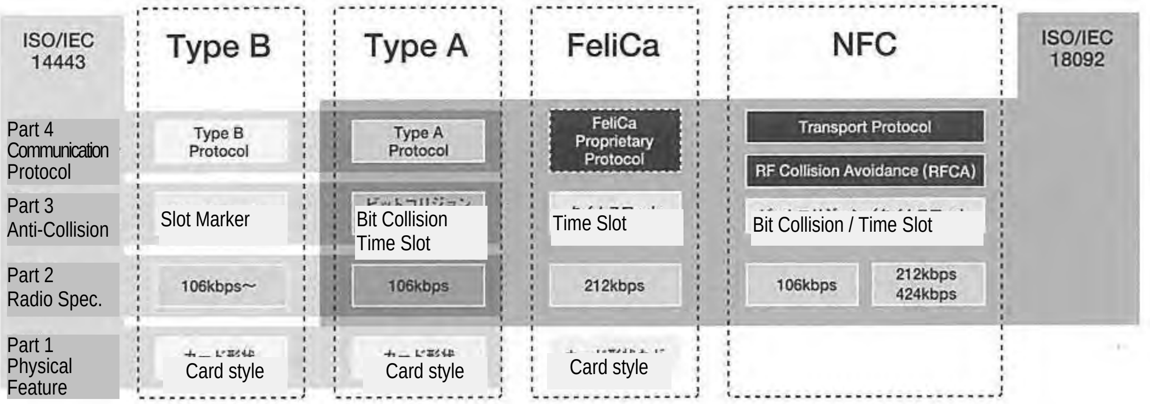
(2) International Standard

International standards for contact-less IC-card are ISO/IEC1443 and ISO/IEC18092 issued in 2003.

ISO/IEC18902 regulates contact-less IC-card based on data transaction within 10 cm using 13.56 MHz radio wave. Transaction speed can be selected from these alternatives: 106, 212 and 424 Kbps.

ISO/IEC18092 defines only standards for communication method between equipments, not specific physical shape/sizes. Therefore, there is flexibility for products shape/sizes.

Figure 7.28 Relationship between ISO/IEC14443 and ISO/IEC18902



Source: VITRANSS2 Study Team

(3) Cryptography (for security)

"RSA" and "AES" are the major cryptography algorithms discussed below.

- **RSA**: In cryptography, RSA is an algorithm for public-key cryptography. RSA is widely used in electronic commerce protocols, and is believed to be secure given sufficiently long keys and the use of up-to-date implementations.
- **AES:** In cryptography, AES (the Advanced Encryption Standard) is a symmetric-key encryption standard adopted by the U.S. government. The AES ciphers have been analyzed extensively and are now used worldwide. AES have no advantage over RSA, however the processing speed is higher than RSA.

"TYPE-A" has several types such as Mifare Classic, Mifare Plus, Mifare Desfire and so on; however, it is reported that "Mifare Classic" has faced a security problem recently, and secure cryptography algorithm "AES" cannot be applied to it.

(4) Anti-Collision Method (Multi-Reaction)

Anti-collision method is used for processing IC-cards when two or more IC-cards exist in the area of a reader/writer (R/W). There are three different types of anti-collision methods.

- **Time Slot method:** Each IC-card creates a random number based on R/W's request, and then IC-card will respond in accordance with created number. R/W can identify each IC-card based on the response timing.
- **Bit Collision method:** R/W can identify each card based on the response with a unique series of "Bit" such as "1" or "0" until R/W recognizes without any duplication of the bits.
- **Slot Marker method:** R/W assigns a random number to IC-card to identify each card.

Table 7.11 Anti-Collision Method

Anti-Collision Method	Characteristics
Time Slot method	Only one request from R/W at initiation stage is needed, therefore, it has less number of transactions.
Bit Collision method	It takes time because R/W requires judging all of the Bit series.
Slot Marker method	It takes time because R/W requests to all cards.

Source: ITS Standards & Operation Plan Study Team

(5) Usage Track Records for Transportation

Asian Region

Asian region is one of the advanced examples to spread Contact-less IC-card, such as “Octopus Card” in China and Hong Kong and “ez-link” in Singapore.

In Soul, Korea, “T-money” IC-card was introduced as a new concept based on the revision of urban transport system in July, 2004.

Recently, the rapid economic developing cities of Shenzhen, Guangzhou, Shanghai and Dalian in China, have promoted Contact-less IC-card as a transportation card.

In Asia, TYPE A or Felica techniques are applied in many cities and TYPE B has a few case of usage. Especially in Vietnam in near future, Felica is to be applied many lines of MRT in Ha Noi and HCMC and TYPE B is to be applied a line in Ha Noi.

European Region

In European region, IC-card is popularized as a additional function with Debit Card (ATM card) in order to realize “Coin-less Payment”, such as “Geldkarte” in Germany, “Danmont” in Denmark, “Proton” in Belgium, “Moneo” in France, and “Chipkaart” in Netherlands.

The transport agencies in France, Italy, Portugal and Germany are studying to introduce contact/contact-less IC-card and box type terminal units for data exchange from contact IC card to contact-less IC card.

In European region, TYPE A and TYPE B are applied in many cities.

(6) Competitive Suppliers

“TYPE-A (Mifare)” and “Felica” are supplied by small number of suppliers. The detail specifications of these types are not disclosed by the suppliers.

(7) Production Cost

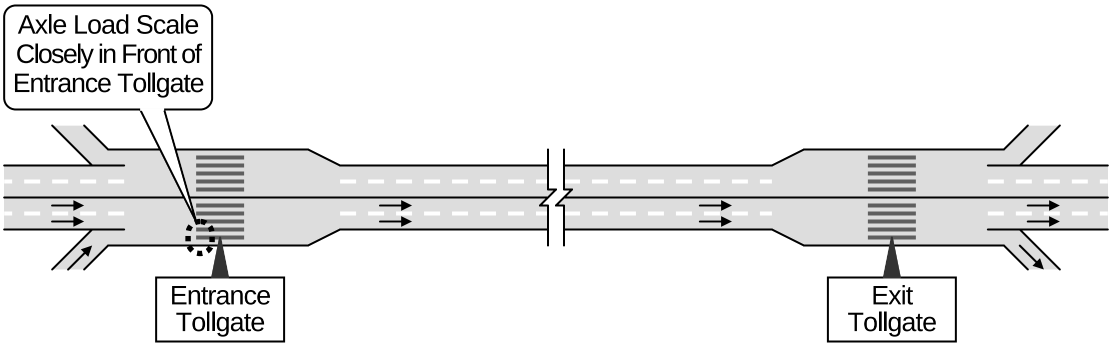
In consideration of IC-cards and reader/writers (R/W), “TYPE-A (especially Mifare Classic)” can be supplied at the lowest cost, and “TYPE-B” can be supplied at lower cost than “Felica”.

7.8 Axle Load Scale Arrangement

Axle load scale is to be installed for the purpose of overloading regulation; however, there are three alternatives of axle load scale arrangement.

- **Alternative 1:** Axle load scale installed in front of entrance tollgate with the requirement for overloaded trucks to go out from the expressway at the next interchange.

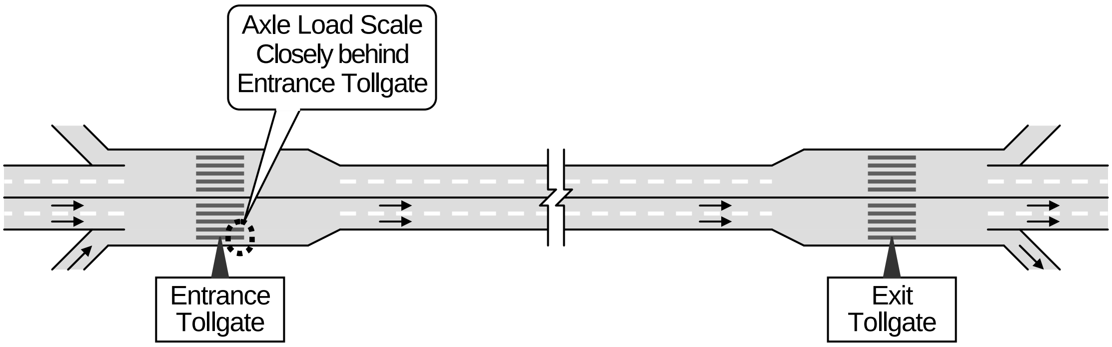
Figure 7.29 Alternative 1: Axle Load Scale in Front of Entrance Tollgate



Source: ITS Integration Project (SAPI) Study Team

- **Alternative 2:** Axle load scale installed behind of entrance tollgate with the requirement for overloaded trucks to go out from the expressway at the next interchange.

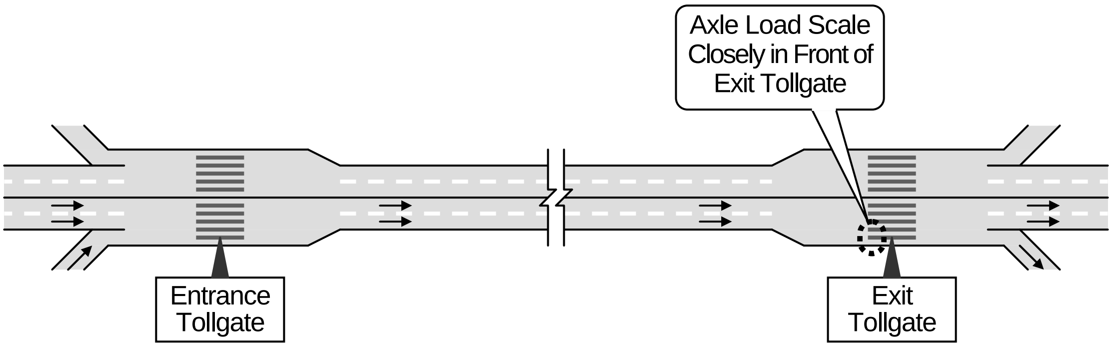
Figure 7.30 Alternative 2: Axle Load Scale behind Entrance Tollgate



Source: ITS Integration Project (SAPI) Study Team

- **Alternative 3:** Axle load scale installed in front of exit tollgate with the requirement for the overloaded trucks to pay high amount of penalty at the tollgate.

Figure 7.31 Alternative 3: Axle Load Scale in Front of Exit Tollgate



Source: ITS Integration Project (SAPI) Study Team

Table 7.12 Comparison on Alternatives of Axle Load Scale Arrangement

	Alternative 1	Alternative 2	Alternative 3
Intended Level of Penalty for Overloaded Trucks	Average Penalty	Avarege Penalty	High Penalty
Installation of Axle load Scale in to All Tollgates to Prevent Avoidance	Possible	Possible	Possible
Control/Stop of Overloaded Trucks	Easy	Not Easy	Easy
Accuracy of Measurement	Enough (within Tollgate Lane)	Enough (within Tollgate Lane)	Enough (within Tollgate Lane)
Additional Installation of Weigh-bridges to Impose a Penaly	Necessary	Necessary	Not Necessary
Preparation of Additional Legal Framework	Necessary	Necessary	Necessary and Difficult
Grading	Recommended	Comparable	Comparable

Source: ITS Integration Project (SAPI) Study Team

The location closely in front of exit tollgates is recommended for axle load scale from the comparison shown in the table above.

Required Condition:

Axle load scale installation in the Project is the 1st stage of implementation of the system for overloading regulation.

The system for overloading regulation is to be implementation stepwise; however, additional measures are necessary as shown by underlines.

In the Project :1st Stage

1) Axle load scales are to be installed in front of the entrance tollgate.

2) The total weight of a truck is to be estimated from the total value of measured axle loads and the license number is to be captured.

3) A ticket for indicating measured weight is to be handed to the driver of the truck beyond the limit of measured weight, and the driver is required to pay penalty and to go out from the expressway at the next (or nearest) exit tollgate: however, it is necessary for the Government to prepare a legal framework to impose penalty by measuring axle loads.

4) Road operators are never to permit the truck beyond the limit to enter any expressway by referring to the captured license number.

In the Future :Next Stage

1) A weighbridge is to be installed additionally at the place along expressways (or at the exit tollgate) with enough space appropriately based on the accumulated data by axle load

measurement.

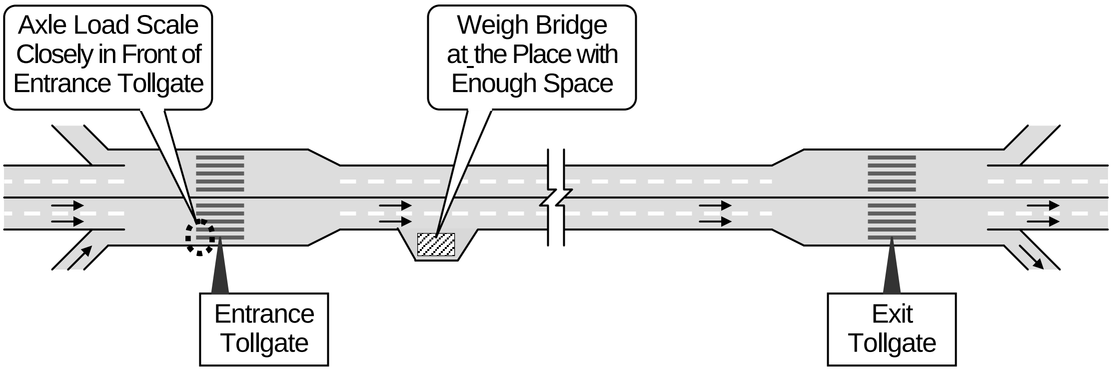
2) The total weight of a truck is to be estimated from the total value of measured axle loads and the license number is to be captured.

3) A ticket for indicating measured weight is to be handed to the driver of the truck beyond the limit of measured weight, and the driver is required to go to the place of weighbridge and to measure the total weight of the truck.

4) In the case the total weight is beyond the limit value, the driver of the truck is required to pay a penalty and to reduce the total weight of truck by reshipment.

5) Road operators are never to permit the truck enter any expressway unless otherwise the payment of the penalty and reducing of the total weight; however, it is necessary for the Government to prepare a legal framework against unlawful drivers who ignores payment of penalty (or toll).

Figure 7.32 Axle Load Scale in Front of Entrance Tollgate (In Future)



Source: ITS Integration Project (SAPI) Study Team

7.9 Integration of Roadside Equipment Control

1) Roadside Equipment for Traffic Information/Control

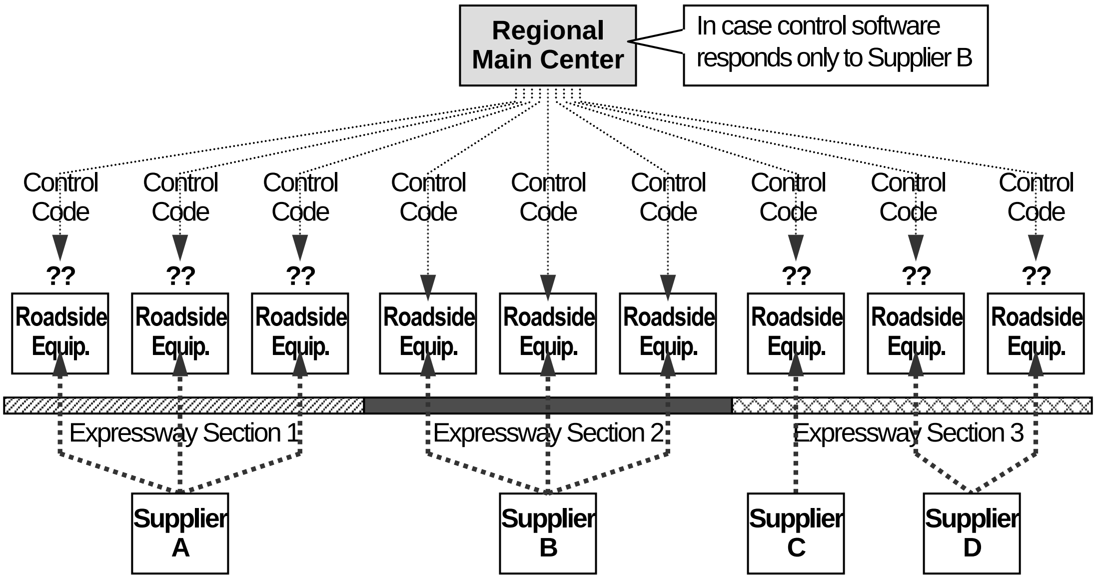
(1) Necessity of Integration of Roadside Equipment Control

As mentioned in Chapter 6, routine monitoring and control of traffic is to be conducted by controlling pieces of roadside equipment under the Regional Main Center. Actual roadside equipment control is performed through control codes transmitted from the Regional Main center.

On the other hand, implementation of roadside equipment is conducted in construction projects of individual road sections based on the expressway construction schedule. Consequently, it is usual that pieces of roadside equipment are different according to the road sections and the suppliers who install them.

In many cases, control codes are not compatible among the pieces of roadside equipment manufactured by different suppliers. In such cases, it is necessary to take countermeasures to make it possible to control all pieces of roadside equipment spread on the different road sections directly by the system installed at the center construction.

Figure 7.33 Control Codes Incompatible among Different Suppliers



Source: ITS Standards & Operation Plan Study Team

A large number of additional CCTV cameras are to be installed for traffic information/control with the increase in the total length of expressways. Also to hold down rising video image data volume from the CCTV cameras, the integration of roadside equipment control is necessary.

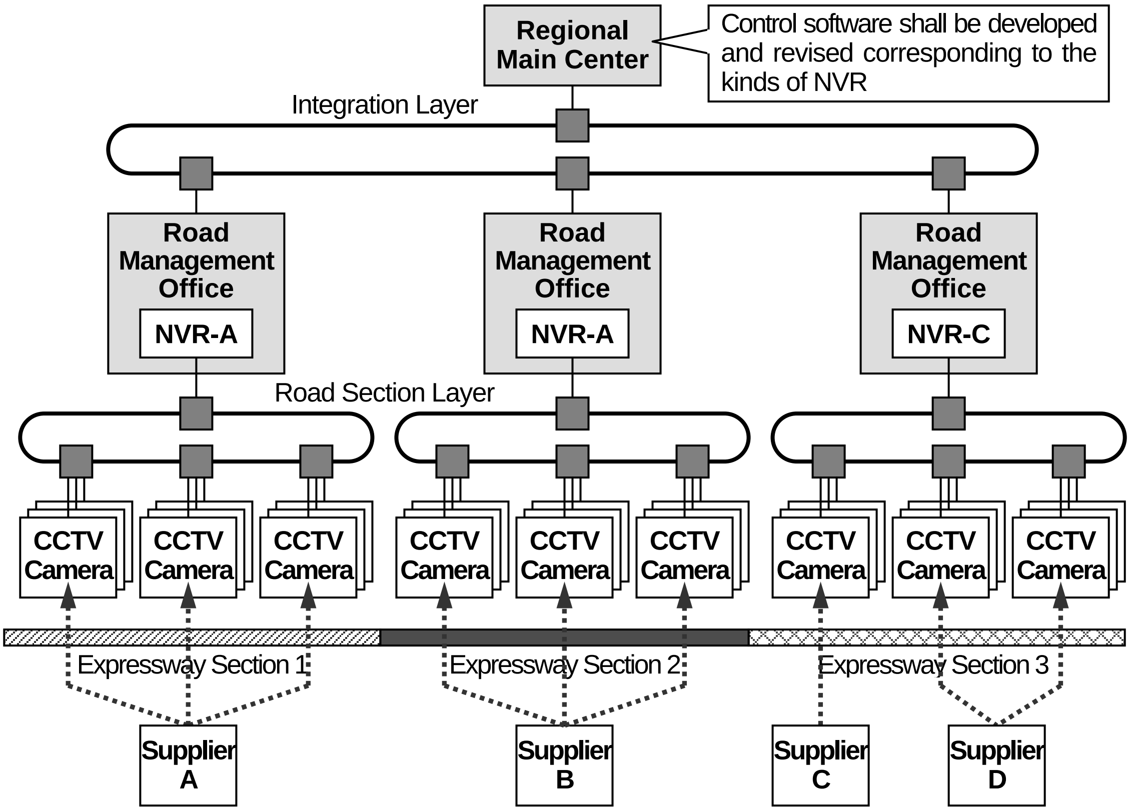
Integration measures for controlling roadside equipment including CCTV camera and VMS are discussed in the following.

(2) Integration of CCTV Camera Control

NVR (Network Video Recorder) is an integration tool useful for controlling many CCTV cameras installed by different suppliers. In the Study, NVRs are assumed to be installed at communication nodes or in road management offices as shown in the figure below. The figure shows that control codes need to be generated only for NVR-A and NVR-C in the Regional Main Center to reduce the variety of control codes. Concurrently, video image data volume sent to integration layer can be reduced as well.

However, disclosure of control codes is indispensable for installing NVR and control software in the Regional Main Center needs to be revised responding to the rise in the number of NVR.

Figure 7.34 Integration of CCTV Camera Control



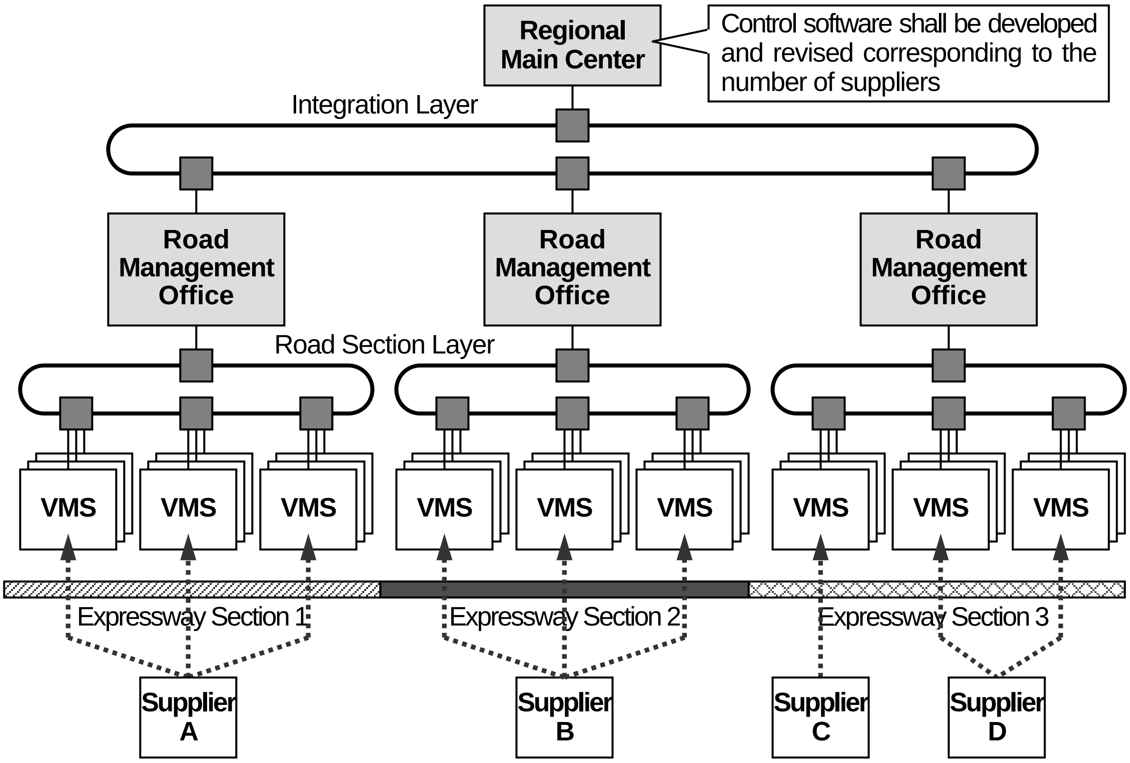
Note: NVR can be installed at communication nodes or in road management offices.

Source: ITS Standards & Operation Plan Study Team

(3) Integration of VMS Control

There is no effective integration tool for controlling many VMSs installed by different suppliers, and control codes need to be generated in the Regional Main Center as many as the number of suppliers who installed VMS. Hence, for VMS installation, suppliers need to be obligated to disclose technological information, and the VMS control software in the Regional Main Center needs to be revised responding to new entrants of suppliers.

Figure 7.35 Integration of VMS Control

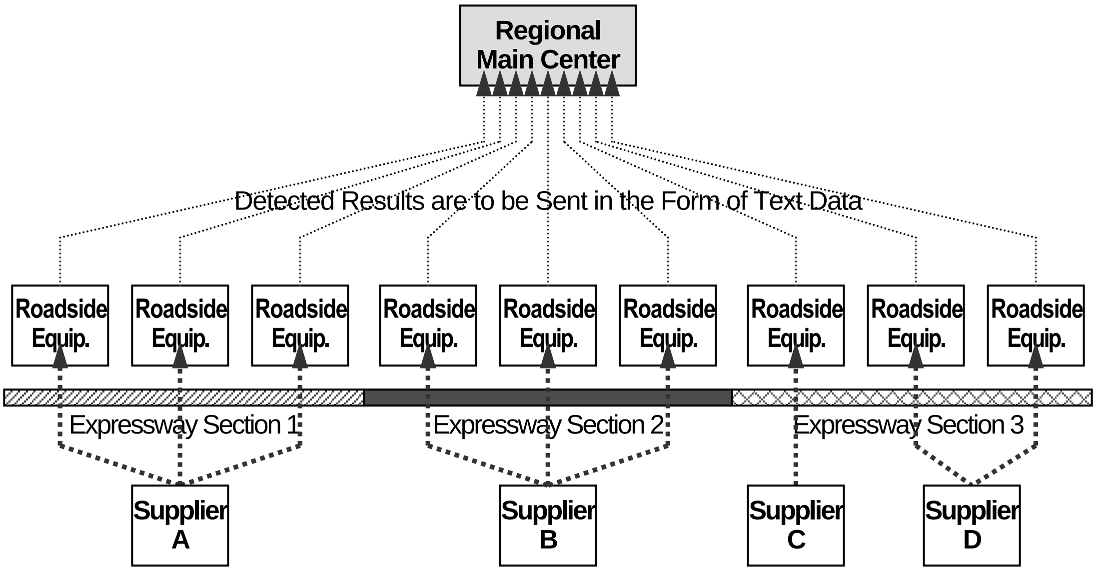


Source: ITS Standards & Operation Plan Study Team

(4) Other Detectors/Sensors

Excluding CCTV camera and VMS, other detectors/sensors need not particular control codes generally. All kinds of detected results are converted to text data and are sent simply to the Regional Main Center. Hence, there are no causes for problems on integration of control, even in the case pieces of equipment are installed by different suppliers.

Figure 7.36 Transmission of Detected Results by Detectors/Sensors

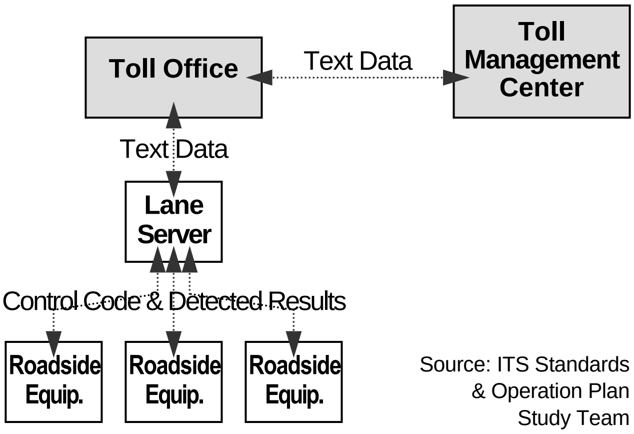


Source: ITS Standards & Operation Plan Study Team

2) Roadside Equipment for Automated Toll Collection

Pieces of roadside equipment for automated toll collection are controlled by a lane server and their detected results also managed by the server. Data exchanges with higher level systems in toll office and others are conducted by using text data, which has no problem on integration of control.

Figure 7.37 Roadside Equipment Control and Transmission of Detected Results for Automated Toll Collection



Source: ITS Standards & Operation Plan Study Team

3) Roadside Equipment for Overloading Regulation

Similar to the case of automated toll collection, pieces of roadside equipment for overloading regulation are controlled under a roadside server and their detected results also managed by the server. Data exchanges with higher level systems are conducted by using text data, which has no problem on integration of control.

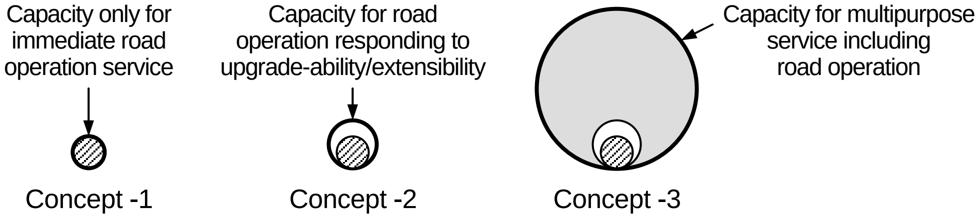
7.10 Transmission Method

Transmission Capacity

Transmission capacity is one of the most important factors for selecting suitable transmission method, which is to respond to the scope of services provided through it. Three typical concepts are proposed for setting target capacity of the communication network for ITS:

- Concept -1: Capacity only for immediate road operation service
- Concept -2: Capacity for road operation service with upgrade-ability/extensibility
- Concept -3: Capacity for multi-purpose service including road operation.

Figure 7.38 Concepts of Target Capacity of Communication Network for ITS



Source: VITRANSS2 Study Team

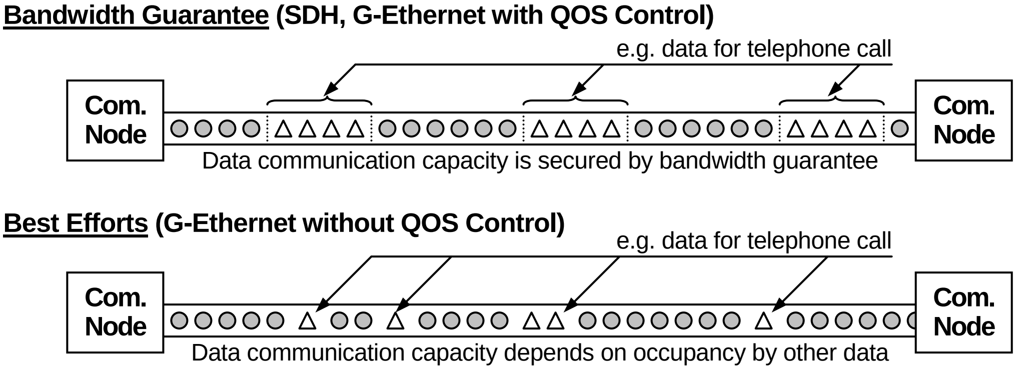
Generally, the target capacities of Concept-2 and Concept-3 are suitable for expressway operation using ITS. IP over SDH and IP over G-Ethernet are to be recommended as suitable transmission methods for realizing Concept-2.

However, the communication system can produce profits through its operation and is to be used for the broader purpose to achieve efficient road operation. For such purpose, IP over SDH/ DWDM and IP over TDM/DWDM are suitable transmission method for realizing Concept-3.

Bandwidth Guarantee

Telephone is to be used for emergency calls and directives any time the need arises, and that requires bandwidth guarantee to create a stable link between the initiating and receiving parties. SDH and G-Ethernet can provide this function and is suitable for the integration layer of the hierarchical communication network for ITS.

Figure 7.39 Concepts of Bandwidth Guarantee and Best Efforts



Source: ITS Standards & Operation Plan Study Team

Table 7.13 Comparison on Transmission Methods

	IP over ATM	IP over G-Ethernet	IP over SDH	IP over ATM/DWDM	IP ovrer SDH/DWDM
Communication Node	ATM	Media Converter	SDH	DWDM	DWDM
Interface of Ethernet	Available	Available	Available	Available	Available
Maximum Capacity	0.6 Gbps (Concept-2)	40 Gbps (Concept-3)	40 Gbps (Concept-3)	1 Tbps (Concept-3)	1 Tbps (Concept-3)
Capacity for ** Additional Service	Not Sufficient	Not Sufficient	Not Sufficient	Sufficient	Sufficient
Bandwidth Guarantee	Capable	Capable	Capable	Capable	Capable
Network Management	Capable	Capable	Capable	Capable	Capable
Compatibility	Low	High	High	High	High
Implementation Cost	Low	Average	Average	High	High
Track Records in Telecom Service	--	--	--	--	Adopted by Viettel
Grading	Not Suitable	Recommended	Comparable	Not Suitable	Not Suitable

Note: **: Leasing of lines as a simple additional services using the remaining capacity of communication network.

Source: ITS Standards & Operation Plan Study Team

7.11 Selected Key System Policies

In the Study, the key policies, as premises for structuring ITS, are discussed from an objective and neutral stand point free from the intentions of individual organizations/firms who have relations with the expressway construction in Vietnam. The discussion is conducted in such a manner as to involve the policies/candidates in on-going expressway construction projects and the following reasoned conclusions are reached.

(1) Arrangement of CCTV Camera for Monitoring
→At 2km intervals continuously along the expressway (→See Table 7.2 and Figure 7.4)

(2) Arrangement of CCTV Camera for Event Detection
→On the through lanes and the ramps on trial (→See Table 7.3, Figures 7.7 and 7.9)

(3) Vehicle Detector Arrangement
→Midway between a pair of interchanges (→See Table 7.4 and Figure 7.12)

(4) Type of Vehicle Detector
→Image recognition type (→See Table 7.5)

(5) Upgrading to Next-generation System based on CCTV Camera for Multi-purpose
(→See Figure 7.10)

(6) Road-to-Vehicle Communication Method for ETC
→Active-DSRC (→See Table 7.6)
Note: Passive-DSRC can be competitive in trial use and RF-Tag is to be followed up.

(7) Tollgate Lanae Operation
→Combined use with Touch&Go (→See Figure 7.20)

(8) Upgrading to Next-generation ETC based on GPS/GSM/DSRC
(→See Figure 7.23)

(9) Checking of Prepaid Balance
→By prepaid-balance-in-card (→See Section 7.6)

(10) Contact-less IC-Card Type
→TYPE-A and Felica as the candidates for conclusive selection through field trial (→See Table 7.10)

(11) Axle Load Scale Arrangement
→ Closely in front of entrance tollgates (→See Table 7.12 and Figure 7.31)

(12) Integration of Roadside Equipment Control
→Combination of NVR introduction and technological disclosure obligation to suppliers (→See Section 7.9)

(13) Transmission Method
→G-Ethernet (→See Table 7.13)

It is necessary, additionally, to finalize the selected results and verify them in ITS integration project as the first stage of system implementation to be compliant with the Draft ITS Standards.

8. Feasibility Study of Project

8.1 General

In this chapter, economic analysis and financial analysis are discussed:

Economic analysis

The economic analysis of the Project is made for the following two effects:

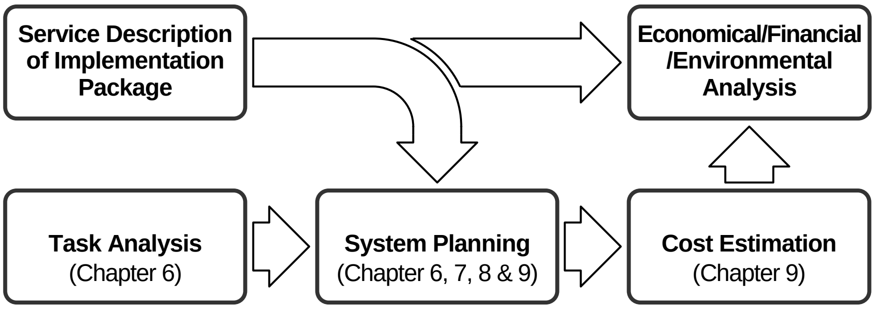
- ITS implementation effects
- Cost reduction effects by system integration compared to without integration

Financial analysis

The financial analysis is made for:

- Cost comparison between ITS Implementation and Road Construction

Figure 8.1 Flowhart of Estimating Effects of ITS Implementation



Source: ITS Integration Project (SAPI) Study Team

8.2 Alternative Cases

The alternative cases below are set-up by the different combinations of expressway sections, which are to be shown in the following, as the scope for making comparisons in economic and financial analysis.

- Base Case
- Comparison case 1
- Comparison case 2.

The Base Case is the Study Scope as mentioned in Section 1.3.

In the estimation process, the traffic volume and road construction cost are obtained in terms of unit of per kilometer, then extended into the operation length km of expressway in each case.

<u>Base Case</u>

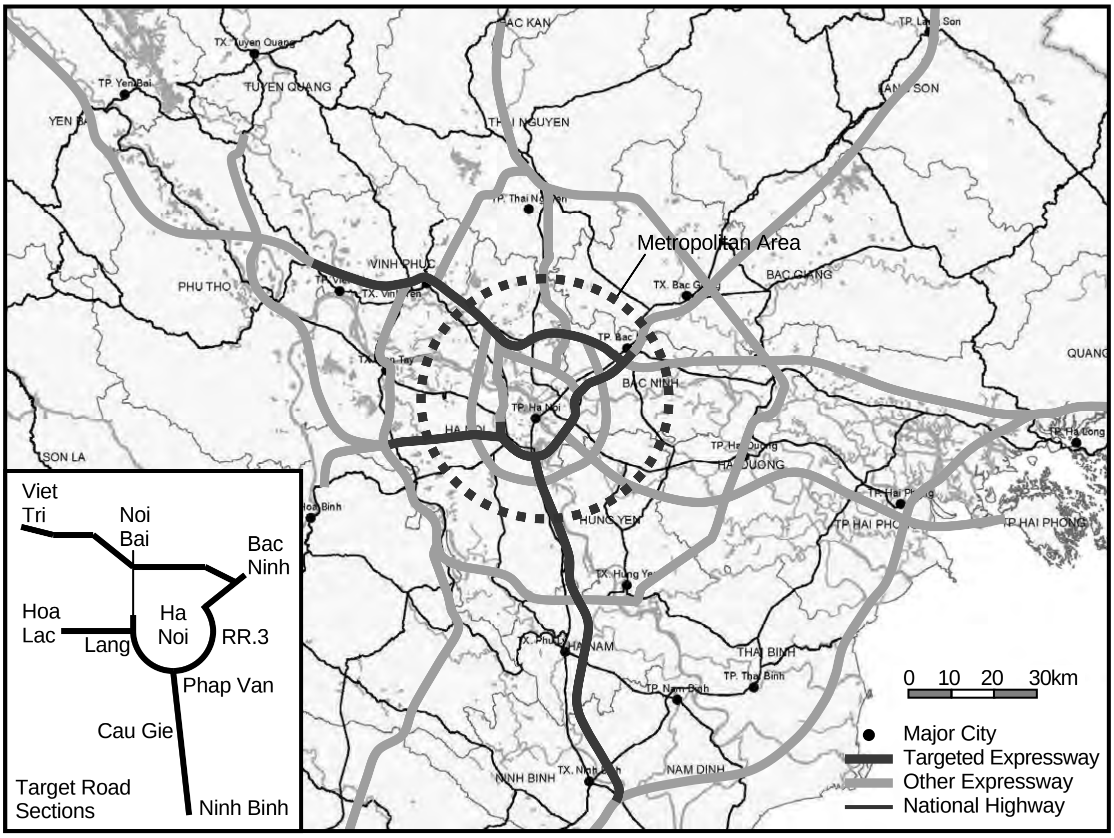
Ha Noi Metropolitan Area is to be defined as the study area. The target road network of the Project is to be formed by selections of the road sections below, which are shown in the official letter 2584/VEC-DA from VEC to MOT, evaluating effects of the project implementation.

(1) Base Case for the target road sections of the Project: Expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section, and connections to candidate locations of the Regional Main Center and the road management offices

(2) Expressway sections to be integrated under the Northern Regional Main Center other than (1).

Total length of the expressway network in the northern area, which is composed of (1) and (2), can be assumed to be around 1000 km.

Figure 8.2 Road Sections of Base Case



Target Road Sections of the Project (Base Case)	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Phap Van–Cau Gie	30 km
Cau Gie–Ninh Binh	50 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Noi Bai–Viet Tri	80 km
Total	268 km

Source: ITS Integration Project (SAPI) Study Team

Comparison Case 1

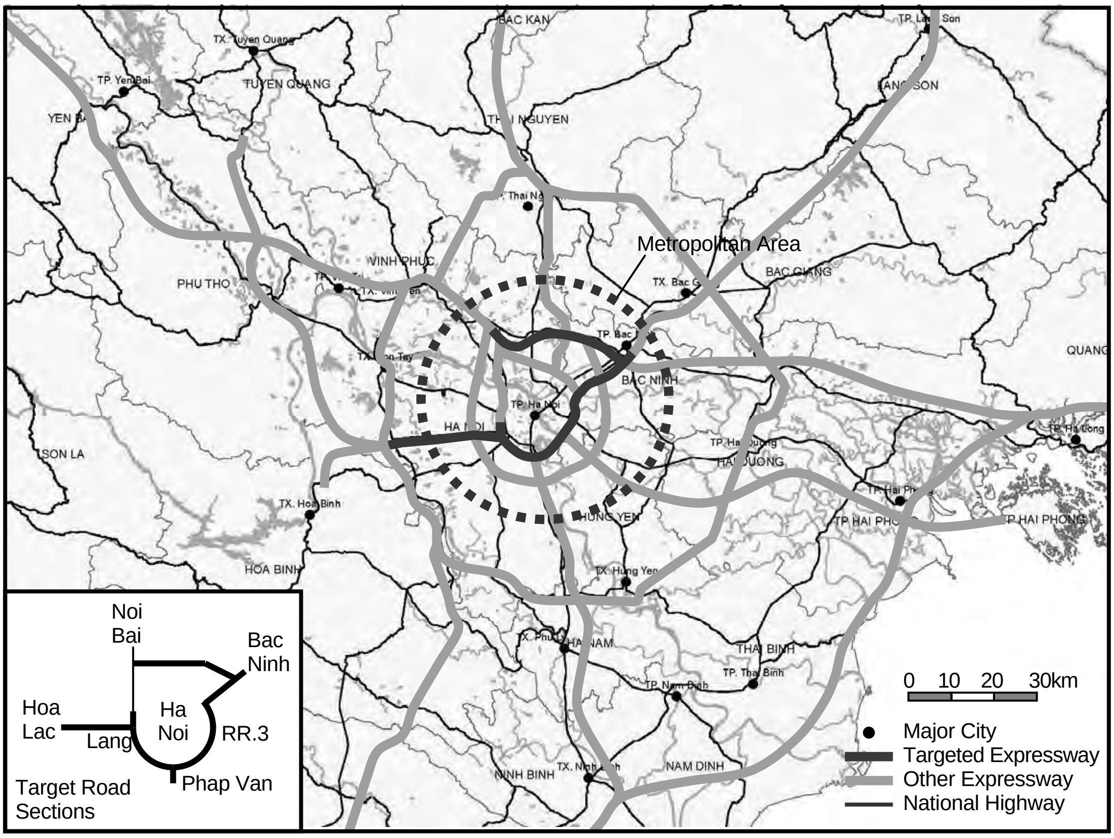
The road network of the comparison case 1 is to be formed consisting of the road sections selected from the followings:

(1) Comparison case for target road sections of the Project: Expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section

(2) Expressway sections to be integrated under the Northern Regional Main Center other than (1).

Total length of the expressway network in the northern area, which is composed of (1) and (2), can be assumed to be around 1000 km.

Figure 8.3 Road Sections of Comparison Case 1



Road Sections of Comparison Case 1	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Total	108 km

Source: ITS Integration Project (SAPI) Study Team

Comparison Case 2

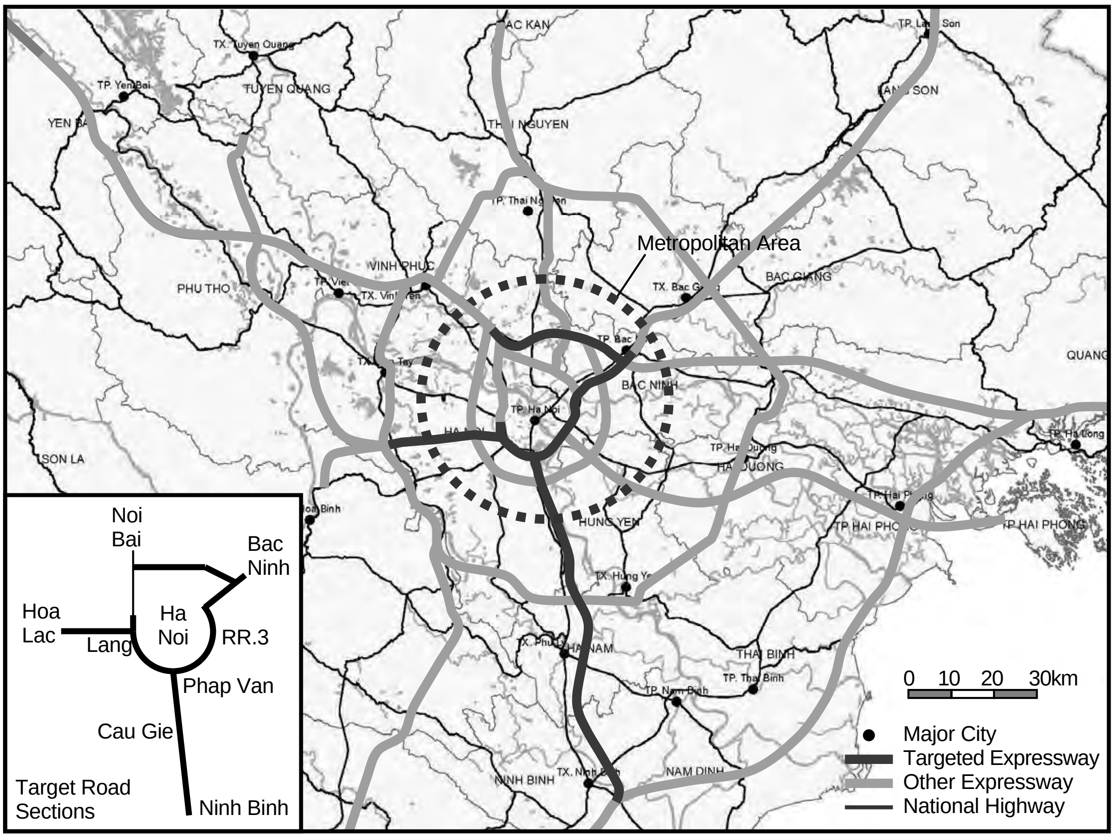
The road network of the comparison case 2 is to be formed consisting of the road sections selected from the followings:

(1) Comparison case for the target road sections of the Project: Expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section, and connections to candidate locations of the Regional Main Center and the road management offices

(2) Expressway sections to be integrated under the Northern Regional Main Center other than (1).

Total length of the expressway network in the northern area, which is composed of (1) and (2), can be assumed to be around 1000 km.

Figure 8.4 Road Sections of Comparison Case 2



Road Sections of Comparison Case 2	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Phap Van–Cau Gie	30 km
Cau Gie–Ninh Binh	50 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Total	188 km

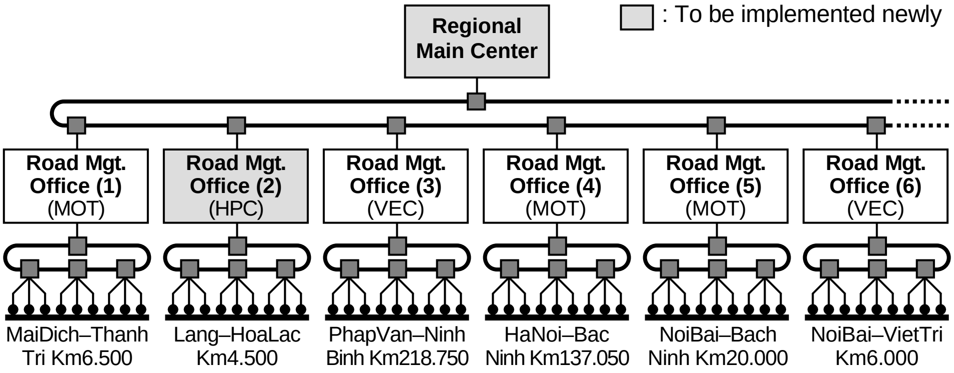
Source: ITS Integration Project (SAPI) Study Team

8.3 Outline of Project

1) Center Equipment

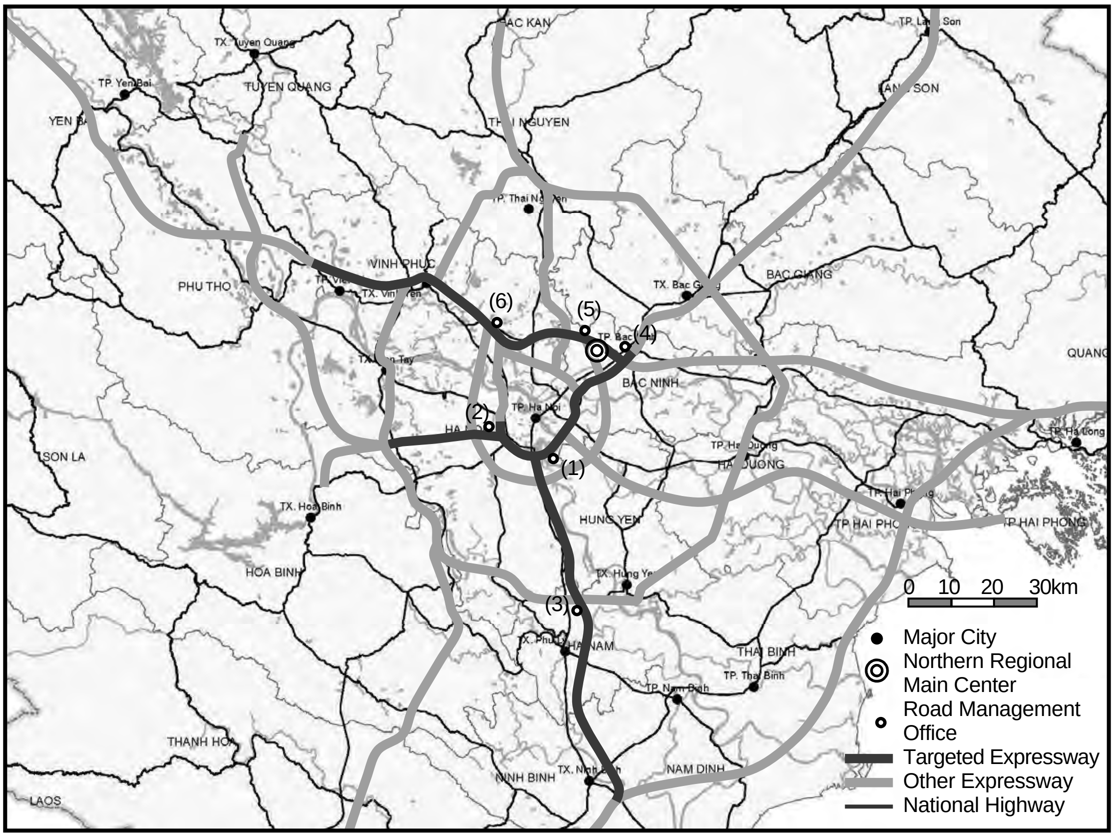
The structure and location of the Northern Regional Main Center and the road management offices are shown in the figures below. The center equipment for all of the Northern Regional Main Center and the road management offices needs to be implemented in the Project. The building construction only for the Northern Regional Main Center and the road management office of the Lang – Hoa Lac section is necessary in the Project.

Figure 8.5 Northern Regional Main Center and Road Management Offices



Source: ITS Integration Project (SAPI) Study Team

Figure 8.6 Location of Northern Regional Main Center and Road Management Offices



Source: ITS Integration Project (SAPI) Study Team

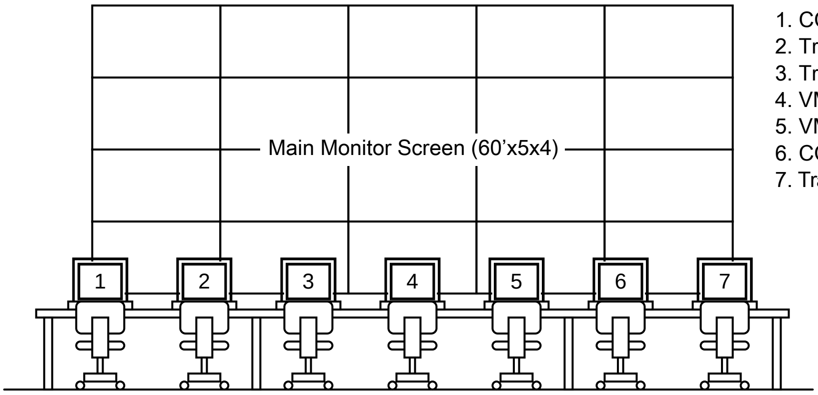
(1) Northern Regional Main Center

Traffic information/control is to be conducted totally from the Regional Main Center using the following functional packages:

(a) CCTV Monitoring
(b) Event Detection (by Image)
(c) Vehicle Detection
(d) Traffic Analysis
(e) Weather Monitoring
(f) Traffic Event Data Management
(g) Traffic Supervision
(h) VMS Indication
(i) Traffic Information

Vehicle detectors, weather sensors and VMSs need to be controlled directly from the Regional Main Center for integrating traffic information dissemination. The center equipment for actualising these functions is to be installed in the Regional Main Center.

Figure 8.7 Equipment Overview in Regional Main Center



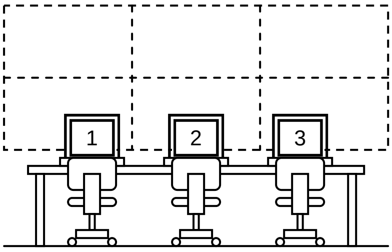
1. CCTV Center Controller Console
2. Traffic Event Data Input Device
3. Traffic Event Data Input Device
4. VMS Center Controller Console
5. VMS Center Controller Console
6. CCTV Center Controller Console
7. Traffic Supervising/Control Console

Source: ITS Integration Project (SAPI) Study Team

(2) Road Management Office

A part of center equipment is to be installed in the road management offices for expressway operation. CCTV cameras are to be controlled and the traffic event data are to be input from the road management office as well for handling and clearing incidents. The traffic event data can be input from the road management office; however, prioritisation of the traffic event data is to be done in the Regional Main Center and the result is to be sent directly to the VMS or CSS.

Figure 8.8 Equipment Overview in Regional Main Center



1. Traffic Event Data Input Device
2. CCTV MonitoringConsole**
3. CCTV MonitoringConsole

**: A CCTV monitoring console can be replaced with the traffic supervising/control console in the case the main monitor screen is installed in the road management office.

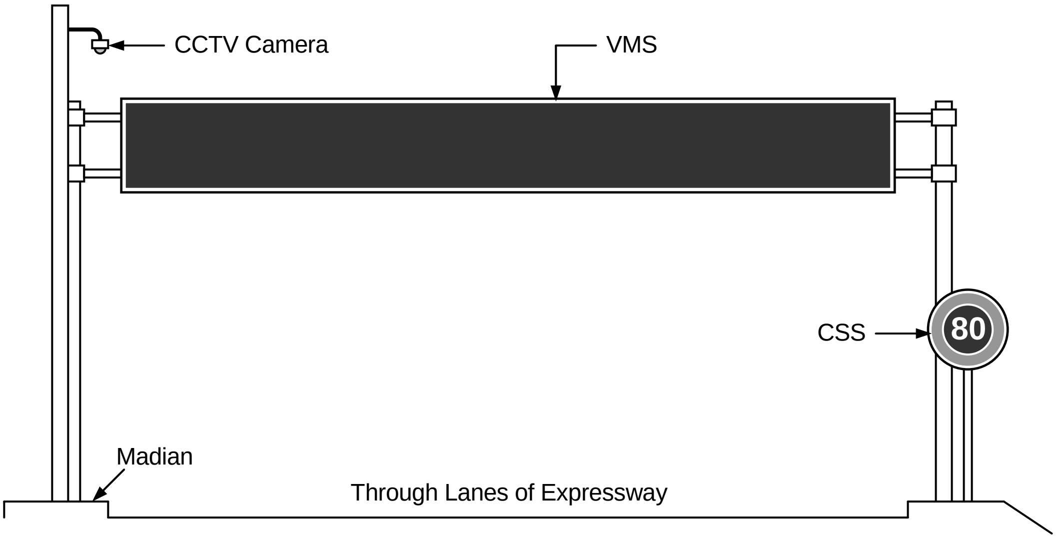
Source: ITS Integration Project (SAPI) Study Team

2) Roadside Equipment

In the Project, roadside equipment components below are to be installed for the 1st stage of stepwise implementation. The arrangement of these components is shown in the following tables.

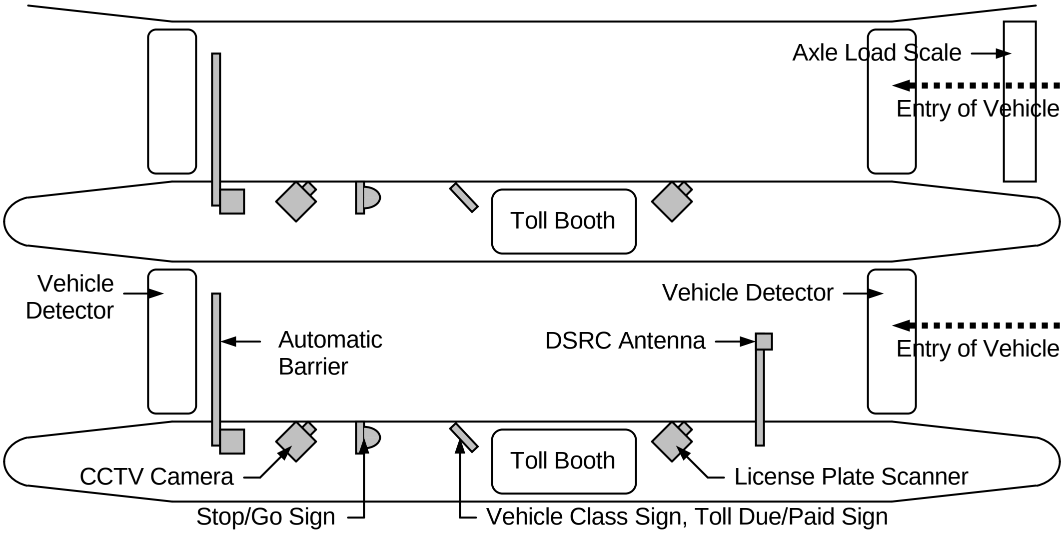
- CCTV camera (for monitoring and for event detection)
- Vehicle detector
- VMS (Variable Message Sign)
- CSS (Changeable Speed Limit Sign)
- ETC (Electronic Toll Collection)
- Touch&Go/manual
- Axle load scale

Figure 8.9 Installation of VMS/CSS



Source: ITS Integration Project (SAPI) Study Team

Figure 8.10 Installation of Roadside Equipment of Toll Collection and Vehicle Weighing



Source: ITS Integration Project (SAPI) Study Team

Table 8.1 Arrangement of Roadside Equipment in the Project

Arrangement of Roadside Equipment		Mai Dich–Thanh Tri Section	Lang–Hoa Lac Section	Phap Van–Cau Gie –Ninh Binh Section	Ha Noi–Bac Ninh Section	Noi Bai–Bac Ninh Section	Noi Bai–Viet Tri Section
1. PTZ Camera: for Monitoring	At regular intervals of 2 km (in practical use)	32 sets	42 sets	0 ** sets	31 sets	48 sets	140 sets
2. Fixed Camera: for Event Detection	At all ramps (in trial use)	10 * sets	20 sets	0 ** sets	27 sets	12 sets	23 sets
3. Vehicle Detector:	At middle point between a pair of interchanges (in practical use)	14 sets	8 sets	12 sets	10 sets	6 sets	14 sets
4. VMS: for Traffic Information	At 100 m back from the diverge to entrance gate and at 200 m back from the diverge to exit gate (in practical use)	18 sets	16 sets	18** sets	18 sets	14 sets	24 sets
5. CSS: for Speed Limitation	At regular intervals of 5 km (in practical use)	14 sets	9 sets	37 sets	10 sets	17 sets	32 sets
6. ETC: for Toll Collection	At a median-side lane of the tollgate which has lanes more than two (in practical use)	2 sets	--	12** sets	2 sets	2 sets	14 sets
7. Touch&Go/Manual: for Toll Collection	At a roadside lane of all toll gates (in practical use)	8 sets	--	60 sets	8 sets	8 sets	56 sets
8. Axle Load Scale: Overloading Regulation	At a roadside lane of entrance toll gates (in practical use)	2 sets	--	6 ** sets	2 sets	2 sets	7 sets

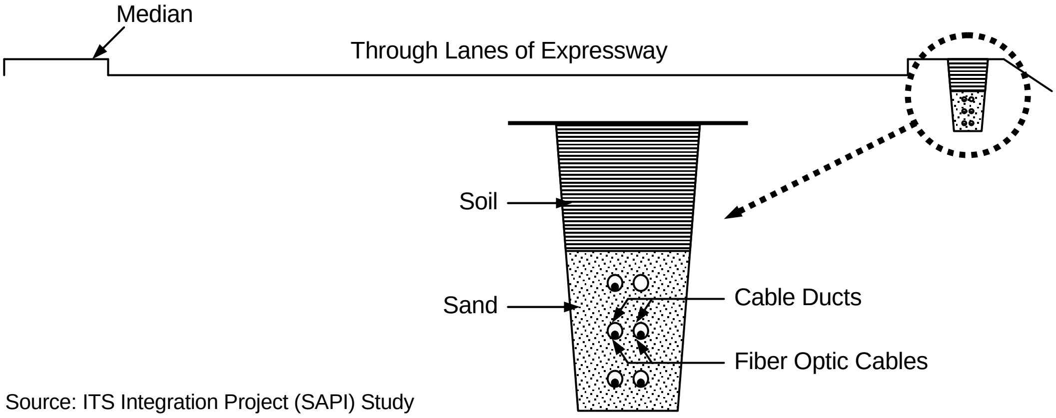
Note, * : Fully equipped with image recognition, ** : Excluding items to be installed by Grant and 1st Stage ITS (designed by Cadpro).

Source: ITS Integration Project (SAPI) Study Team

3) Communication Network

Communication network is to be performed by fiber optic cables installed in the ducts along the expressway network as shown in the figure below.

Figure 8.11 Installation of Communication Network



Source: ITS Integration Project (SAPI) Study

8.4 Estimated Quantities

Estimated quantities of the three cases are shown in the following tables:

- Base case
- Comparison case 1
- Comparison case 2.

Quantity of the project is to be compiled by the equipment components categorized as below.

- Traffic information/control system
- Automated toll collection/management system
- Vehicle Weighing system
- Communication system
- Communication ducts
- Building
- Power Supply.

A quantity table is shown in the following page. In addition, quantity of building of the road management office for Lang Hoa Lac requiring newly construction is shown for reference, which is to be outside the scope of the Project.

Table 8.2 Quantity Table of Base Case

1. Traffic Information/Control

Item No.	Equipment Component	Unit	Q'ty (a)
(2)	**CCTV Monitoring**		
	Roadside		
	CCTV Camera (PTZ type (for Outside))	set	297
	Road Management Office		
	CCTV Center Controller	set	5
	CCTV Monitoring Console	set	5
	Regional Main Center		
	CCTV Center Controller	set	1
	CCTV Monitoring Console	set	1
(3)	**Event Detection (by Image)**		
	Roadside		
	CCTV Camera ((Fix Type) for Image Recognition)	set	92
	Image Recognition Processor	set	3
(4)	**Vehicle Detection**		
	Roadside		
	Loop Coil Vehicle Detector	set	12
	CCTV Camera Data Exchange for Vehicle Detection)	set	64
	Image Recognition Processor	set	64
(5)	**Traffic Analysis**		
	Regional Main Center		
	Traffic Analysis Processor	set	1
	Traffic Data Server	set	1
(6)	**Weather Monitoring**		
	Roadside		
	Rain-Gauge	each	6
	Wind Sensor	each	6
	Visibility Sensor	each	6
	Thermometer	each	6
	Regional Main Center		
	Weather Data Server	set	1
(7)	**Traffic Event Data Management**		
	Road Management Office		
	Traffic Event Data Monitor	set	5
	Traffic Event Data Server	set	5
	Regional Main Center		
	Traffic Event Data Monitor	set	1
	Traffic Event Data Server	set	1
(8)	**Traffic Supervision**		
	Road Management Office		
	Monitor Screen	set	5
	Data Input Terminal	set	5
	Regional Main Center		
	Traffic Supervising/Control Console	set	1
	Traffic Supervising/Control Server	set	1
	Mobile		
	Mobile Data Input Terminal (each Road Management Office x 2)	set	10
(9)	**VMS Indication**		
	Roadside		
	VMS Type-A	set	48
	VMS Type-B	set	48
	VMS Type-C	set	12
	CSS	set	119
	Regional Main Center		
	VMS Center Controller	each	1
(11)	**Traffic Information**		
	Regional Main Center		
	Traffic Information Server	set	1

2. Automated Toll Collection/Management

Item No.	Equipment Component	Unit	Q'ty (a)
(13)	**Lane Monitoring**		
	Roadside		
	CCTV Camera (Fix Type)	set	124
	Toll Booth/Roadside		
	CCTV Monitoring in Booth	set	124
	Toll Management Office		
	CCTV Monitoring Console	set	16
(14)	**Vehicle Identification**		
	Roadside		
	License Plate Scanner	set	124
	Image Recognition Processor	set	124
	Toll Office		
	Lane Server	set	124
(15)	**Lane Control**		
	Roadside		
	Vehicle Detector	set	248
	Entry-Card Issuer	set	59
	Toll Due/Paid Sign	set	124
	Stop/Go Sign	set	124
	Barrier	set	124
	Toll Booth		
	Toll Data Input Device	set	124
(16)	**Road to Vehicle Communication**		
	In-Vehicle		
	OBU	set	5,000
	Roadside		
	Roadside Antenna/Controller	set	32
(17)	**IC-Card Recording**		
	Roadside		
	IC-Card Reader/Writer	set	140
(18)	**Toll Management**		
	Toll Office		
	Toll Manaegment Server	set	16
	Toll Management Center		
	Toll Manaegment Server	set	1
(19)	**OBU Management**		
	OBU Issue Office		
	OBU Registration Terminal	set	16
	OBU Management Center		
	OBU Management Server	set	1
(12)	Integrated Data Management		
	Regional Main Center		
	Integrated Data Management	set	1
	Integrated Data Server	set	1

3. Heavy Truck Control

Item No.	Equipment Component	Unit	Q'ty (a)
(20)	**Axle Load Measurement**		
	Roadside		
	Axle Load Scale	set	19
	Toll Office		
	Heavy Truck Control Data Server	set	17
(21)	**Lane Monitoring for Axle Load Measurement**		
	Roadside		
	CCTV Camera and Control Equipment	set	19
	Toll Office		
	CCTV Monitoring Console	set	17

4. Communication System

Item No.	Equipment Component	Unit	Q'ty (a)
	Communication System (Center/Roadside)		
	Optical Fiber Cables		
	Optical Fiber Cable (Duct Cable) - 42, 28, 24, etc.	km	555
	Regional Main Center		
	L3SW	set	1
	Road Management Office		
	L3SW	set	5
	Terminal Node		
	L2SW	set	18
(1)	**Telephone**		
	Regional Main Center		
	Directive Communication Console	set	1
	Administrative Telephone	set	20
	Road Management Office		
	Directive Telephone and Console	set	48
	Administrative Telephone	set	100
	Toll Office		
	Directive Telephone and Console	set	32
	Administrative Telephone	set	120
(10)	**Mobile Radio Communication**		
	Road Management Office		
	Base Station for Radio Communication	set	21
	Radio Communication Console at Road Management Office	set	6
	Mobile		
	Radio Communication Terminal	set	60

5. Communication Ducts

Item No.	Equipment Component	Unit	Q'ty (a)
	Communiaction Ducts		
	Duct for Earthwork Section	km	184
	Duct for Bridge Attachment	km	31
	Cable Chamber	each	1,503

6. Buildings

Item No.	Equipment Component	Unit	Q'ty (a)
	Buildings		
	Northern Regional Main Center	m2	2160
	Road Management Office for Lang - Hoa Lac	m2	720

7. Electric Power Supply (Back-up)

Item No.	Equipment Component	Unit	Q'ty (a)
	Electric Power Supply (Back-up)		
	Back-up Power Supply Facilities	set	42

Source: ITS Integration Project (SAPI) Study

Table 8.3 Quantity Table of Comparison Case 1

1. Traffic Information/Control

Item No.	Equipment Component	Unit	Q'ty (a)
(2)	**CCTV Monitoring**		
	Roadside		
	CCTV Camera (PTZ type (for Outside))	set	141
	Road Management Office		
	CCTV Center Controller	set	4
	CCTV Monitoring Console	set	4
	Regional Main Center		
	CCTV Center Controller	set	1
	CCTV Monitoring Console	set	1
(3)	**Event Detection (by Image)**		
	Roadside		
	CCTV Camera ((Fix Type) for Image Recognition)	set	69
	Image Recognition Processor	set	3
(4)	**Vehicle Detection**		
	Roadside		
	Loop Coil Vehicle Detector	set	8
	CCTV Camera Data Exchange for Vehicle Detection)	set	38
	Image Recognition Processor	set	38
(5)	**Traffic Analysis**		
	Regional Main Center		
	Traffic Analysis Processor	set	1
	Traffic Data Server	set	1
(6)	**Weather Monitoring**		
	Roadside		
	Rain-Gauge	each	3
	Wind Sensor	each	3
	Visibility Sensor	each	3
	Thermometer	each	3
	Regional Main Center		
	Weather Data Server	set	1
(7)	**Traffic Event Data Management**		
	Road Management Office		
	Traffic Event Data Monitor	set	4
	Traffic Event Data Server	set	4
	Regional Main Center		
	Traffic Event Data Monitor	set	1
	Traffic Event Data Server	set	1
(8)	**Traffic Supervision**		
	Road Management Office		
	Monitor Screen	set	4
	Data Input Terminal	set	4
	Regional Main Center		
	Traffic Supervising/Control Console	set	1
	Traffic Supervising/Control Server	set	1
	Mobile		
	Mobile Data Input Terminal (each Road Management Office x 2)	set	8
(9)	**VMS Indication**		
	Roadside		
	VMS Type-A	set	26
	VMS Type-B	set	28
	VMS Type-C	set	12
	CSS	set	50
	Regional Main Center		
	VMS Center Controller	each	1
(11)	**Traffic Information**		
	Regional Main Center		
	Traffic Information Server	set	1

2. Automated Toll Collection/Management

Item No.	Equipment Component	Unit	Q'ty (a)
(13)	**Lane Monitoring**		
	Roadside		
	CCTV Camera (Fix Type)	set	22
	Toll Booth/Roadside		
	CCTV Monitoring in Booth	set	22
	Toll Management Office		
	CCTV Monitoring Console	set	3
(14)	**Vehicle Identification**		
	Roadside		
	License Plate Scanner	set	22
	Image Recognition Processor	set	22
	Toll Office		
	Lane Server	set	22
(15)	**Lane Control**		
	Roadside		
	Vehicle Detector	set	22
	Entry-Card Issuer	set	11
	Toll Due/Paid Sign	set	22
	Stop/Go Sign	set	22
	Barrier	set	22
	Toll Booth		
	Toll Data Input Device	set	22
(16)	**Road to Vehicle Communication**		
	In-Vehicle		
	OBU	set	5,000
	Roadside		
	Roadside Antenna/Controller	set	6
(17)	**IC-Card Recording**		
	Roadside		
	IC-Card Reader/Writer	set	24
(18)	**Toll Management**		
	Toll Office		
	Toll Manaegment Server	set	3
	Toll Management Center		
	Toll Manaegment Server	set	1
(19)	**OBU Management**		
	OBU Issue Office		
	OBU Registration Terminal	set	3
	OBU Management Center		
	OBU Management Server	set	1
(12)	Integrated Data Management		
	Regional Main Center		
	Integrated Data Management	set	1
	Integrated Data Server	set	1

3. Heavy Truck Control

Item No.	Equipment Component	Unit	Q'ty (a)
(20)	**Axle Load Measurement**		
	Roadside		
	Axle Load Scale	set	6
	Toll Office		
	Heavy Truck Control Data Server	set	3
(21)	**Lane Monitoring for Axle Load Measurement**		
	Roadside		
	CCTV Camera and Control Equipment	set	6
	Toll Office		
	CCTV Monitoring Console	set	3

4. Communication System

Item No.	Equipment Component	Unit	Q'ty (a)
	Communication System (Center/Roadside)		
	Optical Fiber Cables		
	Optical Fiber Cable (Duct Cable) - 42, 28, 24, etc.	km	292
	Regional Main Center		
	L3SW	set	1
	Road Management Office		
	L3SW	set	4
	Terminal Node		
	L2SW	set	13
(1)	**Telephone**		
	Regional Main Center		
	Directive Communication Console	set	1
	Administrative Telephone	set	20
	Road Management Office		
	Directive Telephone and Console	set	32
	Administrative Telephone	set	80
	Toll Office		
	Directive Telephone and Console	set	6
	Administrative Telephone	set	30
(10)	**Mobile Radio Communication**		
	Road Management Office		
	Base Station for Radio Communication	set	11
	Radio Communication Console at Road Management Office	set	4
	Mobile		
	Radio Communication Terminal	set	40

5. Communication Ducts

Item No.	Equipment Component	Unit	Q'ty (a)
	Communiaction Ducts		
	Duct for Earthwork Section	km	95
	Duct for Bridge Attachment	km	22
	Cable Chamber	each	763

6. Buildings

Item No.	Equipment Component	Unit	Q'ty (a)
	Buildings		
	Northern Regional Main Center	m2	2160
	Road Management Office for Lang - Hoa Lac	m2	720

7. Electric Power Supply (Back-up)

Item No.	Equipment Component	Unit	Q'ty (a)
	Electric Power Supply (Back-up)		
	Back-up Power Supply Facilities	set	21

Source: ITS Integration Project (SAPI) Study

Table 8.4 Quantity Table of Comparison Case 2

1. Traffic Information/Control

Item No.	Equipment Component	Unit	Q'ty (a)
(2)	**CCTV Monitoring**		
	Roadside		
	CCTV Camera (PTZ type (for Outside))	set	157
	Road Management Office		
	CCTV Center Controller	set	4
	CCTV Monitoring Console	set	4
	Regional Main Center		
	CCTV Center Controller	set	1
	CCTV Monitoring Console	set	1
(3)	**Event Detection (by Image)**		
	Roadside		
	CCTV Camera ((Fix Type) for Image Recognition)	set	69
	Image Recognition Processor	set	3
(4)	**Vehicle Detection**		
	Roadside		
	Loop Coil Vehicle Detector	set	10
	CCTV Camera Data Exchange for Vehicle Detection)	set	50
	Image Recognition Processor	set	50
(5)	**Traffic Analysis**		
	Regional Main Center		
	Traffic Analysis Processor	set	1
	Traffic Data Server	set	1
(6)	**Weather Monitoring**		
	Roadside		
	Rain-Gauge	each	4
	Wind Sensor	each	4
	Visibility Sensor	each	4
	Thermometer	each	4
	Regional Main Center		
	Weather Data Server	set	1
(7)	**Traffic Event Data Management**		
	Road Management Office		
	Traffic Event Data Monitor	set	4
	Traffic Event Data Server	set	4
	Regional Main Center		
	Traffic Event Data Monitor	set	1
	Traffic Event Data Server	set	1
(8)	**Traffic Supervision**		
	Road Management Office		
	Monitor Screen	set	4
	Data Input Terminal	set	4
	Regional Main Center		
	Traffic Supervising/Control Console	set	1
	Traffic Supervising/Control Server	set	1
	Mobile		
	Mobile Data Input Terminal (each Road Management Office x 2)	set	8
(9)	**VMS Indication**		
	Roadside		
	VMS Type-A	set	36
	VMS Type-B	set	36
	VMS Type-C	set	12
	CSS	set	87
	Regional Main Center		
	VMS Center Controller	each	1
(11)	**Traffic Information**		
	Regional Main Center		
	Traffic Information Server	set	1

2. Automated Toll Collection/Management

Item No.	Equipment Component	Unit	Q'ty (a)
(13)	**Lane Monitoring**		
	Roadside		
	CCTV Camera (Fix Type)	set	94
	Toll Booth/Roadside		
	CCTV Monitoring in Booth	set	94
	Toll Management Office		
	CCTV Monitoring Console	set	10
(14)	**Vehicle Identification**		
	Roadside		
	License Plate Scanner	set	94
	Image Recognition Processor	set	94
	Toll Office		
	Lane Server	set	94
(15)	**Lane Control**		
	Roadside		
	Vehicle Detector	set	188
	Entry-Card Issuer	set	44
	Toll Due/Paid Sign	set	94
	Stop/Go Sign	set	94
	Barrier	set	94
	Toll Booth		
	Toll Data Input Device	set	94
(16)	**Road to Vehicle Communication**		
	In-Vehicle		
	OBU	set	5,000
	Roadside		
	Roadside Antenna/Controller	set	18
(17)	**IC-Card Recording**		
	Roadside		
	IC-Card Reader/Writer	set	84
(18)	**Toll Management**		
	Toll Office		
	Toll Manaegment Server	set	10
	Toll Management Center		
	Toll Manaegment Server	set	1
(19)	**OBU Management**		
	OBU Issue Office		
	OBU Registration Terminal	set	10
	OBU Management Center		
	OBU Management Server	set	1
(12)	Integrated Data Management		
	Regional Main Center		
	Integrated Data Management	set	1
	Integrated Data Server	set	1

3. Heavy Truck Control

Item No.	Equipment Component	Unit	Q'ty (a)
(20)	**Axle Load Measurement**		
	Roadside		
	Axle Load Scale	set	12
	Toll Office		
	Heavy Truck Control Data Server	set	10
(21)	**Lane Monitoring for Axle Load Measurement**		
	Roadside		
	CCTV Camera and Control Equipment	set	12
	Toll Office		
	CCTV Monitoring Console	set	10

4. Communication System

Item No.	Equipment Component	Unit	Q'ty (a)
	Communication System (Center/Roadside)		
	Optical Fiber Cables		
	Optical Fiber Cable (Duct Cable) - 42, 28, 24, etc.	km	340
	Regional Main Center		
	L3SW	set	1
	Road Management Office		
	L3SW	set	4
	Terminal Node		
	L2SW	set	13
(1)	**Telephone**		
	Regional Main Center		
	Directive Communication Console	set	1
	Administrative Telephone	set	20
	Road Management Office		
	Directive Telephone and Console	set	40
	Administrative Telephone	set	80
	Toll Office		
	Directive Telephone and Console	set	20
	Administrative Telephone	set	60
(10)	**Mobile Radio Communication**		
	Road Management Office		
	Base Station for Radio Communication	set	16
	Radio Communication Console at Road Management Office	set	5
	Mobile		
	Radio Communication Terminal	set	50

5. Communication Ducts

Item No.	Equipment Component	Unit	Q'ty (a)
	Communiaction Ducts		
	Duct for Earthwork Section	km	101
	Duct for Bridge Attachment	km	22
	Cable Chamber	each	779

6. Buildings

Item No.	Equipment Component	Unit	Q'ty (a)
	Buildings		
	Northern Regional Main Center	m2	2160
	Road Management Office for Lang - Hoa Lac	m2	720

7. Electric Power Supply (Back-up)

Item No.	Equipment Component	Unit	Q'ty (a)
	Electric Power Supply (Back-up)		
	Back-up Power Supply Facilities	set	31

Source: ITS Integration Project (SAPI) Study

8.5 Estimated Costs

Required cost for the Base Case is estimated as shown in the table below.

Table 8.5 Estimated Cost of Base Case

No.	Category	Foreign Currency (Million JPY)	Local Currency (Billion VND)	Total in JPY (Million JPY)	Total in VND (Billion VND)
1	Traffic Information /Control	1,513	293	2,660	679
2	Automated Toll Collection/Management	884	53	1,090	278
3	Vehicle Weighing	91	26	191	49
4	Communication System	1,166	72	1,447	369
5	Communication Ducts	45	228	938	239
6	Building	0	21	81	21
7	Back-up Power Supply	0	19	74	19
8	Subtotal (1+2+3+4+5+6+7)	3,699	710	6,481	1,654
9	Consulting Service	324	21	407	104
10	Subtotal (8+9)	4,024	731	6,888	1,757
11	Price Escalation	123	200	906	231
12	Physical Contingency	415	93	778	199
13	Subtotal (10+11+12)	4,561	1,025	8,572	2,187
14	Tax (10%, to be paid by LC)	0	219	857	219
15	Grand Total (13+14)	4,561	1,243	9,429	2,406

Exchange Rate (February 2012) 1US$ = JPY 81.68, 1US$ = VND20835

Source: ITS Integration Project (SAPI) Study Team

Required costs for the comparison cases are of estimated as shown in the following tables.

Table 8.6 Estimated Cost of Comparison Case 1

No.	Category	Foreign Currency (Million JPY)	Local Currency (Billion VND)	Total in JPY (Million JPY)	Total in VND (Billion VND)
1	Traffic Information /Control	1,302	188	2,040	520
2	Automated Toll Collection/Management	361	53	567	145
3	Vehicle Weighing	18	7	45	12
4	Communication System	615	42	781	199
5	Communication Ducts	24	122	501	128
6	Building	0	21	81	21
7	Back-up Power Supply	0	9	35	9
8	Subtotal (1+2+3+4+5+6+7)	2,320	442	4,050	1,034
9	Consulting Service	195	14	250	64
10	Subtotal (8+9)	2,516	456	4,300	1,098
11	Price Escalation	77	125	565	144
12	Physical Contingency	259	58	486	124
13	Subtotal (10+11+12)	2,852	639	5,351	1,366
14	Tax (10%, to be paid by LC)	0	137	535	137
15	Grand Total (13+14)	2,852	776	5,886	1,503

Exchange Rate (February 2012) 1US$ = JPY 81.68, 1US$ = VND20835

Source: ITS Integration Project (SAPI) Study Team

Table 8.7 Estimated Cost of Comparison Case 2

No.	Category	Foreign Currency (Million JPY)	Local Currency (Billion VND)	Total in JPY (Million JPY)	Total in VND (Billion VND)
1	Traffic Information /Control	1,430	235	2,315	614
2	Automated Toll Collection/Management	900	59	1,122	298
3	Vehicle Weighing	66	18	134	36
4	Communication System	900	54	1,104	293
5	Communication Ducts	36	131	531	141
6	Building	0	21	77	21
7	Back-up Power Supply	0	14	52	14
8	Subtotal (1+2+3+4+5+6+7)	3,332	532	5,335	1,416
9	Consulting Service	328	18	396	105
10	Subtotal (8+9)	3,660	550	5,731	1,522
11	Price Escalation	160	109	570	151
12	Physical Contingency	381	66	629	167
13	Subtotal (10+11+12)	4,202	725	6,931	1,840
14	Tax (10%, to be paid by LC)	0	184	693	184
15	Grand Total (13+14)	4,202	909	7,624	2,024

Exchange Rate (February 2012) 1US$ = JPY 81.68, 1US$ = VND20835

Source: ITS Integration Project (SAPI) Study Team

8.6 Economic Analysis

ITS to be implemented in the Project is to aid in a part of expressway operation. Its effects are to be provided by using it together with the road structure, accordingly, and are to be included in the effects which are already estimated or will be estimated for the road construction.

Furthermore, it is impossible to estimate most part of the effects of ITS even in the case they can be separated from the effects of road construction. Because, while the effects of ITS are to be brought through the response to traffic accidents or congestions, it is impossible to estimate where or how many traffic accidents or congestions occurs before opening of the expressway.

The economic analysis of the Project is made for the following two effects:

- Estimation of some of individual effects of ITS implementation which are separable from that of road construction and possible to quantification
- Cost reduction effects by system integration compared to without integration.

1) Estimation of Effects of ITS Implementation Separable from Road and Possible to Quantification

The benefit metrics of ITS implementation can be listed with categorization as shown in the following table. Conceptually, the effects of ITS implementation can be quantified using these benefit metrics.

However, most of the benefit metrics of ITS implementation are the values depending on traffic congestion or traffic accident which are included in the benefit metrics of road development. For this reason, most of ITS implementation effects are already estimated as and included in the effects of road development. In most cases, the estimation of the effects of ITS implementation results in the double counting of the effects of road development.

Even though some of ITS implementation effects are separable from that of road development, it is impossible to estimate them without clarifying the features of traffic congestion or traffic accidents or the characteristics of driver’s behaviors responding to disseminated information. In addition, such features or characteristics vary among countries.

However, there are few quantified data which clarifies the features or characteristics of the actual traffic or driving on the expressways in Vietnam. The estimation of the effects of ITS implementation based on such features or characteristics is impossible.

Consequently, in this study, the effects only which is separable from that brought by the road itself and can be clarified by quantitative data are to be estimated as the quantitative effects of ITS implementation.

Table 8.8 Benefit Metrics of ITS Implementation

Category of Benefits	Benefit Metrics
Increase transportation system efficiency and capacity	Traffic flows/Traffic volumes/Number of vehicles
	Lane carrying capacity
	Volume to capacity ratio
	Vehicle hours of delay
	Queue length
	Number of stops
	Incident-related capacity restrictions
	Average vehicle occupancy
	Use of transit and HOV modes
	Inter-modal transfer time
	Infrastructure operating costs
	Vehicle operating costs
Enhance personal mobility	Number of trips taken
	Individual travel time
	Individual travel time variability
	Congestion and incident-related delay
	Travel cost
	Vehicle miles traveled
	Number of accidents
	Number of security incidents
	Exposure to accidents and incidents
Improve safety	Number of incidents/accidents
	Number of injuries
	Number of fatalities
	Time between incident and notification
	Time between notification and response
	Time between response and arrival at scene
	Time between arrival and clearance
	Medical costs
	Property damage
	Insurance costs
Reduce energy consumption and environmental costs	NOx/Sox/CO/VOC emissions
	Liters of fuel consumed
	Vehicle fuel efficiency
Increase economic productivity	Travel time savings
	Operating cost savings
	Administrative and regulatory cost savings
	Manpower savings
	Vehicle maintenance and depreciation

Source: National ITS System Architecture Documents of USA

2) Estimation of Cost Reduction Effect by System Integration

If ITS implementation is carried out without system integration, extremely higher costs will be required as compared to the case of ITS implementation with system integration.

The cost of ITS implementation includes the cost for the Main Center which depends strongly on the condition “with system integration” or “without system integration”. The background of cost difference is based on the following assumption:

- While in case of with system integration, the number of the main center required will be one set for the total distance of expressway of 1,000 km in length,
- In case of without system integration, the function and equipment equivalent to the main center will be required for each of the road management office.

8.7 Effects of ITS Implementation

In this study, the effects related to the following services of ITS implementation are discussed:

- Traffic monitoring
- Traffic accident information dissemination
- Traffic congestion information dissemination
- Weather information dissemination
- Non-stop toll collection
- Vehicle weighing

8.7.1 Traffic Monitoring

1) Traffic Monitoring by CCTV Camera

Traffic monitoring by using CCTV camera allows the road operator to identify and to make prompt action responding to the current situations of traffic accidents, traffic congestion, weather condition and any other conditions which occurs on the expressways.

The identification of the traffic congestion enables the road operator to provide the drivers with the information for avoiding the congestion and to disperse the concentrated traffic evenly over the whole road network. The identification of the weather condition on the road allows the road operator to provide the drivers with the information for avoiding the dangerous driving condition and to reduce the number of traffic accidents.

Especially, the prompt response to the occurrence of traffic accident is effective for reducing the number of fatalities caused by the accident and the monitoring of current situation of the accident allows the road operator to shorten the time required for incident clearance.

The length of the traffic monitoring by CCTV camera can be a quantified indicator for the effects of ITS implementation.

2) Overview of Statistical Data of Traffic Accident

While the statistical data of traffic accident related to expressway in Vietnam are very limited, some of available statistical data of traffic accident in Vietnam are overviewed with some reference data.

The following tables show the road traffic accident rates per 10,000 motorized vehicles and the road traffic accident rates per 10,000 persons during year 2000 to 2010 in Vietnam.

During year 2000 to 2010, while the number of accidents and injuries show a decreased trend, the number of fatalities shows an increased trend with some fluctuation. While the number of motorized vehicles has increased with a high growth rate, the rates per 10,000 motorized vehicles number have decreased for every index of accident, fatalities, and injuries. Especially, the rate of accident and injuries has much decreased. However, the rate of fatalities has relatively less decreased. While the rates of accident and injuries per 10,000 persons have decreased, the rate of fatalities shows a stable level. Generally, it can be observed that while the number of accidents has decreased, the situation of accident has become serious.

Table 8.9 Road Traffic Accident Rates in Vietnam per 10,000 Motorized Vehicles (2000–2010)

Year	Motorized Vehicles	Accident		Fatalities		Injuries	
		Number	Rate (a)	Number	Rate (b)	Number	Rate (c)
2000	6,964,000	22,468	32.3	7,500	10.8	25,400	36.5
2001	8,928,516	25,040	28.0	10,477	11.7	29,188	32.7
2002	10,880,401	27,134	24.9	12,800	11.8	30,999	28.5
2003	12,054,000	19,852	16.5	11,319	9.4	20,400	16.9
2004	14,150,816	16,911	12.0	11,739	8.3	15,142	10.7
2005	16,977,748	14,141	8.3	11,184	6.6	11,760	6.9
2006	19,371,840	14,161	7.3	12,373	6.4	11,097	5.7
2007	22,827,899	13,985	6.1	12,800	5.6	10,266	4.5
2008	26,857,246	12,128	4.5	11,243	4.2	7,771	2.9
2009	29,687,911	11,758	4.0	11,094	3.7	7,559	2.5
2010	34,000,000	14,442	4.2	11,449	3.4	10,633	3.1
（Growth Rate）	17.18%	-4.32%	-18.35%	4.32%	-10.98%	-8.34%	-21.78%

Source: Compiled by ITS Integration Project (SAPI) Study Team based on the data of National Traffic Safety Committee
Number (preliminary) of motorized vehicle in year 2010: Website of "Vietnam Register"
Note: Rate: per 10,000 motorized vehicle number
Growth Rate: Estimated annual average growth rate between year 2000 and year 2010

Table 8.10 Road Traffic Accident Rates in Vietnam per 10,000 Persons (2000 - 2010)

Year	Population (1,000)	Accident		Fatalities		Injuries	
		Number	Rate (a)	Number	Rate (b)	Number	Rate (c)
2000	77,630.9	22,468	2.9	7,500	1.0	25,400	3.3
2001	78,620.5	25,040	3.2	10,477	1.3	29,188	3.7
2002	79,537.7	27,134	3.4	12,800	1.6	30,999	3.9
2003	80,467.4	19,852	2.5	11,319	1.4	20,400	2.5
2004	81,436.4	16,911	2.1	11,739	1.4	15,142	1.9
2005	82,392.1	14,141	1.7	11,184	1.4	11,760	1.4
2006	83,311.2	14,161	1.7	12,373	1.5	11,097	1.3
2007	84,218.5	13,985	1.7	12,800	1.5	10,266	1.2
2008	85,118.7	12,128	1.4	11,243	1.3	7,771	0.9
2009	86,025.0	11,758	1.4	11,094	1.3	7,559	0.9
2010	86,927.7	14,442	1.7	11,449	1.3	10,633	1.2
（Growth Rate）	1.14%	-4.32%	-5.40%	4.32%	3.15%	-8.34%	-9.37%

Source: Compiled by ITS Integration Project (SAPI) Study Team based on the data of National Traffic Safety Committee
Population: Statistical Yearbook of Vietnam, 2010 version
Note: Population in 2010: Preliminary
Rate: per 10,000 persons
Growth Rate: Estimated annual average growth rate between year 2000 and year 2010

The following tables show the traffic accident record between year 2002 and 2005 on the national highway of NH No.3 and NH No.18, respectively. These records show generally decreased trend on number of accidents, fatality and injury, with some fluctuation for NH No.18. In NH No.3, the annual average rates show 2.3 accidents, 1.0 fatalities, and 3.1 injuries per km in length. In NH No.18, the annual average rates show 0.8 accidents, 0.7 fatalities, and 0.5 injuries per km in length.

Table 8.11 Accident Record between 2002 and 2005 on NH No.3 (km 0 to 67)

Section	Year	Number of Accidents			Rate of Accident (per km)		
		Accident	Fatality	Injury	Accident	Fatality	Injury
Whole Section (km 0 – 67)	2002	204	87	243	3.04	1.30	3.63
	2003	161	70	249	2.40	1.04	3.72
	2004	139	63	189	2.07	0.94	2.82
	2005	118	58	155	1.76	0.87	2.31
	Average	156	70	209	2.32	1.04	3.12

Source: The Study on National Road Traffic Safety Master Plan inj Vietnam until 2020,JICA, March 2009

Table 8.12 Accident Record between 2003 and 2005 on NH No.18 (km 0 to 160)

Section	Year	Number of Accidents			Rate of Accident (per km)		
		Accident	Fatality	Injury	Accident	Fatality	Injury
Whole Section (km 0 – 160)	2003	149	130	98	0.93	0.81	0.61
	2004	113	93	77	0.71	0.58	0.48
	2005	117	116	83	0.73	0.73	0.52
	Average	126	113	86	0.79	0.71	0.54

Source: The Study on National Road Traffic Safety Master Plan inj Vietnam until 2020,JICA, March 2009

The following table shows the traffic accident record during 18 months after temporary operation since February 2010 on HCMC – Trung Luong Expressway (40km in length). According to the data, the average traffic accident rate per annum is estimated to be 1.8 per km. It is reported that the accident has much happened during the starting period of operation, then gradually decreased month by month. So that, it is estimated that the recent figures of the accident rate per km has been decreased. (The monthly data of traffic accident has not been available to be obtained.)

Table 8.13 Traffic Accident Record on HCMC – Trung Luong Expressway during 18 Months since February 2010

	Number of Accidents	Fatality
Overturned Vehicles	43	0
Vehicle Encroach, Collide	62	0
Serious Accident with Fatalities	8	21
(Total)	113	21

Source: Traffic Control Center, HCMC - Trung Luong Expressway

Table 8.14 Traffic Accident Rate in Expressway in Japan

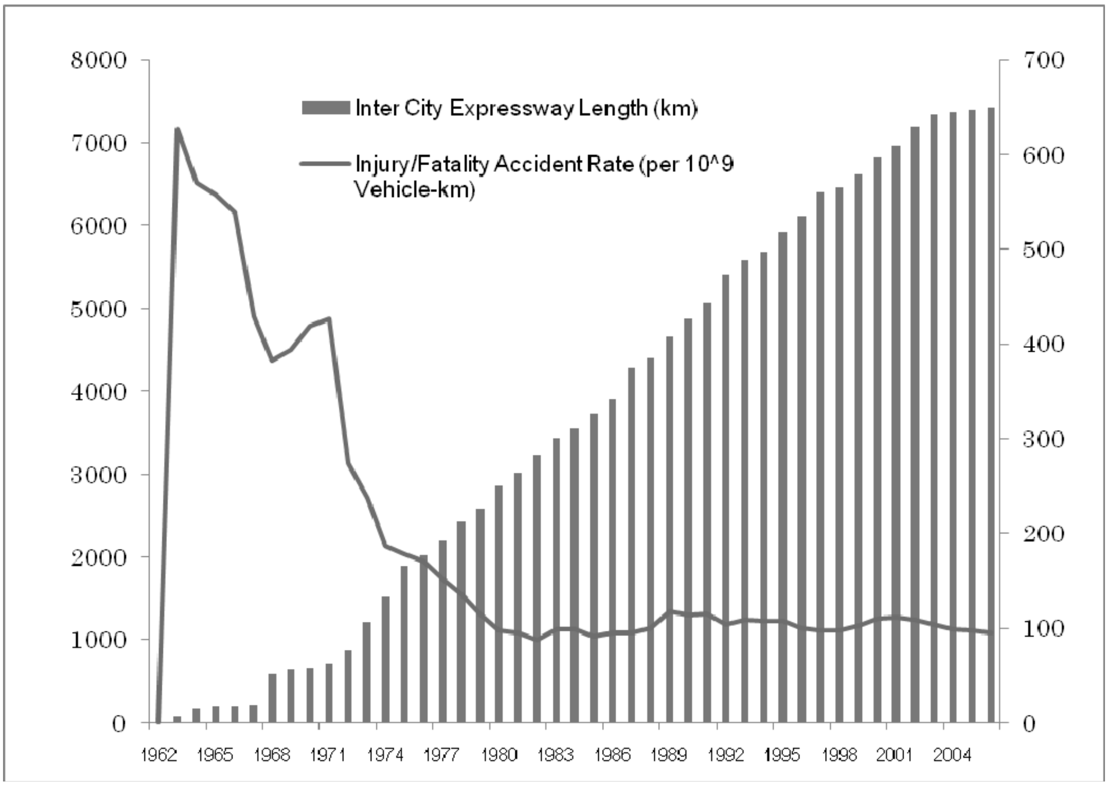
Year	Number of Accidents (Injury/Fatality Accident)	Total Length on Operation (km) of Expressway	Estimated Rate of Accident per km of Expressway Operation Length
1965	301	189.7	1.59
1970	2,671	649.3	4.11
1975	2,271	1,888.3	1.20
1980	2,152	2,859.8	0.75
1985	2,802	3,720.9	0.75
1990	5,541	4,869.4	1.14
1995	6,803	5,929.6	1.15
2000	7,661	6,820.8	1.12
2005	6,797	7,389.1	0.92
2006	6,780	7,421.6	0.91

Source: Compiled by ITS Integration Project (SAPI) Study Team based on Highway Handbook (Japan)

As a reference data, the rate of accident per km (on operation length) in expressway in Japan is referred to the table above: As a general trend, the rate of accident per km in length has been decreased with some fluctuation.

The following figure show the historical data in Japan for the total length of intercity expressway (km) developed and the injury/fatality accident rate per traffic volume (in terms of vehicle-km). (The details of data are shown on the table in Appendix-1.) While as the worst value, the rate of about 600 has recorded in the initial year of operation, as the stable value the rate of about 100 has recorded in recent years. It has revealed that at the early stage of expressway operation high level of traffic accident had occurred. This is considered due to both the poor experience of expressway users (drivers) and the lack of incident management system prepared by road operator. This suggests that the countermeasure for traffic accident should be prepared from the first stage of expressway network development.

Figure 8.12 Historical Data for traffic Accident in Japan



Source: Compiled by ITS Integration Project (SAPI) Study Team based on Highway Handbook (Japan)

The following table shows the cause of traffic accident for the year of 2002, 2004 and 2006 in Vietnam. Most of traffic accidents in Vietnam has been caused by road users errors, among which, “speeding” is the primary cause accounting for about 25%, followed by “wrong lane shifting” accounting for about 18%.

Table 8.15 Traffic Accident Record by Cause (Year 2002, 2004 and 2006)

Causes (Composition: %)	2002	2004	2006
1. Speeding	24.4	26.0	24.8
2. Wrong Overtaking	18.9	15.8	13.7
3. Wrong Lane Shifting	17.0	16.5	18.0
4. Turning Direction without Turning Signal	4.1	2.4	1.7
5. Passing Intersetion with Red Signal	1.1	1.7	0.2
6. Not Keeping Safe Distance	6.9	2.4	0.4
7. Careless driving	15.9	8.1	8.2
8. Careless Crossing of Pedestrians	0.7	2.9	2.6
9. Others	11.0	24.2	30.4
(Total)	100.0	100.0	100.0

Source: Appendix-10: ITS Master Plan, VITRANSS2, JICA, May 2010 (Road and Rail Transport Division, MOPS)

According to another data source (Department of Traffic Safety, Ministry of Transport), the cause of traffic accident in year 2009 is shown in the following table:
In this data, “using wrong lane” is the primary cause, followed by “speeding”.

Table 8.16 Traffic Accident Record by Cause (Year 2009)

Causes (Composition: %)	2009
Using Wrong Lane	40.0
Speeding	24.0
Poor Observation	8.0
Unlawful Overtaking	4.0
Others	24.0
(Total)	100

Source: Department of Traffic Safety, Ministry of Transport

The followings are the information regarding the time taken for ambulance to arrive at scene of accident in Hanoi city and in Japan:

<u>in Hanoi</u>

According to the information obtained at 115 emergency medical dispatch center, shown in the study report of VITRANSS2 (May 2010), regarding the ambulance activity in Hanoi, the average time to arrivals at the point requested is about 10 to 15 minutes after receiving the call. It is noted that the above record is not limited to the case of traffic accident, and the service can reportedly meet only 10% of demand. Recently, the further interview 115 emergency medical dispatch center in Hanoi has revealed that the average time to arrivals at the point requested is in general about 15 minutes after receiving the call.

<u>in Japan</u>

According to the information of Fire and Disaster Management Agency of Ministry of Internal Affairs and Communications, Japan, the average time taken for ambulance to arrive at scene of accident in Japan has ranged about 6 to 8 minutes (not limited to the case of traffic accident) in recent years. (The details of data are shown on the table in Appendix-1.) And, the average time taken for ambulance to travel from scene of accident to hospital has ranged about 21 to 27 minutes in recent years. (The above time has become delayed year by year.)

3) Expected Effect for Road Operator and Road User

According to the investment plan prepared by ITS Integration Project (SAPI) Study Team, the total number of CCTV Camera to be equipped is scheduled by alternative case as shown in the table below.

The range of surveillance per one CCTV Camera (PTZ Camera) can be set-up to be approximately 1.5 km in length in expressway, and then, the possible total length of range (kilometers) of surveillance is estimated for alternative case as shown in the table below.

As a result, when compared between the case “Without CCTV camera” and the case “With CCTV camera”, the difference of the coverage range of surveillance in expressway is obtained.

Then, based on the traffic accident rate which has been shown in Table 8.14, the traffic accident rate per km in length of 1.0 as a recent figure is assumed.

As a result, the estimated number of accidents to be identified by CCTV Camera in expressway is obtained, and the difference of number of accidents to be identified between “Without CCTV Camera case” and “With CCTV Camera case” is considered as effect of CCTV Camera.

Table 8.17 Estimated Number of Accidents in Expressway to be Identified by CCTV Camera (PTZ Camera)

	Without CCTV Camera	With CCTV Camera		
		Base Case	Case 1	Case 2
Total Number of CCTV Camera (PTZ Camera) to be Equipped	Zero	177	71	124
Coverage Length of Surveillance Range by CCTV Camera (km in length)	Zero km	265 km	106 km	186 km
Estimated Number of Accidents to be Identified by CCTV Camera (PTZ Camera) (= Effect by CCTV Camera)	Zero	265	106	186

Source: Estimated by ITS Integration Project (SAPI) Study Team

Note: The objective expressway sections are:
Base Case: Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Viet Tri, Phap Van – Cau Gie and Cau Gie – Ninh Binh
Case 1: Four (4) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh
Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

8.7.2 Traffic Accident Information Dissemination

1) ITS User Service of Incident Information Dissemination

The contents of ITS user services of incident information dissemination are as follows:

- To enable reduction of time between notification and response regarding traffic incident, broken-down vehicles, left obstacles in the expressway and adjacent arterial roads. Then, to support prompt response against traffic incidents by road operator.
- To support detour selection for road users en route and/or in advance in order to avoid the influence of accidents.
- To enable making easy to identify the road conditions/characteristics of accident prone spots (accident black spot) by road operator.

2) Expected Effect for Road Operator and Road User

The followings are expected effects:

- Effect of improvement in the degree of injured persons by traffic accidents through prompt emergency response by road operator against incidents
- Effect of reduction in travel time for road users by proper route selection
- Effect of making easy of execution of countermeasure of road operator against future incidents

(1) Effect of improvement in the degree of injured persons by traffic accidents through prompt emergency response of road operator against incidents

(a) First of all, the reduction of time between notification and response for traffic incidents can be obtained. (Refer to the sub-section mentioned later.)

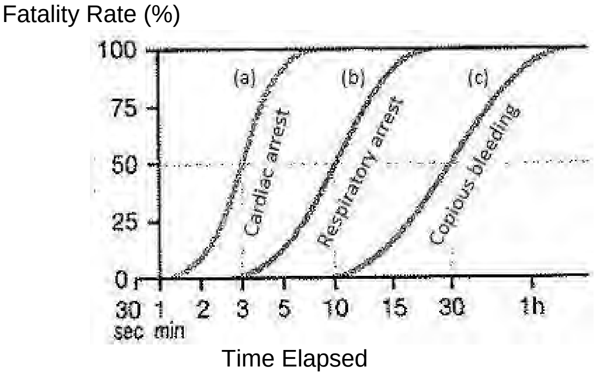
(b) That is, this enable to shorten the required time taken for emergency vehicles (ambulance, police car, tow truck, etc.) to arrive at scene of incidents.
(The reduction of required time for emergency services can be also obtained through mitigation of traffic congestion by detour selection of some portion of traffic of non-emergency vehicles avoiding the scene of accidents.)

(c) Consequently, the prompt response by road operator enables to shorten the total required time taken for “occurrence – detection – notification - arrival of emergency vehicles”.

(d) As a result, the improvement in the degree of injured situations of persons by traffic accidents (for example, reduction of fatalities and serious injuries) can be expected due to shortening the time taken for ambulance to arrive at scene of accident. (Refer to the sub-section mentioned later.)

(e) Regarding the relationship between the degree of injured situation and the required time taken for ambulance to arrive at the scene of accident, the curve of golden hour principle is referred to the following figure:

Figure 8.13 Golden Hour Principle



Legend: (a) A fatality rate of 50% 3 minutes after cardiac arrest
(b) A fatality rate of 50% 10 minutes after respiratory arrest
(c) A fatality rate of 50% 30 minutes after copious bleeding

This figure stands for conceptual idea which has been obtained based on medical survey of experiential results regarding the fatalities by external injury. The medical survey has revealed that the timing of medical care against injury has influenced to the lifesaving, that is, medical operation within one hour for injury has much influenced to improvement in possibility of lifesaving. Consequently, the time band within one hour after injury is called as “golden hour”. For the case of traffic accident in expressway, the curve of “copious bleeding” is to be objective.

(f) Estimation of reduction of time between notification and response

The reduction of time between notification and response for traffic accident by comparison between “With ITS” and “Without ITS” is estimated.

Basic assumptions are:

While in case of “With ITS” emergency vehicles such as patrol car, tow truck, police car, ambulance are stationed in road management office, in case of “Without ITS” emergency vehicle except ambulance are stationed. The background of this assumption is as follows: In case of “With ITS” the traffic information including traffic accident is well aggregated and organized on road management office through computerized information system based on advanced equipments for information gathering. Especially, for prompt checking of severity of accident, CCTV camera will be utilized. The activity of ambulance is functionally realized only with the information of severity of accident. It is assumed that in case of “Without ITS” checking of severity of accident is made by patrol car, then after checking and informing to road management office, ambulance will be dispatched from station outside of expressway after identifying the location of scene.

The average distance of interval of road management office is assumed 80km, and the average speed of emergency vehicles is 80 km/h. The average distance of interval of interchange is 15 km.

The calculation of required time is shown in the following table:

As a result, the time difference between “With ITS” (estimated 30 minutes) and “Without ITS” (estimated 65 - 80 minutes) is expected to be approximately 35 - 50 minutes per one dispatching of ambulance. Then, this time reduction is assumed to be resulted in the reduction of time from notification to medical care, assuming that other conditions are similar.

Table 8.18 Estimation of Time Difference between Notification and Response for Traffic Accident between “With ITS and “Without ITS”

	With ITS	Without ITS
Accident Notification	To Road Management Office	To Road Management Office
Response	Yes	No
Checking Severity of Accident by CCTV Camera		
Dispatching Emergency Vehicles	Dispatching Simultaneously including Ambulance: Average Distance from Office to Scene: 37.5 km Vehicle Speed: 80 km/h Required Time: 30 min (Estimated Total Time: 30 min.)	Dispatching Patrol Car for Checking Severity of Accident: Average Distance from Office to Scene: 37.5 km Vehicle Speed: 80 km/h Required Time: 30 min. Dispatching Ambulance from Outside Expressway: Ambulance Station to Nearest Expressway On-Ramp: Assumed Time 45 min. (including required time for identifying location of scene) (30 min. for the case of urban expressway such as Ring Road No.3) Assumed Average Distance from On-Ramp to Scene: 7.5 km Vehicle Speed: 80 km/h Required Time: 5 min. (Estimated Total Time: 65 – 80 min.)

Source: Estimated by ITS Integration Project (SAPI) Study Team

(g) Effect for Reduction of Fatality Rate in Traffic Accident

When referring the curve (copious bleeding) of golden hour principal previously mentioned (Refer to Figure 8.13), the time difference from notification to medical care in traffic accident between “With ITS” and “Without ITS” can be considered to result in the reduction by approximately 50% of fatality rate.

(h) Estimation of number of accidents

Based on the rate of accident which has been shown in the graph of the historical data for traffic accident of expressway in Japan (Refer to Figure 8.12), the following two cases of injury/fatality accident rate per 10^9 vehicle-km are applied for:

- Rate of 600 accidents per 10^9 vehicle-km (as worst rate)
- Rate of 100 accidents per 10^9 vehicle-km (as stable rate)

Base on the above assumptions and the estimated traffic demand, the number of traffic accidents in expressway on the basis of operation length km in each case is estimated. The estimation results are shown in the following table.

(i) Estimation of number of fatality for “Without ITS” and “With ITS”

Based on the estimated number of accident, the number of fatality for “Without ITS” and “With ITS” are estimated.

According to the statistical data of traffic accident in Vietnam in Table 8.9, the recent trend of the estimated ratio of fatality to accident has ranged between 0.6 to 0.9 for 11 years and

the average ratio of fatality to accident is assumed to be approximately 0.7. Based on the assumed ratio, the number of fatality is estimated as that for “Without ITS”.
As mentioned previously, the fatality rate in the case of “With ITS” can be expected to be decreased by approximately 50% compared to “Without Case”. As a result, the number of fatality in “With ITS” is estimated. The estimation results are shown in the following table.

The difference of estimated number of traffic accidents in expressway between in case (a) (= rate of 100 traffic accident) and in case (b) (= rate of 600 traffic accident) in the following table has suggested that the combination of several countermeasures for the following fields will be useful and necessary in order to reduce number of traffic accidents in expressway:

- Promotion of traffic safety education for vehicle drivers with proper enforcement
- Development/improvement of expressway infrastructure itself
- Development/improvement of operation and management system including ITS implementation

Table 8.19 Estimated Difference between “With ITS” and “Without ITS” on Number of Fatalities in Accidents on Expressway

Case	Year	In Case of Assumed Rate of Number of Accidents per 10^9 Vehicle-km = 100 (a)				In Case of Assumed Rate of Number of Accidents per 10^9 Vehicle-km = 600 (b)			
		Estimated Number of Accidents on Expressway (per Year)	Estimated Number of Fatalities in Accidents on Expressway (per Year)			Estimated Number of Accidents on Expressway (per Year)	Estimated Number of Fatalities in Accidents on Expressway (per Year)		
			Without ITS	With ITS	Red. per km		Without ITS	With ITS	Red. per km
Base Case (268 km)	2015	235	165	82	0.31	1,409	986	493	1.84
	2020	359	251	126	0.47	2.154	1,508	754	2.81
Case 1 (108 km)	2015	109	76	43	0.31	653	457	229	2.11
	2020	138	97	48	0.45	830	581	291	2.69
Case 2 (188 km)	2015	214	150	75	0.40	1,285	900	450	2.39
	2020	320	230	115	0.62	1,919	1,343	672	3.57

Source: Estimated by ITS Integration Project (SAPI) Study Team
Note: i) The number of traffic accidents is estimated on the basis of operation length km of expressway.
ii) The objective expressway sections are:
Base Case: Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Viet Tri, Phap Van – Cau Gie and Cau Gie – Ninh Binh
Case 1: Four (4) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh
Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

(2) Effect of reduction in travel time for road users by proper route selection

By disseminating proper traffic information including incident information for road users en route and/or in advance, the proper selection of routes and on/off ramp, and the avoidance of spot of accidents can be ensured for road users, resulting in reduction in travel time for road users. By supporting detour selection, reducing the size and possible occurrence of bottlenecks associated with the incidents and secondary accidents can be ensured to be mitigated.
(As mentioned above, it is expected that the reduction of required time for emergency

services can be also ensured through the mitigation of traffic congestion by detour selection of some portion of traffic of non-emergency vehicles avoiding the scene of accidents.)

(3) Effect of making easy of execution of countermeasure of road operator against future incidents

It is expected that the road conditions/characteristics of accident prone spots (accident black spot) can be well identified for road operator, thereby the countermeasure (for example, improvement of road alignment and pavement) in order to avoid recurrence of accidents can be facilitated.

8.7.3 Traffic Congestion Information Dissemination

1) Current Situation of Traffic Congestion Information Dissemination

Currently, one of the services of information dissemination of traffic condition on road is radio broadcasting program of “VOV Traffic” by VOV (Radio the Voice of Vietnam). (This radio broadcasting service is made for major cities area in nationwide.) The traffic condition information in metropolitan area is disseminated for Hanoi area over 20 hours per day (from 5:30 to 2:00). The main content of VOV Traffic is traffic information and guidance to drivers. Also the live broadcasting of traffic information and guidance is on rush hour from Monday to Friday.

At present, 100 cameras in important traffic spots (intersection) in Hanoi center area are installed by VOV.

And another live service to public is the internet service disseminating the live monitor of traffic condition of the major intersection (66 intersections in list shown in website) in Hanoi center area.

2) ITS User Service of Traffic Congestion Information Dissemination

The content of ITS user service is traffic congestion information dissemination for road user en route and/or in advance. For information collection/identification of traffic congestion condition in expressway, also CCTV camera as well as vehicle detector is planned to be utilized.

3) Expected Effect for Road Operator and Road User

(1) Effect of reduction in travel time for road users by proper route selection

By disseminating proper traffic information including traffic congestion information for road users en route and/or in advance, the proper selection of routes and on/off ramp, and the avoidance of spot of accidents can be ensured for road users, resulting in reduction in travel time for road users. By supporting detour selection, reduction of the secondary traffic congestion can be ensured.

(2) Effect of making easy of execution of countermeasure of road operator against traffic congestion

It is expected that the road conditions/characteristics of traffic congestion prone spots can be identified for road operator, thereby the countermeasure (for example, improvement of road alignment and pavement) in order to avoid congestion can be facilitated.

8.7.4 Weather Information Dissemination

1) Current Situation of Weather Observation/Forecasting System

In this section, the current condition of weather observation / forecasting system in Vietnam is overviewed base on the information of Appendix-10: ITS Master Plan, VITRANSS2, JICA, May 2010.

National Hydro-Meteorological Service (NHMS) directly under Ministry of Natural Resources and Environment (MONRE) is in charge of weather observation / forecasting system. Regarding main weather observation stations, the northern region has one station per 138 square-km. (International standard for observation station: one station for each 50 square-km.) In general, weather condition is observed every 6 hours and transmitted to NHMS. NHMS is responsible for disseminating weather forecast. Weather forecasting information is disseminated via national and local radio, television, daily newspaper, and internet.

2) ITS User Service of Weather Information Dissemination

The content of ITS user services is weather information dissemination for road user en route and/or in advance. This service includes weather information of rain fall (heavy rain fall), fog/mist, temperature, etc. For information collection/identification of weather condition in expressway, also CCTV camera as well as weather sensors is planned to be utilized.

3) Expected Effect for Road Operator and Road User

(1) Effect of ensuring of safety vehicle driving

The ITS implementation for the service of dissemination of weather information is expected to facilitate safety vehicle driving for road users in expressway considering the weather condition.

(2) Effect of making easy of execution of countermeasure of road operator in accordance with weather condition

It is expected that the countermeasure by road operator (for example, speed limitation, guidance of detour and careful driving for driver, etc.) can be facilitated against the worse driving environment.

(3) Effect of facilitation of reduction of traffic accident and traffic congestion

In line with the above countermeasures prepared by road operator, the traffic accident and traffic congestion can be reduced.

8.7.5 Non-Stop Toll Collection (ETC)

1) ITS User Service of Non-Stop Toll Collection

The contents of ITS user service of non-stop toll collection (ETC: Electric Toll Collection) enable toll collection without stopping vehicles at tollgate.

2) Expected Effect for Road Operator and Road User

(1) Effect of reduction of passing time at tollgates

The service of ETC enables to reduce the traffic congestion around the tollgates due to deceleration, stop for toll payment, and acceleration of vehicles. Consequently, vehicle passing time is expected to be reduced. Then, the service enables to solve long queue at the tollgate and allow smooth incoming and outgoing at the interchange.

The calculation of the effect is made for “Without ETC” condition and “With ETC” condition and the differences between them are obtained as quantified benefits. The basic assumptions are the similar to that for estimating reduction of CO2 emission.

The results are summarized in the following table: The effect by introducing ETC is shown in terms of the reduced rate at approximately 40% in “With ETC” compared to “Without ETC”.

Table 8.20 Summary of Effect of Reduction of Passing Time at Tollgates for Operation Length in km in Each Case (hours/day)

Case	Year	Vehicle Passing Time (Hour in each case)		
		Without ETC	With ETC	Reduction
Base Case	2015	3,494	2,102	1,392 (40%)
	2020	5.344	3,215	2,129 (40%)
Case 1	2015	1,786	1,075	711 (40%)
	2020	2,271	1,367	905 (40%)
Case 2	2015	3,028	1,822	1,206 (40%)
	2020	4,523	2,721	1,802 (40%)

Source: Estimated by ITS Integration Project (SAPI) Study Team

Note: i) The objective expressway sections are:

Base Case: Seven (7) Sections of Hanoi Ring Road No.3 (Mai Dich – Thanh Tri), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Lao Cai (Package 1 - 3), Phap Van – Cau Gie and Cau Gie – Ninh Binh

Case 1: Four (4) Sections of Hanoi Ring Road No.3 (Mai Dich – Thanh Tri), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh

Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

ii) (%) in the column of reduction stands for the reduced rate compared to “Without ETC”.

(2) Effect of reduction of number of tollbooths

The service of ETC enables to reduce the number of tollbooths and solve the difficulties of land acquisition for the tollgates

(3) Effect of efficient toll management

The computerized toll management system enables to realize rational toll collection system resulting in reduction of uncollected toll revenues due to deviation in counting/classifying vehicles, and appropriate sharing of toll revenues among different road operators

(4) Effect of environmental improvement of reduction of CO2 emission from vehicles around the tollgates

The service of ETC enables to reduce the traffic congestion around the tollgates due to deceleration, stop for toll payment, and acceleration of vehicles. Consequently, the emission of gas such as CO2 is expected to be mitigated.

The calculation of effect of mitigation of CO2 is made between “Without ETC” condition and “With ETC” condition, and the differences between both are obtained as quantified benefits.

(a) The assumptions for calculation are as follows:

- i) The calculation is using the formula by Institute of Japan Civil Engineering Associations.
- ii) The traffic volumes used are the number of vehicle per km in terms of estimated weighted average related to the objective expressway sections set for each calculation case, and then extended to the operation length km in each case.
- iii) In case of With ETC, the average speed is assumed as:
  - 80 km/hour at through lane
  - 60 km/hour at speed deceleration/acceleration lane
  - 40km/hour at toll bay

  In case of Without ETC, the average speed is assumed as:
  - 80 km/hour at through lane
  - 45 km/hour at speed deceleration/acceleration lane
  - 10km/hour at toll bay

  The total length for speed deceleration, stop for toll payment and acceleration is assumed to be 280m including 128m of speed deceleration and acceleration lane respectively and 24m of toll bay.
- iv) The average length of tollgate interval is assumed to be 15km.

Table 8.21 Summary of Effect of CO2 Emission Reduction for Operation Length in km in Each Case (Unit : ton-CO2 per day)

Case	Year	CO2 Emission (ton-CO2 per day)		
		Without ETC	With ETC	Reduction
Base Case	2015	2,832	2,824	8.3 (0.3%)
	2020	4,197	4,184	12.3 (0.3%)
Case 1	2015	1,271	1,267	3.8 (0.3%)
	2020	1,572	1,567	4.8 (0.3%)
Case 2	2015	2,686	2,678	7.8 (0.3%)
	2020	3,912	3,901	11.4 (0.3%)

Source: Estimated by ITS Integration Project (SAPI) Study Team

Note: i) The calculation formula is based on that of Institute of Japan Civil Engineering Associations:

(Formula of CO2 Emission Rate: Unit: g-CO2 per vehicle.km)

For passenger car: $1864.3/v - 2.3201v + 0.0020070v^2 + 166.85$

For Bus: $2784.6/v - 12.752v + 0.1590v^2 + 854.18$

For Truck: $50.285/v - 27.312v + 0.20875v^2 + 1592.7$

ii) The objective expressway sections are:

Base Case: Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Viet Tri, Phap Van – Cau Gie and Cau Gie – Ninh Binh

Case 1: Four (4) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh

Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

iii) (%) in the column of reduction stands for the reduced rate compared to “Without ETC”.

(b) The estimation results are summarized in the foregoing table: The effect of CO2 reduction by introduction ETC is shown in terms of the reduced rate of approximately 0.3% in "With ETC" compared to "Without ETC". The details of estimation including traffic data used are shown in the table in Appendix-1.

(5) Effect of reduction of fuel consumption of vehicles

The service of ETC enables to reduce the traffic congestion around the tollgates due to deceleration, stop for toll payment, and acceleration of vehicles. Consequently, fuel consumption is expected to be reduced.

The calculation of effect of fuel consumption reduction is made between "Without ETC" condition and "With ETC" condition for the several cases, and the differences between both are obtained as quantified benefits.

The basic assumptions are the similar to the case of CO2 emission.

The estimation results are summarized in the following table: The effect of fuel consumption reduction by introduction ETC is shown in terms of the reduced rate of approximately 0.3% in "With ETC" compared to "Without ETC". The details of estimation including traffic data used are shown in the table in Appendix-1.

Table 8.22 Summary of Effect of Fuel Consumption Reduction for Operation Length in km in Each Case (Unit: Kilo Litter per day)

Case	Year	Fuel Consumption (Kilo Liter per day)		
		Without ETC	With ETC	Reduction
Base Case	2015	1,001	998	3.1 (0.3%)
	2020	1,487	1,482	4.6 (0.3%)
Case 1	2015	452	450	1.4 (0.3%)
	2020	560	558	1.8 (0.3%)
Case 2	2015	947	944	2.9 (0.3%)
	2020	1,381	1377	4.2 (0.3%)

Source: Estimated by ITS Integration Project (SAPI) Study Team

Note: i) The calculation formula is based on that of Institute of Japan Civil Engineering Associations:

(Formula of Fuel Consumption rate: Unit : cc per vehicle.km)

For passenger car: $802.8/v - 1.0v + 0.0084v^2 + 70.0$

For Bus: $976.9/v - 4.5v\ 0.037v^2 + 299.7$

For Truck: $17.7/v - 9.6v + 0.073v^2 + 558.7$

ii) The objective expressway sections are:

Base Case: Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Viet Tri, Phap Van – Cau Gie and Cau Gie – Ninh Binh

Case 1: Four (4) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh

Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

iii) (%) in the column of reduction stands for the reduced rate compared to "Without ETC".

8.7.6 Vehicle Weighing

1) Current Situation of Overloading Regulation

In 1993, 27 vehicle weigh stations on national highway (among them, 8 stations located in northern region) had been established in order to inspect the weight of truck. It is reported that the rate of vehicle overloading on roads had decreased from 19.13% in 1995 to 0.17% in 2003. However, due to the reasons of technical limitation, long-time required for inspection, etc., these facilities had caused problem of traffic congestion. As a result, in 2003, MOT had decided to suspend the operation of weigh stations, and to make research for modernization of equipment, process innovation and organizational consolidation of weigh station. In 2009, 2010, two pilot stations has been established in national highway NH No.1 (Dau Giay, Dong Nai Province), and NH No.18 (Quang Ninh Province). The pilot operation has revealed that pilot project has achieved the target of both technology and regulation coordination. The result of monitoring at Dau Giay station showed that the rate of vehicles overloading violation decreased from 23.35% (2009) to 19.17% (2010). (based on the information of website managed by Hanoi People’s Committee)

2) ITS User Service of Vehicle Weighing

The content of ITS service is automatic vehicle weighing at interchange in order to control overloading of heavy truck.

3) Expected Effect for Road Operator and Road User

(1) Reduction of damage of road structure

Through the control of overloaded truck, the damage of road structure can be mitigated resulting in the longer duration years of roads and saving in reconstruction or rehabilitation cost.

(2) Reduction of damage of road surface

Through the control of overloaded truck, the damage of road surface (for example, rut or wheel track) can be mitigated resulting in ensuring of the safety vehicle driving and saving in surface overlay cost.

(3) Reduction of traffic accident due to overloaded truck

Through the control of overloaded truck, the traffic accident and traffic congestion due to overloaded truck can be reduced.

8.8 Cost Reduction Effect by System Integration

According to the engineering study results, the cost of ITS implementation will be different regarding the cost related to the main center between "with system integration" and "without system integration". The background of cost difference is based on the following assumption:

- While in case of with system integration, the number of the main center required will be one set for the total distance of expressway of 1,000 km in length,
- In case of without system integration, the function and equipment equivalent to the main center will be required for each of the road management office.

The required cost factor related to the function and equipment of the main center is estimated as follows:

- In case of with system integration, the cost factor is equivalent to be one (one set of the main center).
- In case of without system integration, the cost factor is estimated to be equivalent to 12.5 (= 1,000km / 80km), assuming the average distance of interval of road management office of 80km in length.

Then, the difference of cost factor between "with system integration" and "without system integration" is estimated to be 11.5 (= 12.5 minus 1.0). According to the cost estimates study results, the cost of one set of the main center is estimated to be million 1,505 Yen. As a result, the effect of cost reduction by system integration is estimated as approximately million 10,300 Yen (= million 1,505 Yen times 11.5).

8.9 Financial Analysis

ITS to be implemented in the Project is to aid in a part of expressway operation and implementation cost of the Regional Main Center is to be shared not only among the road sections included in the Project but also among the other road sections. In addition, all cost of ITS is covered by the toll revenue together with the other cost of expressway.

It is impossible to make a financial evaluation only for ITS implementation in the Project, but the evaluation needs to be performed together with the financial evaluation on the road construction of the whole expressway sections under the Center at the same time.

In this study, the road construction costs for the target road network are estimated. And, financial analysis is made on the basis of estimation of cost ratio in terms of cost per unit of road length between the cost of ITS implementation and the cost of road development itself. Then, financial reasonability for the investment of ITS implementation is examined.

8.10 Cost Comparison between ITS Implementation and Road Construction

1) Estimated Cost of ITS Implementation

The estimated cost for ITS implementation and the cost per kilometer in distance for alternative case are shown as follows:

Table 8.23 Estimated Cost for ITS Implementation

	Estimated ITS Implementation Cost (Million Yen)	Distance km	Estimated ITS Implementation Cost per Kilometer (Million Yen)
Base Case	9,429	268	35.2
Case 1	5,886	108	54.5
Case 2	7,624	188	40.6

Source: Estimated by ITS Integration Project (SAPI) Study Team
Note: The objective expressway sections are:
Base Case: Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Viet Tri, Phap Van – Cau Gie and Cau Gie – Ninh Binh
Case 1: Four (4) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh
Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

2) Estimated Cost of Road Construction

The road construction cost are estimated through adjustment based on the obtained cost data from study report or interview at project offices, and applying price adjustment about exchange rate and price escalation in accordance with the year of cost estimates or the cost disbursement years.

Table 8.24 Estimated Cost of Road Construction by Objective Expressway

Expressway	Estimated Cost Adjusted Yen Basis (Million Yen at Year 2011 Price)	Total Length (km)	Adjusted Cost per km (Million Yen per km)
Mai Dich to Thanh Tri (Ring Road 3)	86,944	27	3,220
Lang - Hoa Lac	38,630	28	1,380
Hanoi – Bac Ninh	11,634	20	582
Noi Bai – Bac Ninh	14,970	33	454
Noi Bai – Viet Tri	48,943	80	612
Phap Van – Cau Gie	19,896	30	663
Cau Gie – Ninh Binh	36,742	50	735

Source: Estimated by ITS Integration Project (SAPI) Study Team
Note: Adjustment based on the obtained cost data from study report or interview at project offices, and applying price adjustment about exchange rate and price escalation in accordance with the year of cost estimates or the cost disbursement years

Based on the estimated cost data shown in the above table, the weighted average road construction cost per kilometer for each alternative case are estimated as follows:

Table 8.25 Estimated Weighted Average Road Construction Cost per Kilometer for Each Alternative Case

	Estimated Road construction Cost (Adjusted Yen Basis Million Yen at Year 2011 Price)	Distance Km	Estimated Weighted Average Road Construction Cost per Kilometer (Million Yen)
Base Case	257,759	268	962
Case 1	152,178	108	1,409
Case 2	208,816	188	1,111

Source: Estimated by ITS Integration Project (SAPI) Study Team
Note: The objective expressway sections are:
Base Case: Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Viet Tri, Phap Van – Cau Gie and Cau Gie – Ninh Binh
Case 1: Four (4) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh
Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

3) Cost Ratio of ITS Implementation to Road Construction

The following table shows the cost ratio of ITS implementation to the road construction. The estimated ratio for each alternative case fell within the range of 3% to 4%. These ratios are considered not so high as a level of percentage of investment amount compared to the road construction cost. Then, it can be said that the level of estimated ITS implementation costs for all cases is considered financially reasonable.

Table 8.26 Cost Ratio of ITS Implementation to Road Construction for Each Alternative Case

	Estimated ITS Implementation Cost per Kilometer (Million Yen) (a)	Estimated Weighted Average Road Construction Cost per Kilometer (Million Yen) (b)	Estimated Ratio (a) / (b)
Base Case	35.2	962	3.66%
Case 1	54.5	1,409	3.87%
Case 2	40.6	1,111	3.65%

Source: Estimated by ITS Integration Project (SAPI) Study Team
Note: The objective expressway sections are:
Base Case: Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Viet Tri, Phap Van – Cau Gie and Cau Gie – Ninh Binh
Case 1: Four (4) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh
Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

8.11 Study Results

<u>Observation on Quantified Indicators:</u>

The quantified ITS implementation effects and the cost ratio of ITS implementation to road construction for the alternative cases are shown using the indicators -1 to -5 in the table. The followings can be observed:

- Regarding Indicator-1: estimated number of accidents to be identified by CCTV Camera, the Base Case with the largest scope of integration shows the highest value. This indicator represents that ITS implementation covering larger operation length of expressway network provides larger effect in identifying the occurrences of traffic accidents.

Table 8.27 Quantified Effect by Alternative Case

	Without ITS	With ITS		
		Base Case	Case 1	Case 2
Operation Length km	Zero	268	108	188
Indicator-1: Estimated Number of Accidents to be Identified by CCTV Camera for Operation Length in km	Zero	265	106	186
Indicator-2: Estimated Reduction of Fatalities in Accidents on Expressway for Unit Length in the Case Assumed Rate of Number of Accidents per 10^9 Vehicle-km = 600 (Unit : fatalities/year/km)				
(Number of Fatalities in Base Case in 2015)	986	493		
(Number of Fatalities in Base Case in 2020)	1,508	754		
(Number of Fatalities in Case 1 in 2015)	457		229	
(Number of Fatalities in Case 1 in 2020)	581		291	
(Number of Fatalities in Case 2 in 2015)	900			450
(Number of Fatalities in Case 2 in 2020)	1,343			672
Reduction per Unit Length in Year 2015	--	1.84	2.11	2.39
Reduction per Unit Length in Year 2020	--	2.81	2.69	3.57
Indicator-3: Effect of Reduction of Passing Time at Tollgates for Operation Length in km (Unit : hours/day)				
(Base Case in 2015)	3,494	2,102		
(Base Case in 2020)	5.344	3,215		
(Case 1 in 2015)	1,786		1,075	
(Case 1 in 2020)	2,271		1,367	
(Case 2 in 2015)	3,028			1,822
(Case 2 in 2020)	4,523			2,721
Reduction in Year 2015	--	1,392	711	1,206
Reduction in Year 2020	--	2,129	905	1,802
Indicator-4: Effect of CO2 Emission Reduction for Operation Length in km (Unit : ton-CO2 per day)				
(Base Case in 2015)	2,832	2,824		
(Base Case in 2020)	4,197	4,184		
(Case 1 in 2015)	1,271		1,267	
(Case 1 in 2020)	1,572		1,567	
(Case 2 in 2015)	2,686			2,678
(Case 2 in 2020)	3,912			3,901
Reduction in Year 2015	--	8.3	3.8	7.8
Reduction in Year 2020	--	12.3	4.8	11.4
Indicator-5: Effect of Fuel Consumption Reduction for Operation Length in km (Unit : Kilo Litter per day)				
(Base Case in 2015)	1,001	998		
(Base Case in 2020)	1,487	1,482		
(Case 1 in 2015)	452		450	
(Case 1 in 2020)	560		558	
(Case 2 in 2015)	947			944
(Case 2 in 2020)	1,381			1377
Reduction in Year 2015	--	3.1	1.4	2.9
Reduction in Year 2020	--	4.6	1.8	4.2
Indicator-6: Cost Ratio of ITS Implementation to Road Construction	--	3.66%	3.87%	3.65%

Source: Estimated by ITS Integration Project (SAPI) Study Team

Note: The effects in terms of "per original distance km" have been estimated by multiplying the effects per one km by the total distance km in each case.

The objective expressway sections are:

Base Case: Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Noi Bai – Viet Tri, Phap Van – Cau Gie and Cau Gie – Ninh Binh

Case 1: Four (4) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, and Noi Bai – Bac Ninh

Case 2: Six (6) Sections of Above Case 1 plus Phap Van – Cau Gie and Cau Gie – Ninh Binh

- Regarding Indicator-2: The estimated reduction of fatalities for the unit length showed the highest value in the Case 2 and fell within the range of 1.8 to 3.6 fatalities/year/km depending on the average traffic volume for each road network of alternative case.
- Regarding indicators -3 to -5: The estimated effect of reduction of passing time at tollgates, effect of CO2 emission reduction, and effect of fuel consumption reduction showed the highest value in the Base Case with the largest scope of integration.
- Regarding Indicator-6: The estimated cost ratio of ITS implementation to the road construction each alternative case fell within the range of 3.5% to 4.0%. These ratios are considered not so high as a level of the investment amount in ITS compared with the road construction cost and can be determined financially reasonable.

Cost Reduction Effect by System Integration:

The effect of cost reduction by system integration is estimated as approximately million 10,300 Yen for the total distance of expressway of 1,000 km in length, which is equivalent to the difference in implementation cost of the Main Center between the cases “with system integration” and “without system integration”.

At the present stage in Vietnam where expressway usage has been just begun, ITS implementation is premised on stepwise approach responding to user’s needs or budgetary constraints. It is critically important to involve as many expressway section as possible in early stage in order to ensure the achievement of cost reduction effect by system integration.

Additionally, it should be noted that most part of the effects by system integration is provided by center software based on the technology of traffic event data management: the mainstay of traffic information/control and by ETC based on prepaid IC-card. These technologies are highly advanced through actual application to traffic information/control over the expressway network more than 5,000 km in Japan and include the equipment components for traffic analysis, traffic event data management, traffic supervision, VMS indication, traffic information, integrated data management, lane control, road to vehicle communication, OBU management and toll data management.

8.12 Conclusion

Typical effects of the ITS introduction are shown by the indicators foregoing from economic and financial aspects. It has been examined that the Base Case and the Case 2 with larger scopes of integration show higher values of effects. Additionally to the results, it is requested to exclude the Noi Bai – Viet Tri section from the Project Scope by the Official Letter 400/VEC-DA from VEC to JICA. Considering these conditions, it is concluded that the Case 2 is to be the Project Scope.

Project Scope (Case 2)	• Mai Dich–Thanh Tri (Ring Road 3) • Lang–Hoa Lac • Phap Van–Cau Gie • Cau Gie–Ninh Binh • Ha Noi–Bac Ninh • Noi Bai–Bac Ninh

8.13 Target to be Set-up for Post-evaluation

The following targets are set-up for the post-evaluation which is to be conducted by the implementation organization: VEC in 2018: after two (2) years from the completion of th Project.

(1) Time taken for froviding traffic information to road users:

- Base : Approx. 30 to 40 minutes in 2012 (by updated information in radio broadcasting)
- Target : Approx. 5 minutes in 2018 (using VMS)

Note: Objective of expressway sections (in Case 2) are:
Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Hanoi – Bac Ninh, Noi Bai – Bac Ninh, Phap Van – Cau Gie and Cau Gie – Ninh Binh.

(2) Time taken for dispatching emergency vehicle onto the through lanes of expressway:

- Base : Approx. 30 minutes in 2012
- Target : Approx. 5 minutes in 2018 (using ITS).

Note: Number of fatalities in accidents is determined by vehicle kiometers, driver's/vehicle's performance, notification/response time, etc. ; however, the vehicle kilometres is depending on the effects of road construction and the traffic demand but not relating to the effects of ITS. The driver's/vehicle's performance is depending on the drivers and the management of vehicles. Consequently, only the notification/response time is related to effects of ITS, which includs the time taken for dispatching emergency vehicle. The notification/response time is to be reduced no long after the ITS introduction and will be approximately constant.

- Number of fatal accidents ←Vehicle kilometers, driver's/vehicle's performance, notification/response time, etc.
- Vehicle kilometers ←Constructed road network, traffic demand, etc.
- Notification/response time ←Effects of ITS, etc.

(3) Time taken for passing through 24 m length of tollgate lane including the tollgate:

- Base : Approx. 14 seconds in 2012
- Target : Approx. 3 seconds in 2018 (using ETC).

Note: Passing time at tollgates in total is determined by traffic volume at tollgates and deceleration/ acceleration around tollgates; however, the traffic volume at tollgates is depending on the effects of road construction, the traffic demand and the toll amount but not relating to the effects of ITS. Consequently, only the passing speed around tollgates is related to effects of ETC. The tendency of passing speed around tollgates is to be changed no long after the ETC introduction and will be approximately constant. The same relations are on CO_2 emission and fuel consumption as well.

- Passing time at tollgates in total ←Traffic volume at tollgates, deceleration/acceleration around tollgates, etc.
- CO_2 emission ←Traffic volume at tollgates, deceleration/acceleration around tollgates, etc.
- Fuel Consumption ←Traffic volume at tollgates, deceleration/acceleration around tollgates, etc.
- Traffic volume at tollgates ←Constructed road network, traffic demand, toll amount, etc.
- Passing speed around tollgates ← Effects of ETC, etc.

9. Location of Northern Regional Main Center

9.1 General

Expressway network in Vietnam being constructed by sections funded by different donors, it has become an important issue how operate such sectioned road network and ITS in integrated form. Striving toward the development of the ITS Standards in Vietnam, the Project aims to unify the ITS implementation levels covering the whole road network including a number of expressway sections, to verify/establish a procedure for integrating systems, to build up the Northern Regional Main Center, to initiate expressway operation/ maintenance (O&M) using ITS and to show the way to utilize ITS for solving traffic problems in the metropolitan areas.

9.2 Criteria for Selection of Candidate Site of Northern Regional Main Center

Candidates of the location of the Northern Regional Main Center are to be evaluated, as the prerequisite for discussing the communication network for ITS and the cooperation among relevant organizations, focusing on the following criteria:

(1) Landuse suitable on surroundings and easiness of land acquisition: total required area 3,000 m^2 includes 800 m^2 for building, 1,500 m^2 for car park and passage way and 700 m^2 for green area

(2) Connectivity to optical fiber cable network installed along the expressways

(3) Easiness on commutes for staffs and accessibility to other organizations

(4) Security against natural disaster and stableness on power supply

(5) Pollution related impacts.

9.3 Analysis of Candidate Site of the Northern Regional Main Center

1) Twelve Candidate Sites for the Northern Regional Main Center

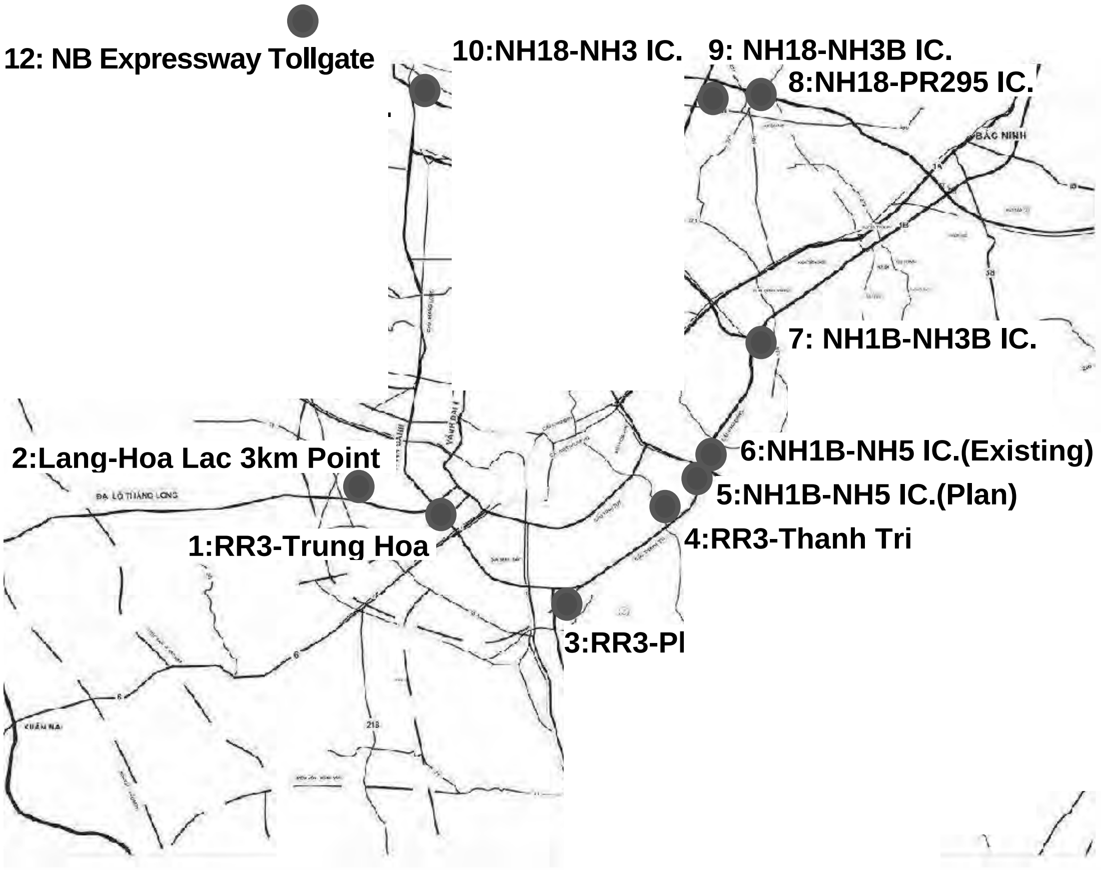
Following twelve (12) candidate sites have been selected according to the foresaid criteria.

Basically all of twelve (12) candidate sites have consistency with broader plans and programs or already constructed/under way of road construction projects.

Most of security against natural disaster or power failure such as folding and blackout problems is free or manageable issues. Most of selected sites area regarding an accessibility of optical fiber cable for ITS installed along the expressways, it is advantageous location for the Northern Regional Main Center within interchange/junction areas or nearby these areas. For easiness on commutes for staffs of the center and accessibility for related organization, most of candidate sites are located either within Hanoi city area or metropolitan area and rather easy access from the major trunk roads. Regarding Easiness of land acquisition of site (or building) for the center, most of them are within the road right of way or some adjacent area of which require land acquisition.

For space requirement of the Regional Main Center is totally 3,000 m^2 of which 800 m^2 for building lot area, 1,500 m^2 for car parking/passage area and 700 m^2 for green area; however, when road maintenance/management related facility site is in associated with the Regional Main Center, space for the green area is to be much reduce the area. The following figure shows location map of candidate sites for the Northern Regional Main Center.

Figure 9.1 Location Map of Candidate Sites for Northern Regional Main Center



Source: ITS Integration Project (SAPI) Study Team

2) Flood risk area of the Hanoi city

In rainy season, some parts of Hanoi city area usually flooded by heavy rainfalls. Typical trend of the ground elevation in Hanoi city is in the inclination in the south-West direction. Following map illustrates satellite-detected water over the flood-affected in Hanoi city area, Red River Delta Region. Probable flood waters were detected with DMC multispectral data acquired on 9 November 2008 at a spatial resolution of 32m. The proposed location of the Northern regional main Center should locate flood free area due to avoid critical situation for operating ITS and constantly stable and safety in condition. According flood risk map of figure below, all of twelve candidate sites are located flood free area.

Figure 9.2 Flood Risk Area of Hanoi City

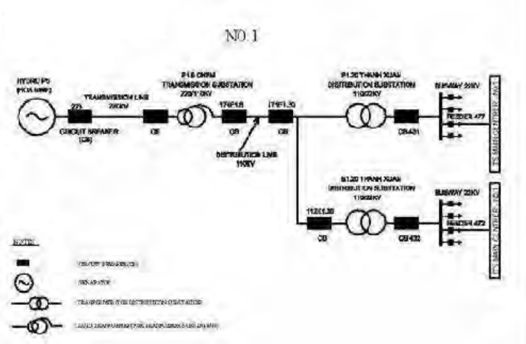
Source: ITS Integration Project (SAPI) Study Team

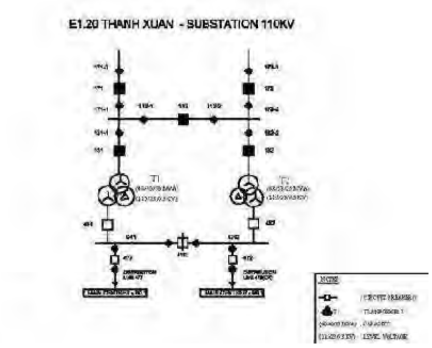
3) Power Supply Distribution to Candidate Sites

According to the power supply distribution system in Hanoi city and Bac NInh province, twelve candidate sites are confirmed by the power company and power distribution system for each twelve candidate sites area shown in the following tble.

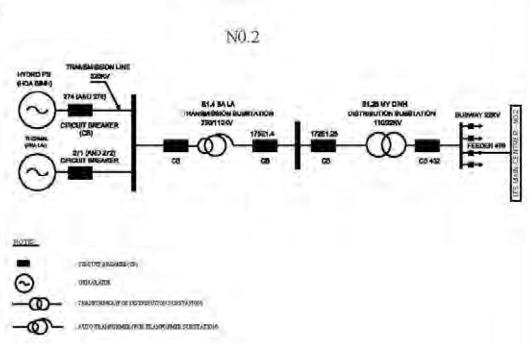
Table 9.1 Candidate Sites and Power Distribution System

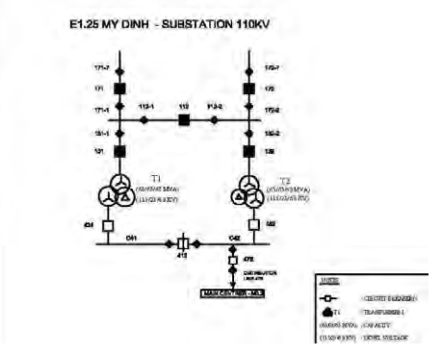
Candidate site 1: RR3–Trung Hoa



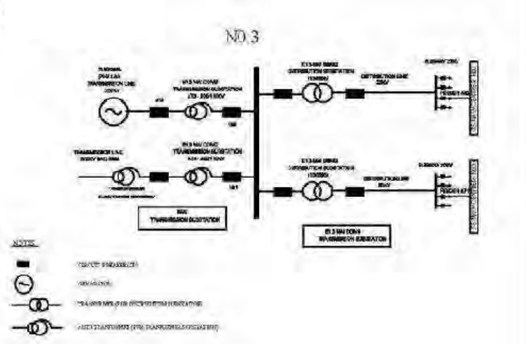


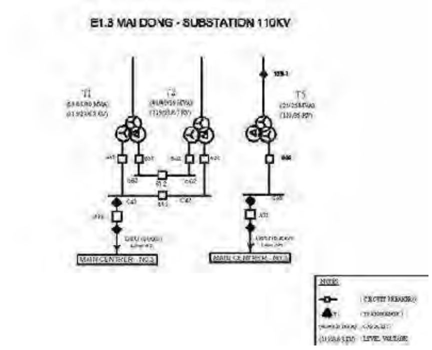
Candidate site 2: Lang–Hoa Lac 3km Point



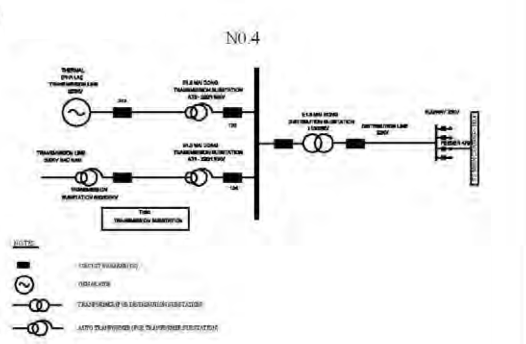


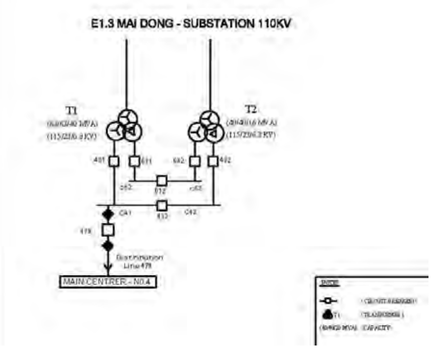
Candidate site 3: RR3–Phap Van IC



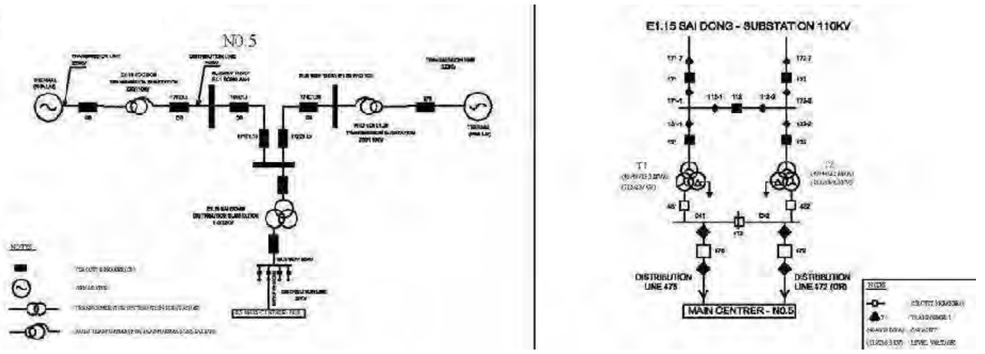


Candidate site 4: RR3 – Thanh Tri

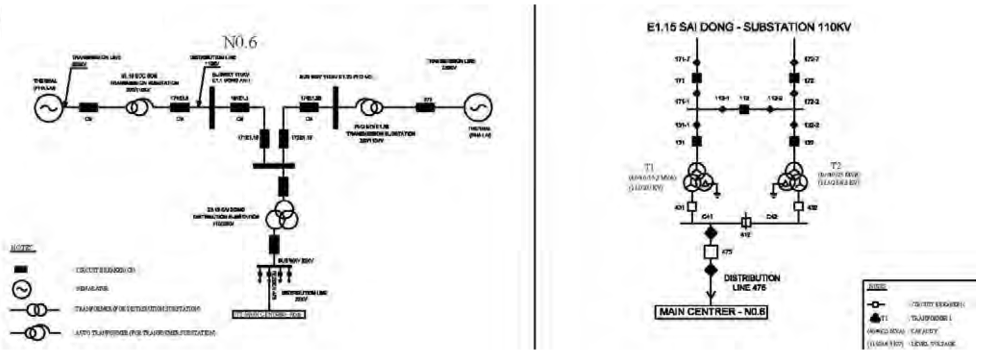




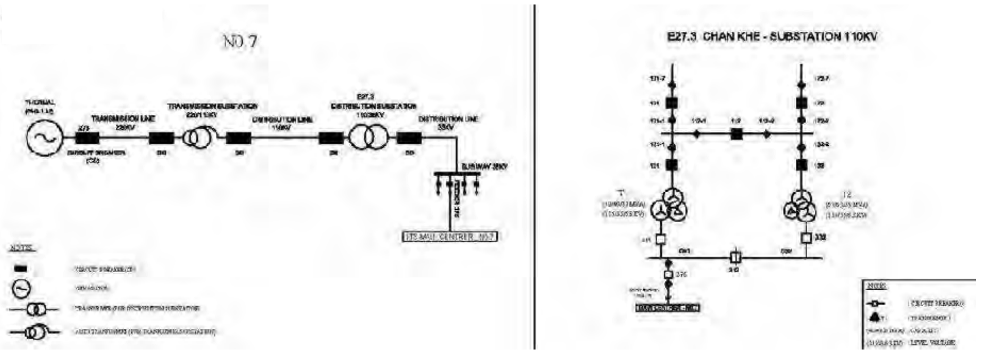
Candidate site 5: NH1B–NH5 IC. (Plan)



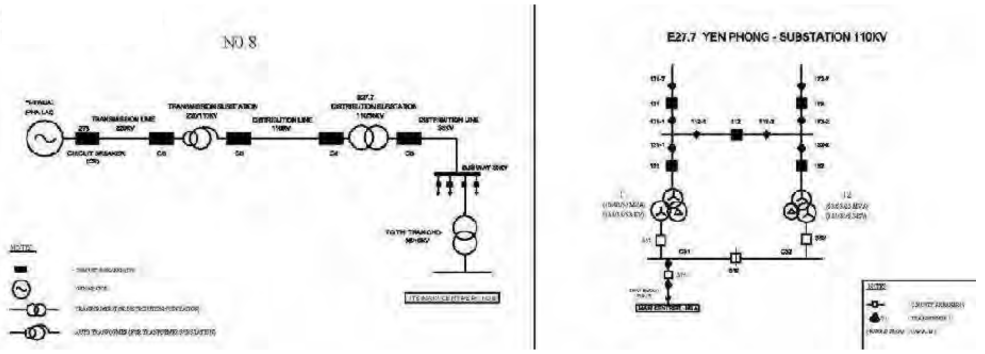
Candidate site 6: NH1B–NH5 IC. (Existing)



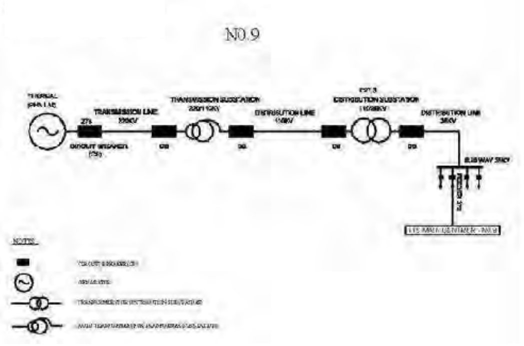
Candidate site 7: NH1B–NH3B IC

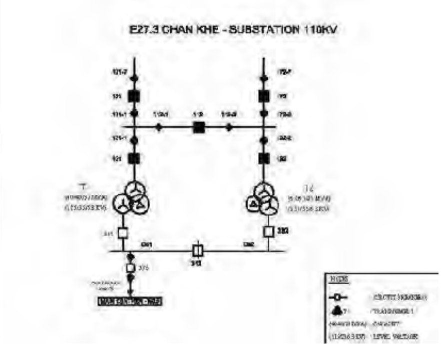


Candidate site 8: NH18–PR295 IC

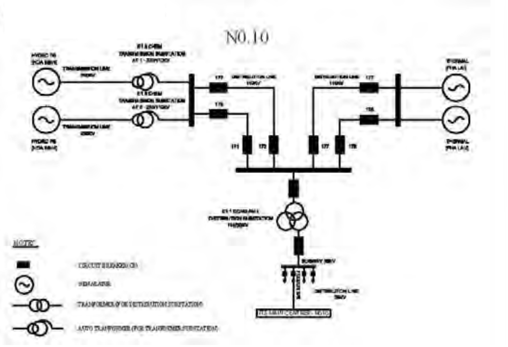


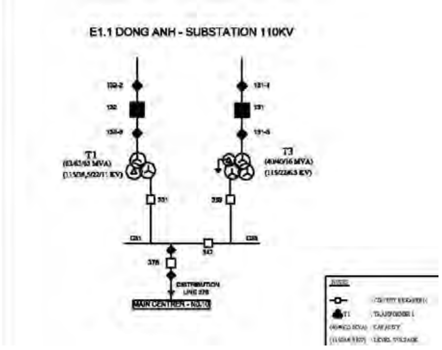
Candidate site 9: NH18–NH3B IC



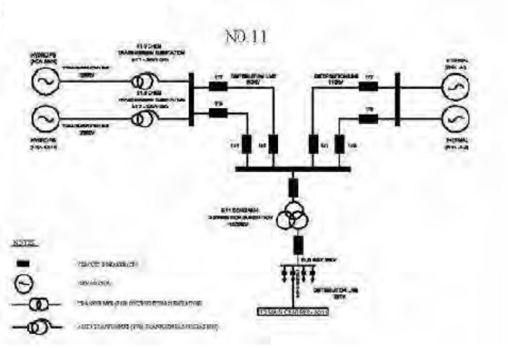


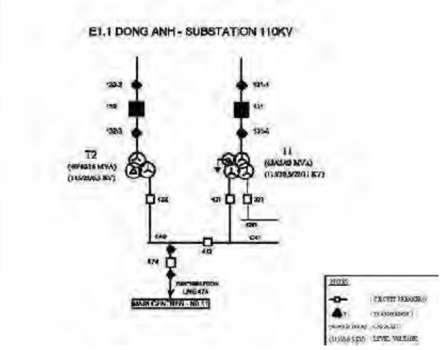
Candidate site 10: NH18–NH3 IC



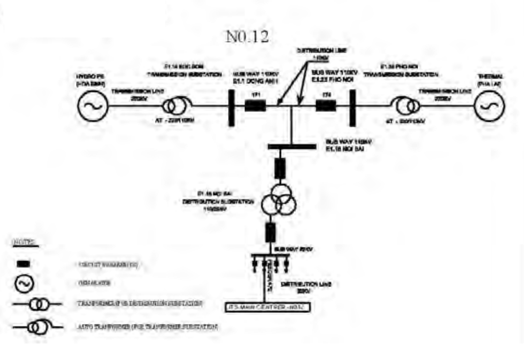


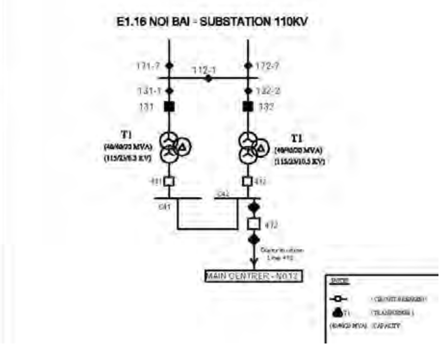
Candidate site 11: Thang Long–NH18 IC





Candidate site 12: Noi Bai Expressway Tollgate





Source: ITS Integration Project (SAPI) Study Team

4) VPN (Virtual Private Network) service connection in case of emergency

The network link with the Northern Regional Main Center to each of road management offices in the expressway sections should be secured by redundancy network. However if an emergency case is happened like cable line is damaged and communication between the Northern Regional Main Center and other each of the road management offices suffered. The alternative solution to connect local network provider for secure this ITS network must always be considered.

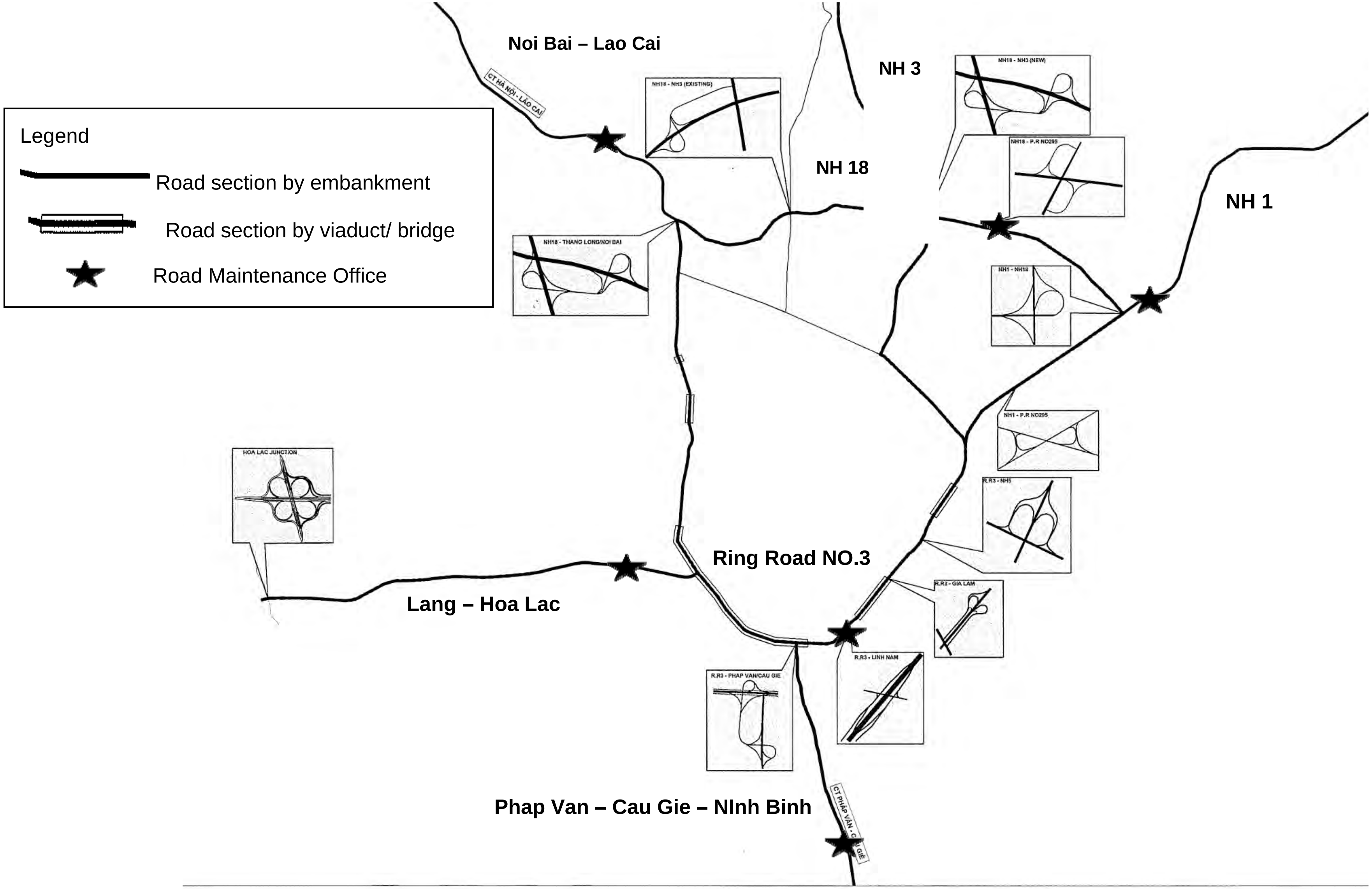
VPN operated by local network provider can be supported for the network linkage by the contract basis. The cost for VPN service per month is depended on Network data traffic capacity and numbers of station as the Northern Regional main Center and six (6) road management offices in showing the following figure. The unit cost of one (station or location) is shown in the table below.

Table 9.2 Cost of VPN Connection Service by Local Network Provider

Network data traffic capacity	Unit cost / Month /location (VND)	Location (the Main Center and road management office)	Contract base cost /Month
100Mbps	31,000,000	7	217,000,000
1Gbps	147,000,000	7	1,029,000,000

Source: ITS Integration Project (SAPI) Study Team

Figure 9.3 Outline of Road Network Map



Source: ITS Integration Project (SAPI) Study Team

9.4 Screening and Comparison on Candidate Sites for the Northern Regional Main Center

The following table shows comparison analysis for twelve (12) candidate sites with satellite photos.

Table 9.3 Screening and Comparison on Conditions around Candidate Sites

Candidate site 1: RR3–Trung Hoa 	**Land use and land property:** Institutional and commercial. The proposed Northern regional Main Center site may be at vacant area in South and East side, land acquisition is required, very few inhabitants may settle. **Socioeconomic condition:** Large commercial activities at nearest shopping center, mostly new town business activity oriented. **Accessibility:** Very good. The site faces Ring Road 3 and not far from the Hanoi central area. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Hanoi City Power Coorporation and confirmed distribution network. **Natural condition:** Along the Ring Road 3 the surrounding area is furnished with landscaping. It is flood free area **Pollution:** There is not expected seriously.
Candidate site 2: Lang–Hoa Lac 3km Point 	**Land use and land property:** Surrounding area of the proposed site is residential and agricultural land use. The proposed site is enclosed by the through lanes and a frontage road of Lang – Hoa Lac Expressway, which is owned and managemed by HPC. **Socioeconomic condition:** New residential area with new town business activity and some other commercial activities. **Accessibility:** Very good. The site faces the frontage road and not far from the Hanoi central area. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Hanoi City Power Coorporation and confirmed distribution network. **Natural condition:** The area in eastward is facing a flood affecting area, the site itself in flood free area. **Pollution:** There is not expected seriously.
Candidate site 3: RR3–Phap Van IC. 	**Land use and land property:** Residential and lake with recreational park area. The proposed site is enclosed by the interchange access circuit. The area has been handed over to HPC recently and a Car Parking Company is in management. The area has been embanked and utilized temporally concrete fabrication yard for construction in some portion. **Socioeconomic condition:** New residential area with some commercial activities and recreational activities. **Accessibility:** Good. But, the site requires modification on the access road. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Hanoi City Power Coorporation and confirmed distribution network. **Natural condition:** It is flood free area and East side is lake where will be the water front park area with rich natural environment. **Pollution:** There is not expected seriously.

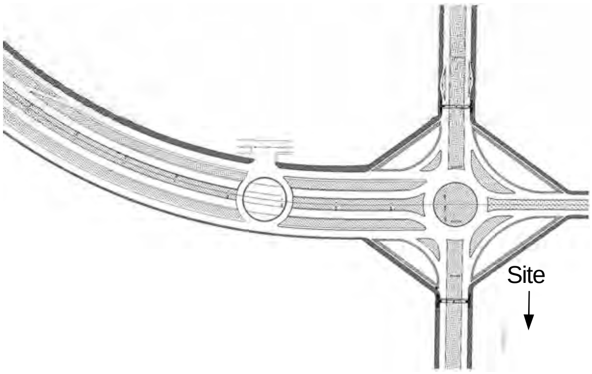
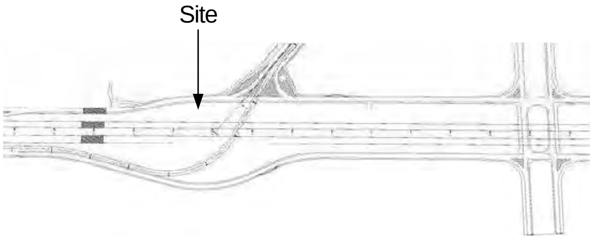
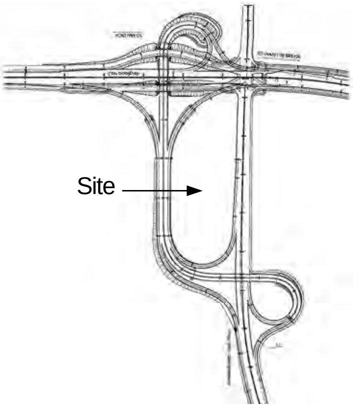
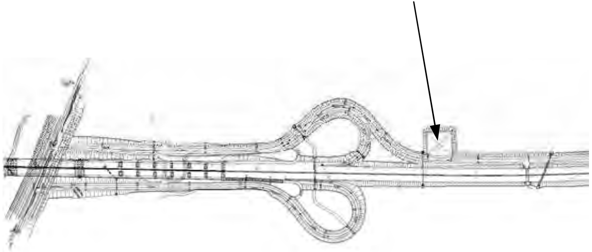
Candidate site 4: RR3 – Thanh Tri 	**Land use and land property:** Surrounding area of the proposed site is agricultural land use. The proposed site is in the vicinity of the Thanh Tri Bridge across the Red River and is the land for a building with narrow parking space managemend by PMU-TL. **Socioeconomic condition:** Surrounding area is basically agricultural land use with rural residential activity **Accessibility:** Very good. The site faces Ring Road 3 and not far from the Hanoi central area. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Hanoi City Power Coorporation and confirmed distribution network. **Natural condition:** The area in eastward is facing a flood affecting area, the site itself in flood free area. **Pollution:** There is no pollution expected.
Candidate site 5: NH1B–NH5 IC. (Plan)  	**Land use and land property:** Mainly agricultural land use. The proposed site has 2 areas enclosed by the interchange access circuits, which will be owned by PMU-TL temporarily for interchange construction. **Socioeconomic condition:** Surrounding area is basically agricultural land use, commercial business activities are only along NH5 and the interchange. **Accessibility:** Fair. The site is not far from the Hanoi central area, but requires modification on the access road. Traffic on NH5 is congested allways. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Hanoi City Power Coorporation and confirmed distribution network. **Natural condition:** The area in eastward is facing a flood affecting area, the site itself in flood free area. **Pollution:** There is not serious pollution affected. Noise level along NH5 is a little concentrated but not serious to the site.
Candidate site 6: NH1B–NH5 IC. (Existing)  	**Land use and land property:** Green area for landscaping. The proposed site is scenic green area enclosed by the interchange access circuits, which is has been handed over to HPC. **Socioeconomic condition:** Surrounding area is basically agricultural land use, commercial business activities are only along NH5 and the interchange **Accessibility:** Very good. The site faces NH5 and not far from the Hanoi central area, but traffic on NH5 is congested allways. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Hanoi City Power Coorporation and confirmed distribution network. **Natural condition:** The area in eastward is facing a flood affecting area, the site itself in flood free area. **Pollution:** There is not serious pollution affected. Noise level along NH5 is a little concentrated but not serious to the site.

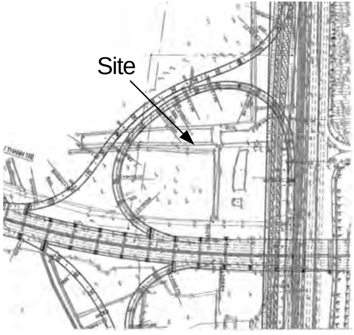
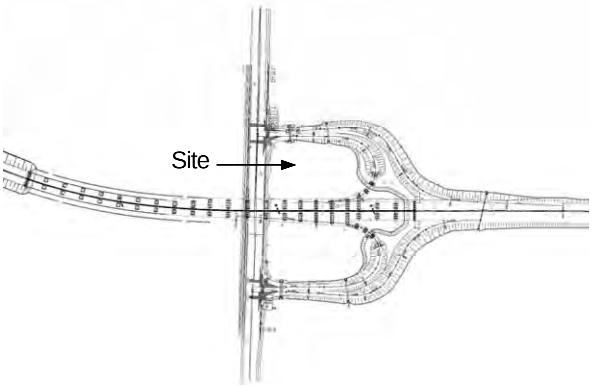
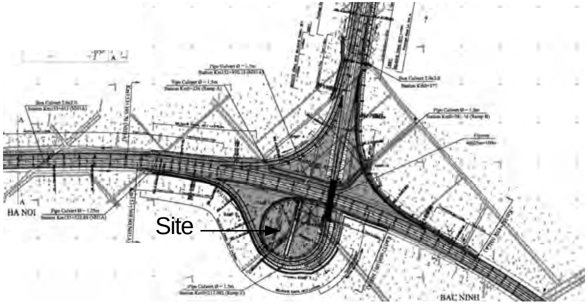
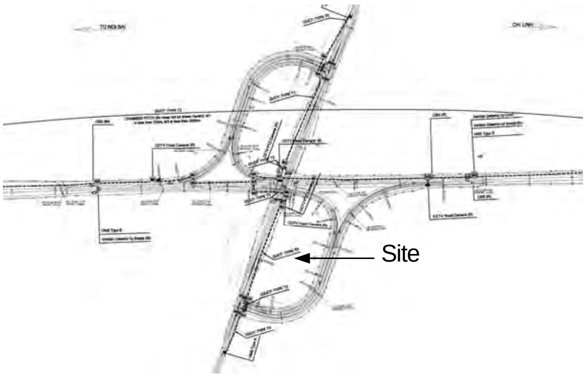
Candidate site 7: NH1B–NH3B IC. 	**Land use and land property:** The proposed area is agricultural use and ponds. Almost there is no residential area existed in surrounding. The proposed site will be within round shaped interchange access circuit. The proposed site will be owned by PNU-2 temporarily for interchange construction and land filling will be required for the facility area. **Socioeconomic condition:** It is an isolated agricultural area and interchange function for traffic only. **Accessibility:** Fair. The site needs safe traffic control for access and has no bus service tor the access from Hanoi to the site. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Power Company Bac Ninh and confirmed distribution network. **Natural condition:** It is flood free and wide spread plane area. **Pollution:** There is no pollution expected.
Candidate site 8: NH18–PR295 IC. 	**Landuse and land property:** The proposed site is flat vacant land in wide area of agricaltural use and owned by DRVN. The proposed site is within a provincial road and round shaped interchange access circuit. **Socioeconomic condition:** Surrounding area is basically agricultural land use, commercial business activities are only along PR295 and the interchange. **Accessibility:** Good. But, the site needs some traveling time from the Hanoi central area before the construction of NH3B is completed. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Power Company Bac Ninh and confirmed distribution network. **Natural condition:** Geographic condition of this area is flat and flood free area. **Pollution:** There is no pollution expected.
Candidate site 9: NH18–NH3B IC. 	**Land use and land property:** The site is in wide area of agricultural use and along a small reiver. Almost there is no residential area existed in surrounding. The proposed site will be within round shaped interchange access circuit. The proposed site requires land acquisition and land filling for the facility area. **Socioeconomic condition:** Local agricultural activity. **Accessibility:** Good. But, the site needs some traveling time from the Hanoi central area before the construction of NH3B is completed. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Power Company Bac Ninh and confirmed distribution network. **Natural condition:** It is plane flat agricultural land, and flood free area. **Pollution:** There is no pollution expected.

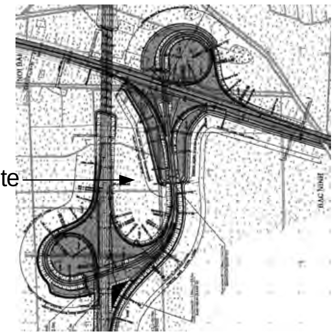
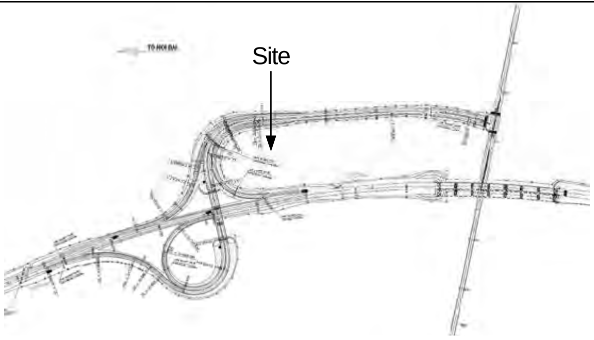
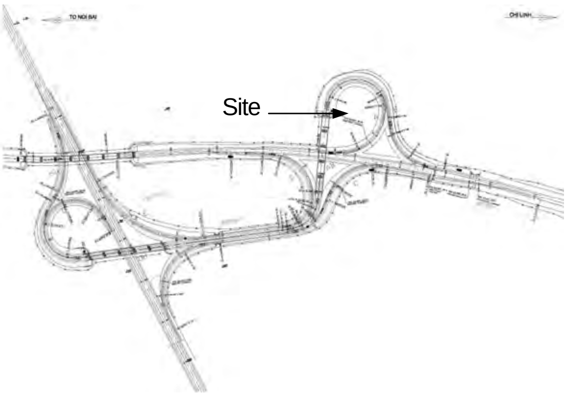
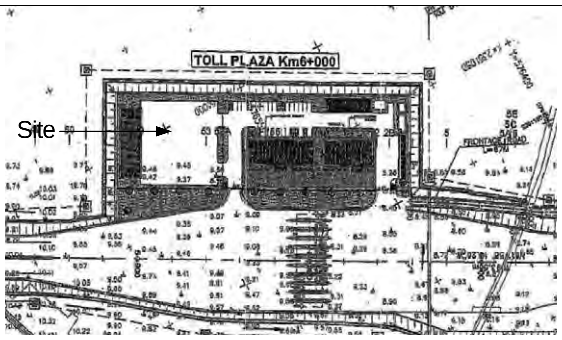
Candidate site 10: NH18–NH3 IC. 	**Land use and land property:** The proposed site and surrounding area is agricultural land use, ponds and a few residential area. The proposed site is within round shaped interchange access circuit. This area is many plots of agriculture and these landowner/stake holders are to be required discuss on land acquisition and compensation and land filling is required for the facility area. **Socioeconomic condition:** Local agricultural activity. **Accessibility:** Good. But, the site needs some traveling time from the Hanoi central area. **Connectability of comm. network:** Good. This area is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Hanoi City Power Coorporation and confirmed distribution network. **Natural condition:** Geographic condition of this area is flat and flood free area. **Pollution:** There is no pollution expected.
Candidate site 11: Thang Long–NH18 IC. 	**Land use and land property:** The proposed site is flat vacant land with a small house owned by road management company and a pond. The proposed site is at a distance about 2.5 km from the edge of the Noi Bai International Airport, and is enclosed by the interchange access circuits. Land filling is required for a part of the facility area. **Socioeconomic condition:** Rural agricultural activity, **Accessibility:** Fair. The site needs safe traffic control for access and some traveling time from the Hanoi central area. **Connectability of comm. network:** Good. The site is located along the target road network of the Project. **Power supply:** Power supply given higher priority by Hanoi City Power Coorporation and confirmed distribution network. **Natural condition:** Geographic condition of this area is flat and flood free area. **Pollution:** There is not expected any pollution without some noise level caused by take-off and landing at air field and radio wave transmitted for air traffic control.
Candidate site 12: Noi Bai Expressway Tollgate 	**Land use and land property:** The proposed site and surrounding area is agricultural land use and ponds. The proposed site is at a distance about 3.5 km from the edge of the Noi Bai International Airport. The site is within the land for the Road Management Office along Noi Bai – Lao Cai expressway. Land acquisition and compensation are planned to be finalized by VEC. **Socioeconomic condition:** Rural agricultural activity, **Accessibility:** Good. The site can be accessed using NH2, NH135 and NH18 (Connect to Noi Bai Airport), but needs some traveling time from the Hanoi center area. **Connectability of comm. network:** Fair. The site is located along the target road network of the Project in the case Noi Bai – Viet Tri section is included in the Project Scope, but otherwise the site has no good connectability. **Power supply:** Power supply given higher priority by Hanoi City Power Coorporation and confirmed distribution network. **Natural condition:** Geographic condition of this area is flat, flood free area **Pollution:** There is not expected any pollution without some noise level caused by take-off and landing at air field and radio wave transmitted for air traffic control.

Source: ITS Integration Project (SAPI) Study Team

Table 9.4 Comparison on Features of Candidate Sites

	Drawing / Collateral condition	Features
Candidate site 1: RR3–Trung Hoa		Land Area: As required Land owner: Private Land acquisition: Required Resettlement: Required Access: Very good 
Candidate site 2: Lang–Hoa Lac 3km Point		Land Area: More than 1.2 ha Land owner: HPC Land acquisition: Required to take over Resettlement: Not required Access: Very good 
Candidate site 3: RR3–Phap Van IC.		Land Area: More than 5 ha Land owner: HPC Land acquisition: Difficult to take over Resettlement: Not required Access: Good 
Candidate site 4: RR3 – Thanh Tri	The land for existing building, but not wide enough. 	Land Area: About 0.23 ha Land owner: PMU-TL Land acquisition: Not required Resettlement: Not required Access: Very good 

Candidate site 5: NH1B–NH5 IC. (Existing)	The Land will be acquired temporarily for the interchange construction by PMU-TL, but the time is uncertain. 	Land Area: More than 2.5 ha Land owner: PMU-TL Land acquisition: Not required Resettlement: Not required Access: Fair 
Candidate site 6: NH1B–NH5 IC. (Plan)		Land Area: More than 1.5 ha Land owner: HPC Land acquisition: Difficult to take over Resettlement: Not required Access: Very good 
Candidate site 7: NH1B–NH3B IC.	The Land will be acquired temporarily for the interchange construction by PMU-2. 	Land Area: More than 2 ha Land owner: PMU-2 Land acquisition: Not required Resettlement: Not required Access: Fair 
Candidate site 8: NH18–PR295 IC.		Land Area: About 3 ha (6 ha in total) Land owner: DRVN Land acquisition: Not required Resettlement: Not required Access: Good 

Candidate site 9: NH18–NH3B IC.	 The Land will be acquired temporarily for the interchange construction by PMU-2.	Land Area: About 6 ha Land owner: Private Land acquisition: Required Resettlement: Not required Access: Good 
Candidate site 10: NH18–NH3 IC.	 About 2.5 km from the Noi Bai Airport, but not under the air route.	Land Area: About 5 ha Land owner: Soc Son District ** Land acquisition: Required Resettlement: Not required Access: Good 
Candidate site 11: Thang Long–NH18 IC.		Land Area: More than 1 ha Land owner: Soc Son District ** Land acquisition: Not required Resettlement: Not required Access: Fair 
Candidate site 12: Noi Bai Expressway Tollgate	 About 3.5 km from the Noi Bai Airport and right under the air route.	Land Area: About 0.3 ha (1 ha in total) Land owner: VEC Land acquisition: Not required Resettlement: Not required Access: Good 

Note: **: Temporary land owner, but the original land owner is DRVN.

Source: ITS Integration Project (SAPI) Study Team

9.5 Evaluation of Candidate Sites

Based on the following conditions and the screening and comparison of the 12 candidate sites through the measure criteria, the table below shows the evaluated advantages for each site.

- The land owner of the candidate site 2: Lang–Hoa Lac 3km Point is the Ha Noi People's Committee and there is no objection to take over the land to the Project
- The land owner of the candidate site 8: NH18–PR295 IC. is DRVN and there is no objection to take over the land to the Project
- The original land owner of the candidate site 10: NH18–NH3 IC. is DRVN and there is no objection to acquire the land for the Project
- The 6 km distance from the edge of the existing Project Scope to the candidate site 12: the Noi Bai Expressway Tollgate is never to be included in the Project Scope.

According the matrix table and evaluation advantage weight, the most recommendable site of the Northern Regional Main Center is identified IC location of the NH18–PR295 Interchange. The second recommendable sites are the Lang–Hoa Lac 3km Point and the NH18–NH3 Interchange.

Table 9.5 Evaluation Matrix of Candidate Sites

	Site location	Sufficiency of land area	Easiness of land acquisition of sufficient area	Good accessibility and easiness on commutes	Connectivity to optical fiber cable network in the Project	Security against natural disaster and stableness on power supply	Pollution related impacts	Evaluation advantage of positive side	Remarks
1	RR3 – Trung Hoa	+++	-	++	++	++	-	9	
2	Lang – Hoa Lac 3km Point	+++	++	++	++	++	-	11	Second recommended
3	RR3 – Phap Van IC.	+++	-	+	++	++	-	8	
4	RR3 – Thanh Tri	-	-	++	++	++	+	7	
5	NH1B – NH5 IC.(Plan)	+++	-	-	++	++	-	7	
6	NH1B – NH5 IC.(Existing)	++	-	++	++	++	-	8	
7	NH1B – NH3B IC.	+++	++	-	++	++	+	10	
8	NH18 – PR295 IC.	+++	+++	+	++	++	+	12	Most recommended
9	NH18 – NH3B IC.	+++	-	+	++	++	+	9	
10	NH18 – NH3 IC.	+++	++	+	++	++	+	11	Second recommended
11	Thang Long – NH18 IC.	+++	+++	-	++	++	-	10	
12	Noi Bai Expressway Tollgate	++	+++	+	-	++	-	8	

Note: +, ++, +++ : shown prioritized advantage, - : shown disadvantage weight

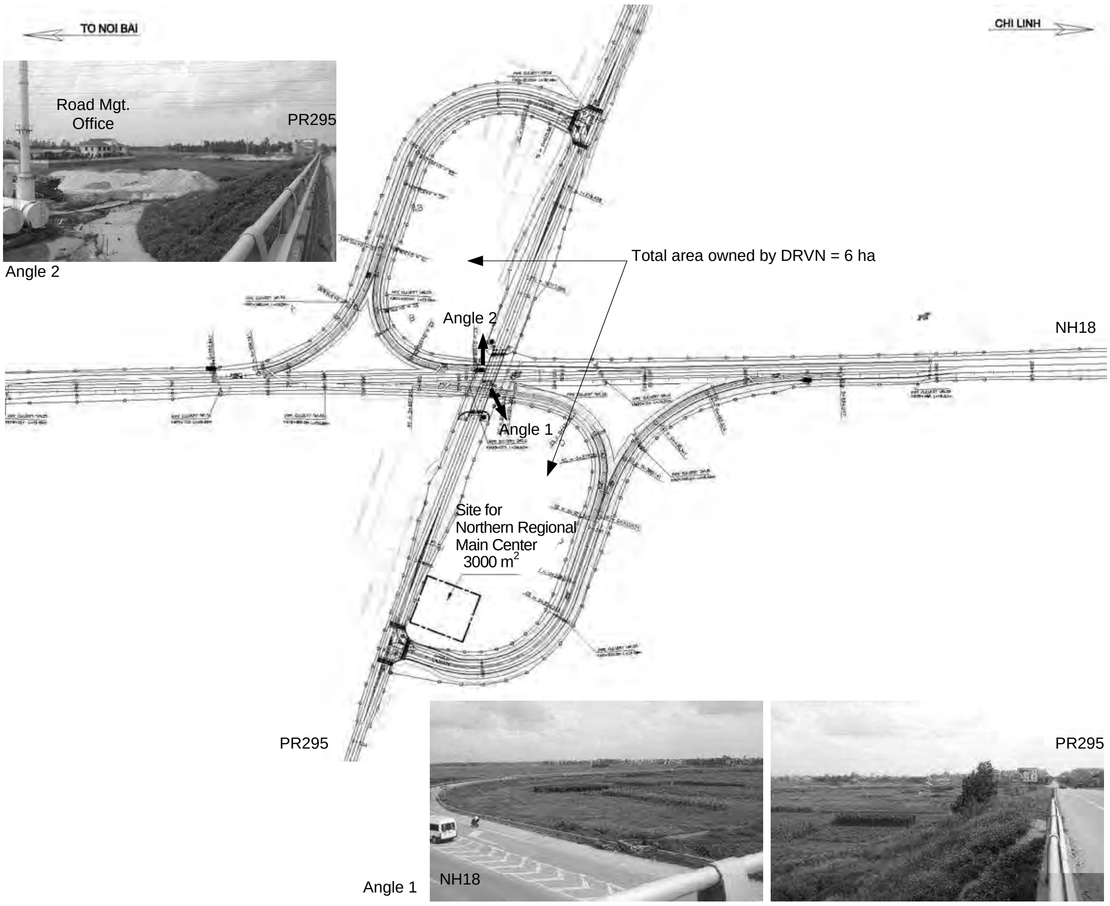
Source: ITS Standards & Operation Plan Study Team

9.6 Conclusion

Based on the evaluation results above, the NH18–PR295 Interchange is to be concluded for site location of the Northern Regional Main Center.

The Northern Regional Center, which requires the site of 3000 m^2, is to be constructed in the area surrounded by the ramps in the interchange between Noi Bai – Bac Ninh and the Provincial Road 295 in the Project as shown in the following figure.

Figure 9.4 Location of Northern regional Main Center



Source: ITS Integration Project (SAPI) Study Team

10. Environmental Social Consideration Study of Project

10.1 General

1) Project Overview

The ITS project (Intelligent Transport System) is located on the Red River Delta including the new Hanoi (Hanoi and former Ha Tay province) and other three provinces of Bac Ninh, Ninh Binh, Ha Nam. The major project components are as follows:

- Total road length for cable installation (within right of way): approximately 85 km
- Power (for transmission): less than 100 W
- Area of Northern Regional Main Center: 3000 m^2
- Area of Road Management Office: 3000 m^2 (only one for Lang – Hoa Lac section)

2) Major Environmental and Social Impacts of project components

The major environmental consequences of the project stem mainly from the Main Center and the Road Management Office and partially from construction of plastic conduit system. Not any resettlement program and livelihood restoration program is required for construction work as well as equipment installation.

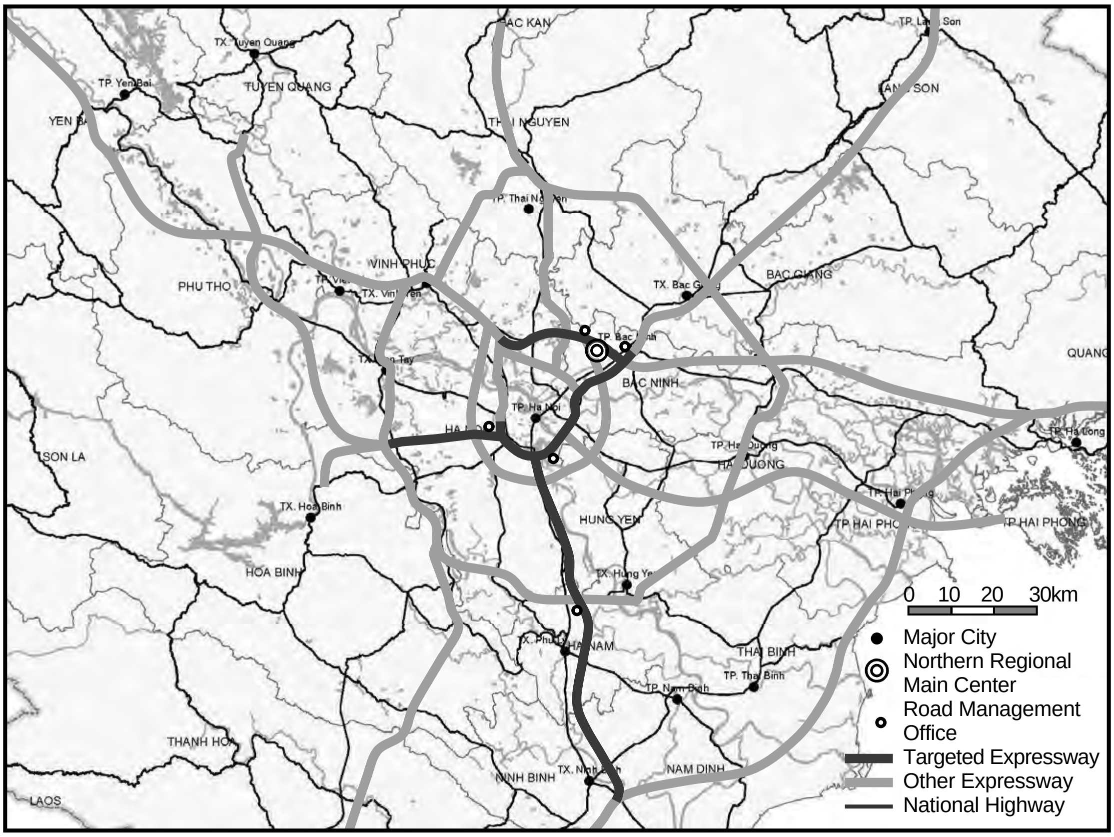
The project will not damage any natural habitat. The area of the project does not have a rich biodiversity. Direct impacts on cultural heritage value are not existed. The construction of the office building itself poses perhaps the highest environmental and social risk. At its peak, a labor force of around 50 workers will be housed in camps for office construction. Indirect impacts stemming from the inflow of workers into zone prompted by the construction of the office and enhance consumption and other economic activities in the areas.

10.2 Project Regulatory and Legal Framework

The New Environmental protection Law of Vietnam was in effect in July 2006. The Law provides an umbrella framework for environmental management and protection in Vietnam, and the prime authority is the Ministry of Natural Resources and Environment (MoNRE). At the provincial level, the Provincial Department of Natural Resources and Environment (DONRE) is the operating unit for overall environmental management in the province. In addition, other national laws are also important for environmental protection and natural resources management. Vietnam has a State Plan on Environmental and Sustainable Development, 1991-2000 (1991), National Biodiversity Action Plan up to 2010 and Orientations towards 2020 (2007); Land Use Law (1993); Water Resources Law (1998); Ordinance of Radiation Safety and Control (1996). Most recently, a Biodiversity Law came into effect in 2009 and a revised Cultural Heritage Law came into effect in 2010.

According to Decree No.29/2011/NĐ-CP dated 18 April, 2011 regarding “Providing strategic environmental assessment, environmental impact assessment, and environmental protection commitment”, the project with less than 100 km of total length of optical fiber cable installation, or less than 2kW capacity of power for transmission, or smaller 5ha constructions of office building is not required to prepare Environmental Impact Assessment but necessary to submit Environmental Protection Commitment to any District People's Committee among Districts that under the project area.

Figure 10.1 Project Location



Source: ITS Integration Project (SAPI) Study Team

10.3 Environmental and Social Setting

The area of the project presents popular ecological and cultural characteristics which make this project simple.

1) Natural Habitats and Biodiversity

In 1992, the World Conservation Monitoring Centre ranked Vietnam as one of the 16 most biologically diverse countries in the world. Its biodiversity is characterized by 295 species of mammals, 828 species of birds, 296 species of reptiles, 162 species of amphibians, and more than 700 species of fresh water fish and 15,000 species of fauna have been identified. New species are discovered every year.

The ITS project is located in the urbanized area or suburban area of greater Hanoi, historically the area has been influenced by human activities and there is not of any specific vegetation or inhabited area of endangered or rare species enlisted in the Red Data Book.

There is not any Natural Reserves located in the area of influence of the project.

2) Archaeological, Cultural and Historical Resources

Archaeological investigations were undertaken to identify and study potential areas containing relics and artifacts. Incidentally, the ITS site is already designated existing ROW of main trunk road or nearby these areas. There is no impact to archaeological, cultural and historical resources.

3) Socio-Economic Setting

(1) Population

The ITS project and main facilities are located in the greater Hanoi which includes Hanoi, and small parts of others province such as Ninh Binh, Bac Ninh, and Ha Nam with respectively more than 7 millions peoples. The project area sparsely populated with population densities ranging from 1,962 inhabitants per square kilometer in Hanoi, 1,257 in Bac Ninh, 914 in Ha Nam, and 648 in Ninh Binh.

No indigenous people or minorities were confirmed to reside in the ITS project site.

(2) Culture, Family and Community Structure

Cultural customs of Kinh commune is very simple that originate in agricultural production activities of wet rice cultivation. There are minor cultural differences between the Kinh and other groups, most of which are centered on traditional ceremonies. Worship tends to last for whole day and people pray for good rain and wind and health crops for prosperity.

In the Northern Delta Region, traditional family structures have dramatically changed amongst Kinh and other groups as nuclear family, consisting of three to four generations no longer exists. Since land is under state control and subdivided amongst households, it is more economical for families to live separately from one another as this allows for more land to be owned.

Most villages are physical separated by agricultural land and people tend to disperse after marriage. Though some communes do not have immigrants, people of the same descent often join other villages for meetings or to help family members.

(3) Economic condition

In the past decade during 2001 – 2010, there were rapid economic growth in the Northern Delta Region, and the economic structure has been modernized, and efficient. The GDP of Hanoi City during 2000 to 2005, grew at a level of annual 10.7%, and 6.72% during 2007 to 2010. The real GDP of Hanoi city in 2010 reached to 246 trillion 723 billion Vietnam Dong, with share of 13.0% of the real GDP nationwide.

(4) Transportation

Transportation throughout the Northern Delta Region is generally good as roads are mainly asphalt based and the terrain is full flat. Currently, all districts have roads that reach their communes and relatively good condition.

The existing inter-village roads are also good and mostly cement based. It is very easy to access communes as the road networks are worked well even during the flood season.

(5) Power outage

EVN will upgrade three Hanoi areas 220KV transformer stations (Ha Dong, Chem and Mai Dong) as a temporary expedient. However, fundamental improvements in the power transmission capability of the national grid may be many years in coming, even though more power plants will begin operation in the meantime.

A shortage of water in northern hydro-electricity reservoirs between March and June makes these four months the most problematical for power supply. The company rotates supply to different parts of the city together with upgrades and repairs to cope with the shortage. Hospitals, schools, traffic lights, administrative, diplomatic offices and water plants will be given priority during the expected outages.

10.4 Analysis of Alternatives

Development of infrastructure including transportation sector is the most important target in the Five-Year Social and Economic Development Plan. The development strategy for transport sector established in 2009 pointed out importance of development of trunk road network in major cities such as Hanoi, and construction of expressway network is in progress so as to cope with rapidly increasing traffic demand.

In a part of expressways in Vietnam, the ITS has been developed. However, the system is introduced in several sections of expressways recently completed without compatibility of technical standards. As a result, convenience for users is not sufficient, and investment for the system is not so efficient.

This project aims to install ITS, especially Northern Regional Main Center and traffic control equipment for the priority sections of the expressways in Hanoi metropolitan area. Consequently it is expected smooth traffic in the expressways. The subsequent evaluation of alternative project configurations was based on environmental and social considerations – including minimization of flood and inundation risk, minimizing number of project affected people, and avoiding land acquisition. Thus, the analysis of alternatives included three dimensions: alternatives to cable installation, alternative to power of transmission, and alternatives main center.

1) Alternatives for optical fiber cable installation

There are three installation alternatives for optical fiber cable network. That includes:

Alternative I: Hang on the light poles installed in the Right of Way

Advantages:

- Lower cost of installation
- Shorter period of time for project implementation
- Land acquisition not required

Disadvantages:

- High risk of natural disaster such as storm, strong wind
- Risky traffic safety during construction
- Environmental impacts not existed

Alternative II: Lay underground inside of the Right of Way

Advantages:

- Land acquisition not required
- Low risk of natural disaster

Disadvantages:

- Construction activities are more difficult due to earth work taken place in asphalt layer
- Highest cost for construction of conduit system (compared to other alternatives)
- Risk of traffic safety
- Pollutions of air, noise, watercourse expected

Alternative III : Lay underground outside of the Right of Way

***Advantages*:**

- Easiness of earth work
- Lower risk of traffic safety
- Low risk of natural disaster

Disadvantages:

- Land acquisition required
- Higher cost for construction of conduit system (compared to alternative I)
- Pollutions of air, noise, watercourse expected

The total road length for cable installed under the ground is 84.62 km (earth work required) and 11.38 km cable installed via duct (no earth work required). Conduit system will be constructed inside the right of way. The detailed cable installation in table as follows.

Table 10.1 Total road length for cable installation under ground

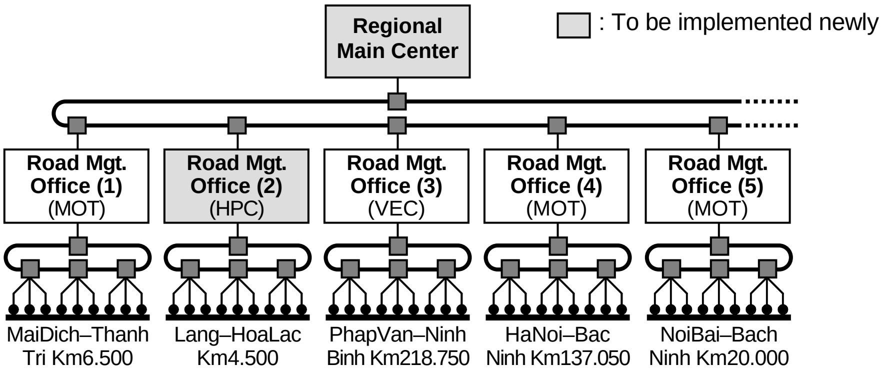
Target road section	Road length for cable installation (km)	Note
Mai Dich–Thanh Tri (Ring Road 3)	3.62 (Excluding via Duct =11.38km)	Earth work not required when cable installed via duct
Lang–Hoa Lac	28.0	
Phap Van–Cau Gie	-	Cable installed by others
Cau Gie–Ninh Binh	-	Cable installed by others
Ha Noi–Bac Ninh	20.0	
Noi Bai–Bac Ninh	33.0	
(Noi Bai–Viet Tri)	-	Connection length from Noi Bai to cable installation system
Total road length For cable installation	**84.62**	

Source: ITS Integration Project (SAPI) Study Team

2) Alternatives for Regional Main Center

The structure of the Northern Regional Main Center is as follow.

Figure 10.2. The Northern Regional Main Center and Road Management Office



Source: ITS Integration Project (SAPI) Study Team

There are two alternatives for location of the Main Center: either locates in the Center of Hanoi or along the intercity expressway network.

Alternative I: Locate in the Central City of Ha Noi

Advantages:

- Convenient for travelling
- Available infrastructures such as water and power supply

Disadvantages:

- It is impossible to do site clearance for constructing connection system from the Regional Main Center to Road Management Office and to expressway in Hanoi urban area
- Very difficult to construct conduit system for optical fiber cable installation, that link Main Center with Road Management Office and road side equipments, due to high density of population in Hanoi metropolitan area
- Much higher cost for project implementation, compared to other alternative that location of the Main Center located outside of Hanoi center, due to very high budget for land acquisition and compensation.
- Serious environmental and social impacts expected

Alternative II: Locate along the intercity expressway network

Advantages:

- Very convenient to construct the conduit system for optical fiber cable installation that linkage of the Regional Main Center and Road Management Office and road side equipments
- Compensation and land acquisition are not required for most of candidate locations. If needed, it is not difficult to take over land or the budget of compensation and land acquisition is still low.
- Lower cost for construction component
- No environmental and social impacts expected

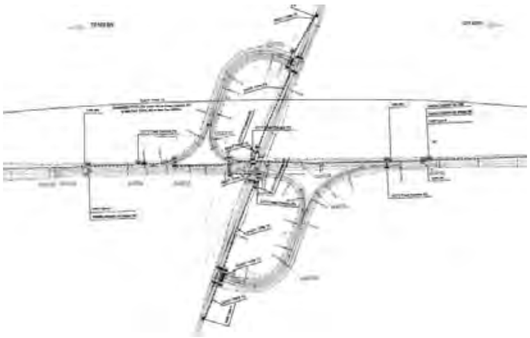
Disadvantages:

- Inconvenient for travelling
- New infrastructures need to be setup

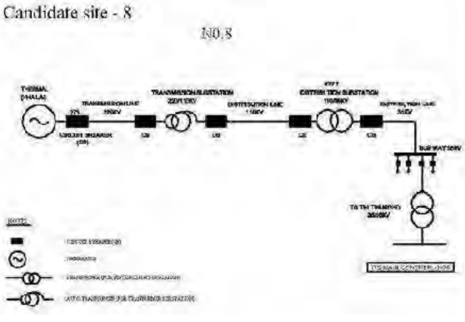
The selection of the best location was based on (i) Land use suitable on surroundings and avoiding land acquisition: total required area 3,000 m^2 includes 800 m^2 for building, 1,500 m^2 for car park and passage way and 700 m^2 for green area; (ii) Connectivity to optical fiber cable network installed along the expressways; (iii) Easiness on commutes for staffs and accessibility to other organizations; (iv) Security against natural disaster and stableness on power supply; (v) Environmental impacts. Of the twelve (12) considered alternatives, the location of interchange NH18-PR295 was considered the best. These feature good technical condition, and have sufficient size and no land acquisition. They are economically and financially viable and have smaller environmental and social impacts compared to others.

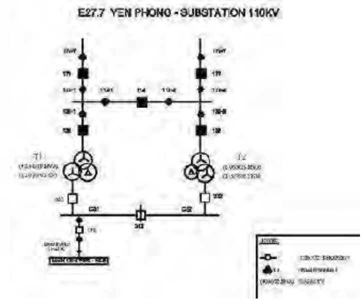
Location of Northern Regional Main Center at NH18–PR 295 Interchange (most recommended): has the most favorable conditions, convenient to connect fiber cable network, sufficient size, land acquisition not required, insignificant environmental impacts.

Table 10.2 Location of Northern Regional Main Center at NH18–PR 295 Interchange



1) Landuse and land property: The proposed site is flat vacant land in wide area of agricultural use and owned by DRVN. The proposed site is within a provincial road and round shaped interchange access circuit.
2) Accessibility: Good. But, the site needs some traveling time from the Hanoi central area before the construction of NH3B is completed.
3) Socioeconomic condition: Surrounding area is basically agricultural land use, commercial business activities are only along PR295 and the interchange.
4) Power supply: Power supply given higher priority by Power Company Bac Ninh and confirmed distribution network.





5) Broad band cable connection: Good. This area is located along the target road network of the Project.
6) Natural condition: Geographic condition of this area is flat and flood free area.
7) Pollution: There is no pollution expected.

Source: ITS Integration Project (SAPI) Study Team

10.5 Anticipated Environmental and Social Impacts

1) Environmental and Social Impacts during Construction

Construction Main Center and Road Management Office impacts

The construction of the Regional Main Center as well as Road Management Office and their ancillary infrastructure will entail potentially insignificant negative impacts on communities and surrounding habitats. The proper management of excavation materials, the reduction of nuisances such as dust, noise, increased traffic, and the presence of a number work force in or near communities, will require management plan and closed supervision. During the construction period, construction and material carrier vehicles will use existing roads and partial congestion may occur with some negative impacts upon local traffic. But they are temporary and in short time period.

A workforce that will peak at 50 workers is expected during construction period. Potential impacts arising from the workforce include generation of solid and liquid wastes and increased public health risks, especially of sexual transmitted disease such as HIV/AIDS. The interaction of the workforce with the local people may occur.

Mitigation: Appropriate management of construction activities include sediment and erosion control, disposal sites management, traffic management, nuisances (dust, noise) reduction measures, and waste and wastewater management. Environmental specifications will be included in all bidding documents and contracts. Solid waste management will be implemented in all work sites. Environmental and social awareness programs for workers will be implemented. A community relation will be required of the contractors. Environmental supervision of all construction activities will be required.

Construction plastic conduit system

Around 85 km of plastic conduit will be installed. Potential impacts include erosion, slope instability, dust, and traffic safety risks. The construction of conduit system can also exert impacts along the route but insignificant due to very small dimension (depth x width = 40 cm x 30 cm).

Mitigation: environmental specifications for contractors include measures for erosion, dust and traffic control, road signage and enforcement of maximum speeds.

2) Environmental and Social Impacts during Operation

Operation impacts may potentially occur upon completion of the office building’s construction. This includes the operation of the Main Center itself, housing and other supports for around 20 operational staff.

There will be an increase in demand for resources and community and health services. The operational staff may share the services with communes and local villagers which could result in social conflicts.

Mitigation: Sustainability of resources management shall be maintained through education and awareness programs. Co-management of existing resources between communes and operational staff shall be encouraged in order to maintain the integrity of natural and social resources in the project area.

Besides that, several publications in the scientific literature have raised concern about the individual and public health impact of adverse non-ionizing radiation from electromagnetic field exposure emanating from certain power, electrical and wireless devices commonly found in the home, workplace, school and community. Despite the many challenges in establishing irrefutable scientific proof of harm and the various gaps in elucidating the precise mechanisms of harm, epidemiological analyses continue to suggest considerable potential for injury and affliction as a result of adverse non-ionizing radiation exposure.

Also, regarding theoretical and experimental investigation into the effects on an optical fiber communication system of electromagnetic interference induced by a conducting wire antenna indicate that the susceptibility of an optical fiber communication device to electromagnetic interference is determined by the power and frequency of the interference source, the input resistance of the device, the reverse saturation current and ideality factor of the light-emitting diode, the total length and attenuation coefficient of the transmitting fiber and the quantum efficiency of the PIN photodiode.

Mitigation: To mitigate impacts of electromagnetic radiation, time of human exposures to radio frequency electromagnetic radiation and work place arrangement should be taken into account.

3) Cumulative Impact in the Project Area

The analysis of cumulative impacts for the ITS project considered the interaction of the following four project components:

- Construction and operation of the Regional Main Center
- Construction and operation of the Road Management Office
- Construction and operation of the plastic conduit system
- Installation and operation of the road side equipments

The immediate cumulative impacts from project activities will be increased the pressure on air quality such as dust, noise, and traffic safety.

Mitigation: Briefly Environmental Management Program has been prepared. Environmental monitoring program and traffic safety solution for contractors are required.

10.6 Implementation Arrangements

1) Environmental and Social Management Plans

The management of environmental and social impacts and measures to mitigate them are briefly encompassed in a report of Environmental and Social Considerations. The contents and objectives of environmental management plan are as follow.

Table 10.3 Objective and content of environmental management plan

Objectives: Chapter of Environmental Management Plan for the ITS Project identifies the principles, approach, procedures and methods that will be used to control and minimize the environmental and social impacts of all construction and operational activities associated with project. The environmental management plan contains guiding environmental principles and procedures for communication, reporting, training, monitoring and plan review to which all contractors and subcontractors are required to comply with throughout the preconstruction, construction and operation phases of the ITS**.**
Contents: • Construction impact management plan – measures to minimize negative impacts of construction activities on local communities and the natural environment, to reduce the induced impacts of camp followers, to prevent pollution; • Environmental monitoring plan – measures to ensure project compliance, and the success of proposed mitigation, continue baseline monitoring and review environmental and social performance; • Community relations measures to inform local communities on progress of the project and ensure community safety;

Source: ITS Integration Project (SAPI) Study Team

2) Roles and responsibilities for environmental management implementation

The ITS project management board will be responsible for the management, implementation, monitoring and compliance of the environmental management plan and any approval conditions including supervision of all contractors and all subcontractors (if any). The organizational structure and responsibilities for implementation of environmental management program is presented in the table below.

Table 10.4 Responsibility for Environmental Management Plan Implementation

Organization	Responsibility
Project owner	• Overall responsibility for environmental performance of ITS project
	• Decision-maker on applicable policies to the ITS project
	• Oversight supervisory role during the construction and operational phase
	• Review reports of the Independent Environmental Monitoring Consultant (if needed)
	• Approves changes to the environmental management plan, as necessary, as part of an adaptive approach to environmental and social management of the ITS
The ITS project management board	• Establish an environmental unit to implement environmental management plan responsibilities
	• Management, implementation, monitoring and compliance of the environmental management plan and any approval conditions, including supervision of all contractors and all subcontractors
	• Review of environmental management plan performance and implementation of correction actions, or stop work procedures, in the event of breaches of environmental management plan conditions, that may lead to serious impacts on local communities, or affect the reputation of the project
	• Assisting the contractor with implementation of environmental management plan
	• Ensuring compliance to all project commitments
	• Report environmental performance of the ITS directly to the project owner

Supervising engineer	• Preparation and implementation of the Environmental Supervision Program during construction
	• Preparation and implementation of the Environmental Monitoring Program during construction
	• Reporting any incidents or non-compliance with the environmental management plan to the ITS management board
	• Making recommendations to the ITS management board regarding environmental management plan performance as part of an overall commitment to continuous improvement
Contractor	• Preparation and implementation of the Construction Management Plan
	• Prepare and maintain records and all required reporting data as stipulated by the environmental management plan, for submission to the Supervising Engineer
	• Ensure that all construction personnel are informed of the intent of the environmental management plan and are made aware of the required measures for environmental and social compliance and performance
	• During construction, maintain traffic safety along access roads, with special emphasis on high trafficked areas

Source: ITS Integration Project (SAPI) Study Team

The project owner takes responsibility to ensure project implemented in accordance with both government and JICA requirements. Included within this is the responsibility to ensure the environmental management is implemented in compliance with the plan set out. The project owner will oversee implementation by the ITS project management board and coordinate with district level on environmental issues. The project owner has entrusted ITS management board with all aspects in relation to implementation of the project.

3) Budget

An estimated cost for the implementation of the environmental management plan is presented in the table below.

Table 10.5 Environmental Management Budget

Environmental management cost	Estimated cost (VND)
Contractor – built into contract	1% of total construction costs
Supervision – environment – to be built into the contract for Engineering Supervision (includes sampling for environmental quality); built into contract	10% of engineering supervision cost plus VND 300,000,000 (separate estimate for environmental monitoring)
Independent Environmental Monitoring (if needed)	VND 300,000,000 (2-3 years)

Source: ITS Integration Project (SAPI) Study Team

10.7 Public Consultation

The project telecommunication line with ducts and optical cable will be installed within right of way (ROW) of expressways like Hanoi Ring road No.3, Hanoi- Bac Ninh, Noi Bai- Bac Ninh, Lang- Hoa Lac and part of Phap Van –Cau Gie, Cau Gie –Ninh Binh.

According enlisted project for requires EIA on Appendix II, Decree No.29/2011/ND-CP, it is not necessary to prepare EIA report due to the length of optical fiber cable is less than 100 km or the area of Main Center or Road Management Office is smaller than 5 ha. Therefore, the Environmental Protection Commitment has been prepared to meet requirements of Vietnamese Government (separated report in Vietnamese version).

Actually the duct with optical cable installation will be implemented on the shoulder of the road within the right of way, no land acquisition required and quite simple work in general. Work place for duct/optical cable installation will be within the protected and separated area from the inside area of each expressway. There are not any households located in the project area. The objectives of consultation are:

- Screening locations for Northern Regional Main Center in term of power supply, flood and inundation, land acquisition.
- Collect opinion/information to complete Environmental and Social Considerations report

Consultation with stakeholders was carried out from Sep 2011 to Apr 2012.

The results of public consultation are: (i) selection of location for Main Center; (ii) implementation of mitigation measures specified in environmental management plan; and (iii) security and environment shall be sustained.

10.8 Conclusion

It is concluded that the ITS Integration Project will not give serious environmental impact, but the project will give many beneficial effects to the region wide socio-economic condition as well as peoples in the region. The Project is concluded to be feasible.

The Environmental Commitment will be prepared in advance of the Project Implementation and the Project will be implemented based on the environmental management/monitoring program.

11. Basic Design of Project

11.1 General

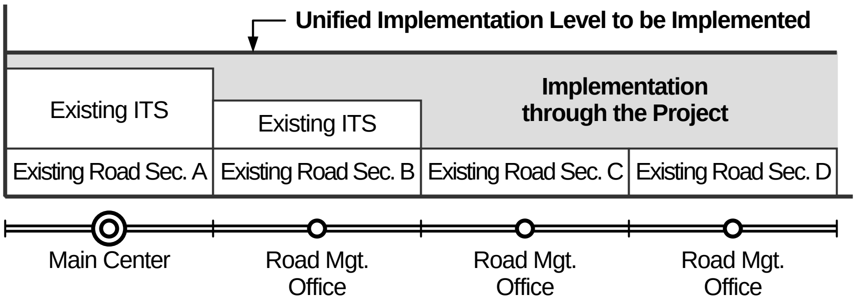
In this chapter, the items below are discussed. The objective and the Scope of the Project are to be mentioned at the outset, and outlines of the Project are to be clarified, Consequently, the discussion results of the cost, packages and schedule of the Project implementation are shown according to the outlines

- Objective of Project
- Project Scope
- Standards and regulations
- General notes
- System design
- Structures and ohters
- Summary of specifications
- Quantities
- Project cost

11.2 Objective of Project

The Project is to aim to unify the ITS implementation levels covering the whole road network including a number of expressway sections, to verify/establish a procedure for integrating systems, to build up the Northern Regional Main Center, to initiate expressway operation/ maintenance (O&M) using ITS and to show the way to utilize ITS for solving traffic problems in the metropolitan areas.

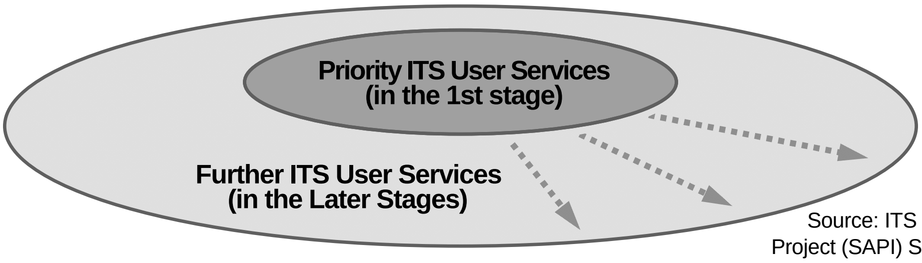
Figure 11.1 Unification of Implementation Levels through the ITS Integration Project



Source: ITS Standards & Operation Plan Study Team

The Project is to initiates the priority ITS user service focusing on the road operation aming at extension to the further ITS user services in the later stages based on the ITS Master Plan.

Figure 11.2 Initiation of ITS User Services



Source: ITS Integration Project (SAPI) Study Team

11.3 Project Scope

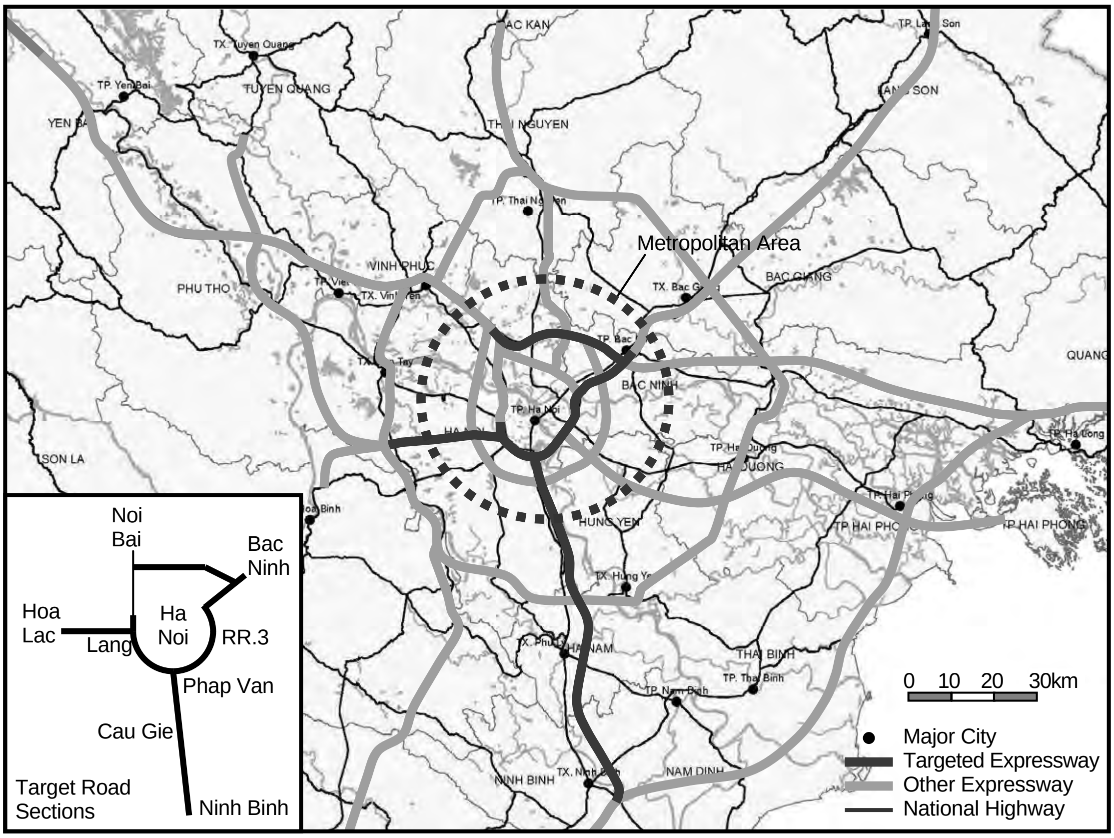
1) Project Area

Based on the study results of Section 8.11, the target road network of the ITS Integration Project is formed as follows:

The expressway sections that are to be completed by 2013 and to include a ring road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section, and connections to candidate locations of the Regional Main Center and the road management offices

Total length of the expressway network in the northern area including other expressways to be integrated under the Northern Regional Main Center can be assumed around 1000 km.

Figure 11.3 Road Sections of Project Area



Road Sections of Comparison Case 2	Length
Mai Dich–Thanh Tri (Ring Road 3)	27 km
Lang–Hoa Lac	28 km
Phap Van–Cau Gie	30 km
Cau Gie–Ninh Binh	50 km
Ha Noi–Bac Ninh	20 km
Noi Bai–Bac Ninh	33 km
Total	188 km

Note: Discussion results of Noi Bai – Viet tri section is included in Appendix 4 only for reference.

Source: ITS Integration Project (SAPI) Study Team

2) Systems to be Implemented

The following four systems are to be implemented in the Project:

- System for road traffic information/control
- System for non-stop toll collection
- System for heavy truck control
- Communication system.

11.4 Standards and Regulations

The results of the basic design of the Project are shown in the Appendix-4 and Appendix-5. The basic design is based on the Project implementation plan aforementioned and the following regulations:

- ITU-T G. 107: The E-Model, a computational model for use in transmission planning
- ITU-T Y. 2012: Functional Requirements and Architecture of Next Generation Networks
- ITU-T Y. 1541: Network performance objectives for IP-based services
- ITU-T H. 264 and ISO/IEC 14496-10: (MPEG4-Part 10)
- ITU-R M.1453: DSRC at 5.8 GHz (Physical Layer)
- ITU-T G.652: Characteristics of single-mode optical fibre cable
- ITU-T G.655: Characteristics of a non-zero dispersion shifted single-mode optical fibre cable
- IETF, RFC 3261 SIP: Session Initiation Protocol
- IETF, RFC 3550 RTP: A Transport Protocol for Real-+Time Applications
- IETF, RFC 4566 SDP: Session Description Protocol
- ISO 14813-1:2007 Intelligent transport systems – Reference model architecture(s) for the ITS sector
- ISO 15628: DSRC Applications
- ISO 14906: Application Interface Definition for DSRC
- ISO/IEC 14496-2: (MPEG4-Part 2)
- ISO/IEC 14496: (Coding of audio-visual objects)
- ISO/IEC 11179: Information technology – specification and standardization of data elements
- ISO/IEC 14443: Contact-less Integrated Circuit Cards
- ISO/IEC 18092: Near Field Communication – Interface and protocol
- ISO/IEC 13818-1:2000 Information Technology – Generic coding of moving pictures and associated audio information
- ISO/DIS 14817: Transport information and control systems – requirements for an ITS/ TICS central data registry and ITS/TICS data dictionaries
- ISO/CD 24533: Data directory and Message set for tracking of freight and It's intermodal transfer
- IEC 60529: Degrees of Protection provided by Enclosure (IP Code)
- IEEE 802.3af: Power over Ethernet
- IEEE 802.3at: 10BASE-T/100BASE-TX PoE Plus
- IEEE 802.3: Ethernet (Carrier Sense Multiple Access with Collision Detection)

- WMO-No.544 Manual on the Global Observing System (WMO)
- EN 12253:2004: Road transport and traffic telemetric – Dedicated short range communication: – Physical Layer using microwave at 5.8 GHz
- EN 13372:2004: Road transport and traffic telematics (RTTT) – Dedicated short range communication – Profiles for RTTT application
- EN 15509:2007: Road transport and traffic telematics (RTTT) – Electronic fee collection interoperability application profile for DSRC
- TCVN 5729
- TCVN 2737:1995
- TCVN 4054
- TVCN 6384:1998: Code/Bar Code on items - UPC-A Code - Technical Requirements
- TVCN 6513:1999: Code/Bar Code on items - Barcode ITF - Technical Requirements
- TVCN 6755:2008 ISO/IEC 15417:2007: Code/Bar Code on items - Barcode EAN-UCC 128 - Technical Requirements
- 22TCN331-05: Documents on message/signs for highways
- 22TCN237-01: Regulation on Road Signs
- TCCS 01:2008/VRA: One-stop Charging Toll Gate using Printed Barcodes
- Decree No. 24/2004/ND-CP dated January 14, 2004: Detailing the Implementation of a Number of Articles of the Ordinance on Post and Telecommunications Regulating Radio Frequencies
- Decree No. 34/2010/ND-CP: Processing for measured overload heavy truck
- Circular No. 36/2009/TT-BTTTT dated December 3, 2009: Stipulating Specifications and Exploiting conditions of short range Radio Frequency Devices of conditional use
- Circular No 06/2009/TT-BCB(C11)
- Circular 07/2010/TT-BGTVT: Legal regulation for measurement of overloaded heavy truck

11.5 General Notes

(1) The drawings, specifications and reports developed in the Study are the results of basic design of the Project, and that of detailed design shall be prepared by the Contractor of the Project Implementation in compliance with the results of the basic design.

(2) In the case regulations are updated, the specifications shall be updated in the detailed design by the Contractor of the Project Implementation in compliance with the latest regulations.

(3) Modifications on the drawings and supplementary drawings shall be prepared by the Contractor of Project Implementation based on the actual conditions and in compliance with the latest regulations at the point in time of the Project Implementation.

(4) The drawings and reports for the Noi Bai – Viet Tri Section are included in the results of Study only for reference; however, the results of this Section are not included in the quantity table and cost estimation of the Project.

(5) The drawings of architecture are shown only for reference. The drawings of detailed design of architecture shall be prepared additionally in other study.

11.6 System Design

11.6.1 Design Items

1) Traffic Information/Control System

The following discussion results are to be shown for the design of the traffic information/control system.

- Outline and system architecture
- Required function of functional packages
- Range of surveillance
- Required function/performance of CCTV camera
- Location/instasllation of CCTV camera
- Display for CCTV monitoring at Regional Main Center and road management office
- Traffic event to be detected
- Detection algorithm by image recognition
- Vehicles/classes to be identified
- Types of vehicle detector
- Values of traffic/vongestion to be estimated
- Observation elements for weather monitoring
- Bad weather categories
- Required function/performance of weather sensors
- Location of weather sensors
- System for traffic information/control
- Definition of traffic events
- Correlation between traffic events
- Required functions/performance of main monitor screen
- Indication items on main monitor screen
- Equipment for indicating information on expressway
- Location and contents to be indicated on VMS
- Prioritisation of traffic events for VMS indication
- Indication layout on VMS
- Traffic events and names of places to be indicated on VMS
- Required functions/performance of VMS indication
- Location and Indication criteria of CSS
- Required functions/performance of CSS indication
- Required function of mobile radio communication
- Contents of traffic information
- Data to be compiled/generated for integration
- Data sets and data dictionary.

2) Automated Toll Collection/Management System

The following discussion results are to be shown for the design of the automated toll collection/ management System.

- Outline and system architecture
- Required function of functional packages
- Required functions/performance of CCTV camera
- Location/installation of CCTV camera
- Identifying method of vehicle/class
- Calculation of toll rate
- Tollbooth arrangement at tollgate
- Capacity and calculating number of tollgate lanes
- Arrangement of roadside equipment at tollgate
- Required functions/performance of roadside equipment
- Procedure of toll collection by ETC
- Procedure of toll enforcement assistance
- Procedure of toll collection by manual
- Procedure of toll collection by Touch&Go
- Procedure of toll data management
- Procedure of OBU management
- Data sets and data dictionary.

3) Vehicle Weighing System

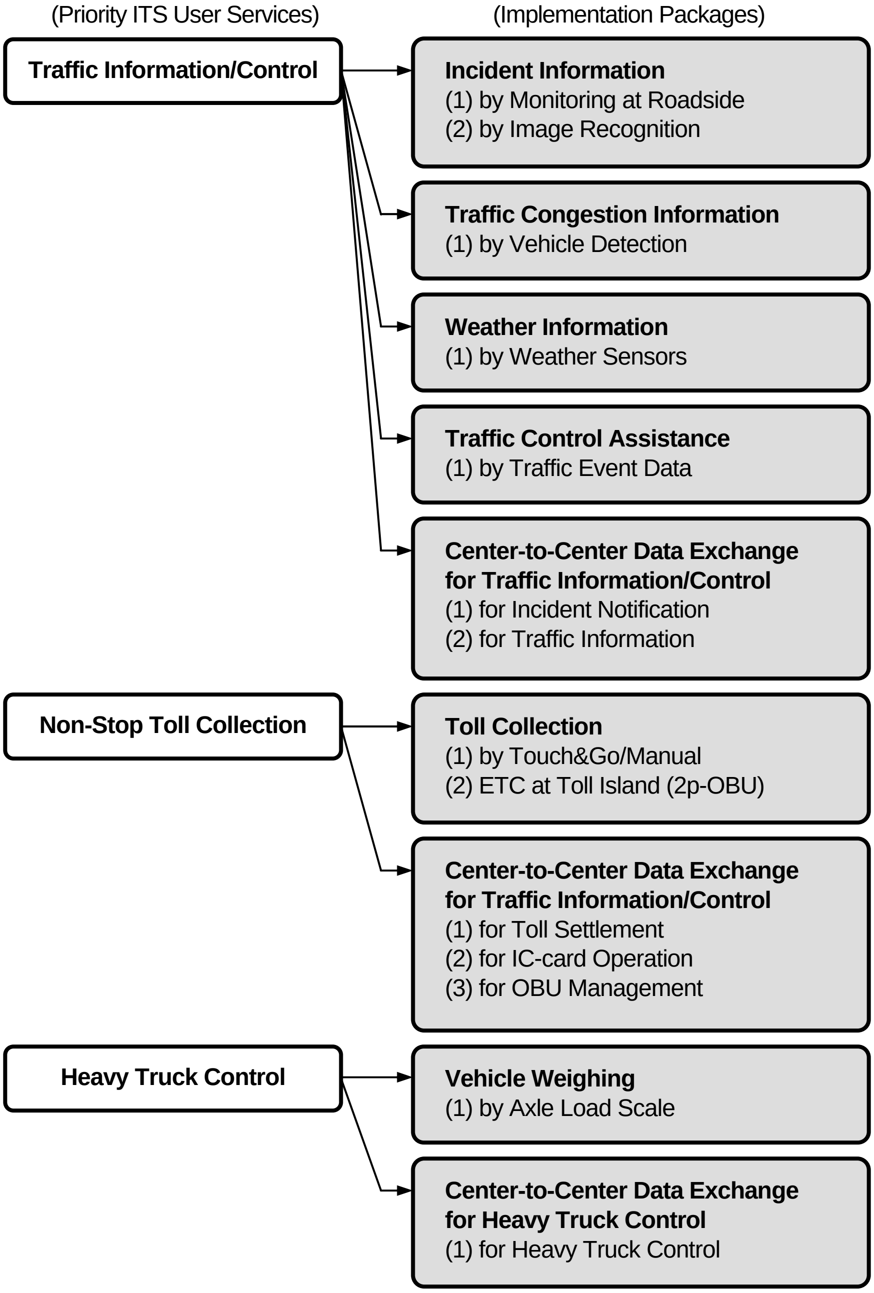
The following discussion results are to be shown for the design of the vehicle weighing system.

- Outline and system architecture
- Required function of functional packages
- Procedure of axle load measurement
- Required function/performance of equipment
- Location of axle load scale
- Axle load scale arrangement at tollgate
- Procedure of axle load data management
- Data sets and data dictionary.

11.6.2 System Architecture

The system to be implemented in the Project is to consist of the implementation packages shown in the figure below for providing the three priority ITS user services to the road users and operators. Center-to-center data exchange is the implementation package necessary for all of the three services. Each implementation package can be actualized by one or more implementation methods.

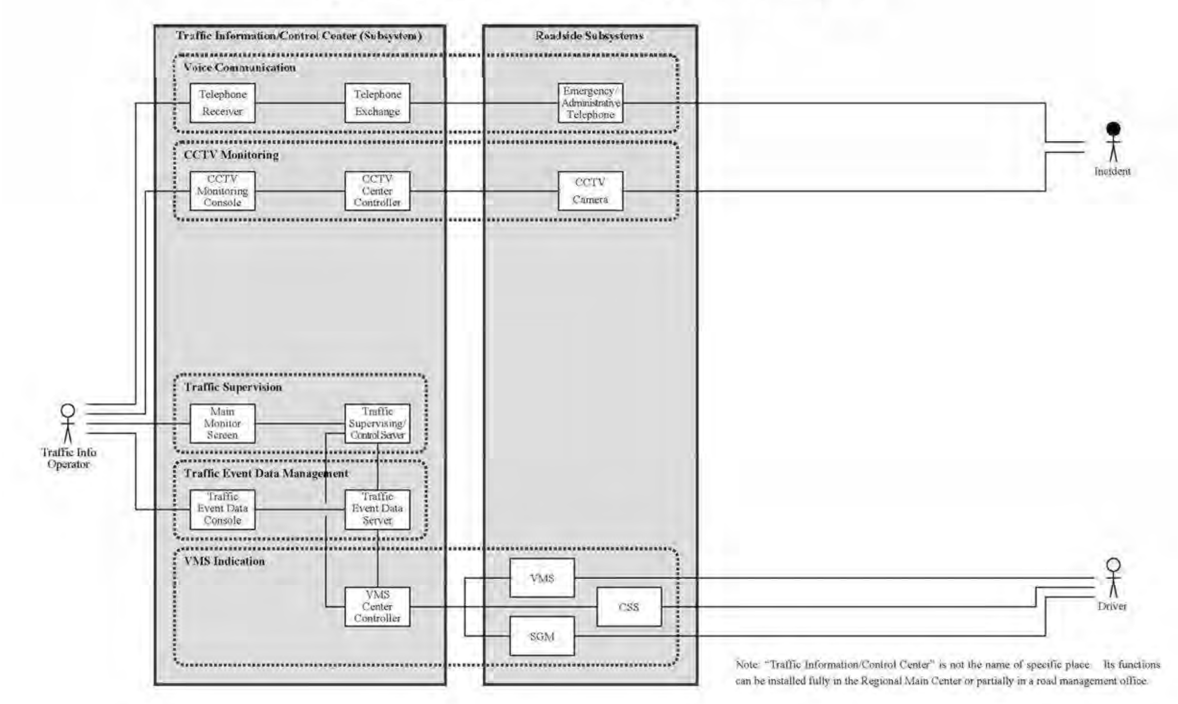
Figure11.4 Implementation Packages for Priority ITS User Services



Source: ITS Integration Project (SAPI) Study Team

The system architecture is to be prepared for actualizing each implementation package being composed of subsystems as shown in the following pages.

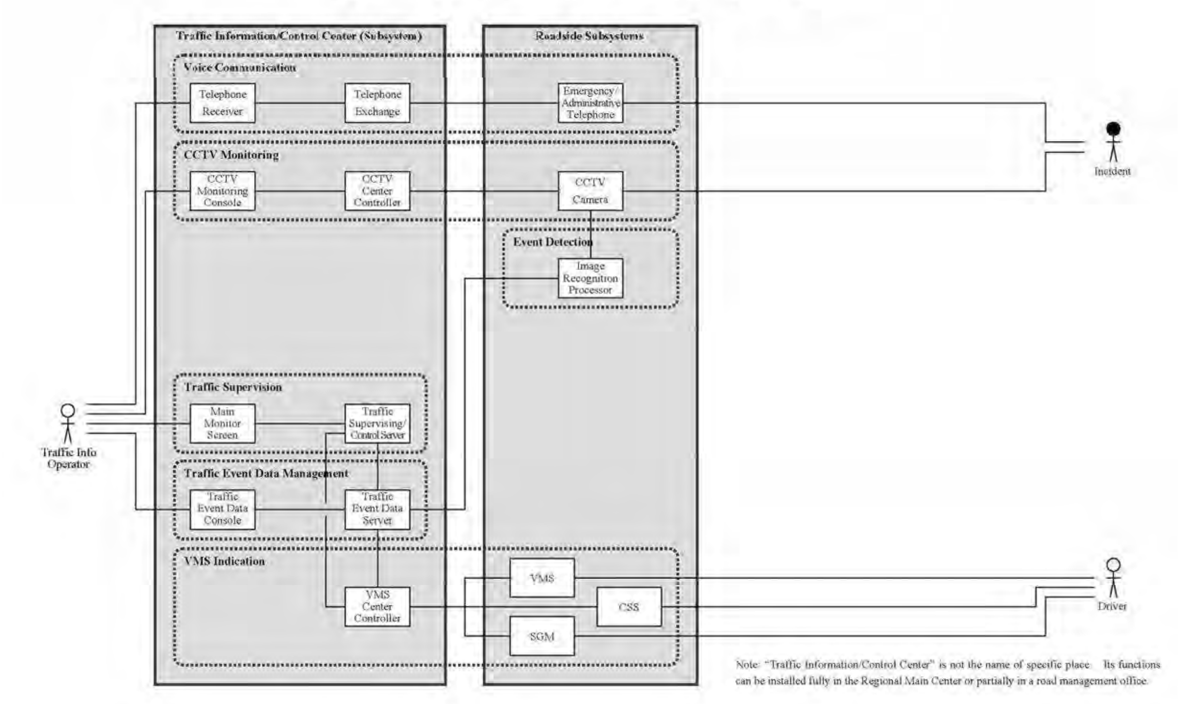
Figure 11.5 Incident Information – (1) by Monitoring at Roadside



Note: "Traffic Information/Control Center" is not the name of specific place. Its functions can be installed fully in the Regional Main Center or partially in a road management office.

Source: ITS Integration Project (SAPI) Study Team

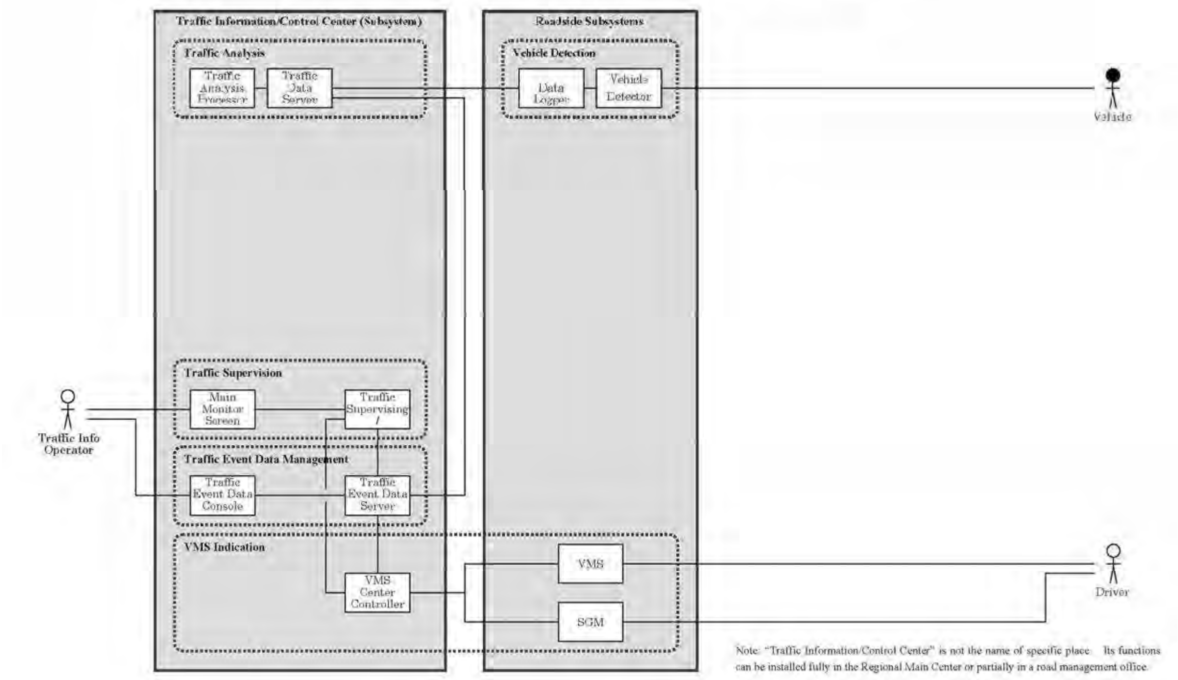
Figure 11.6 Incident Information – (2) by Image Recognition



Note: "Traffic Information/Control Center" is not the name of specific place. Its functions can be installed fully in the Regional Main Center or partially in a road management office.

Source: ITS Integration Project (SAPI) Study Team

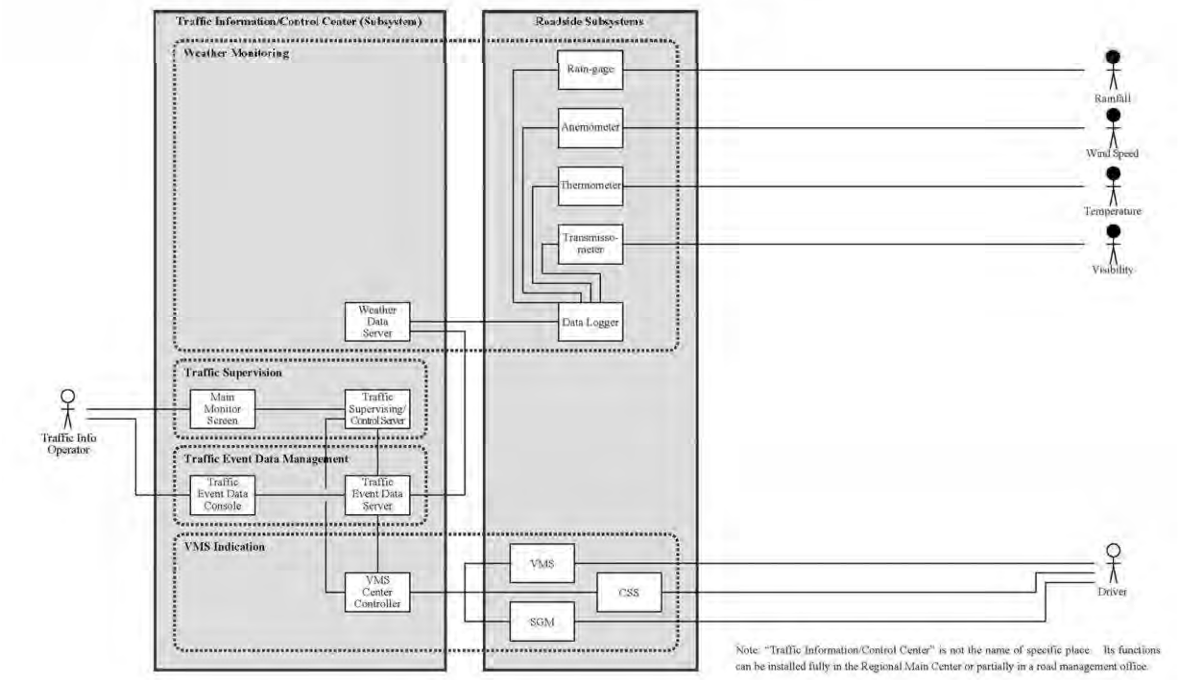
Figure 11.7 Traffic Congestion Information – (1) by Vehicle Detection



Note: "Traffic Information/Control Center" is not the name of specific place. Its functions can be installed fully in the Regional Main Center or partially in a road management office.

Source: ITS Integration Project (SAPI) Study Team

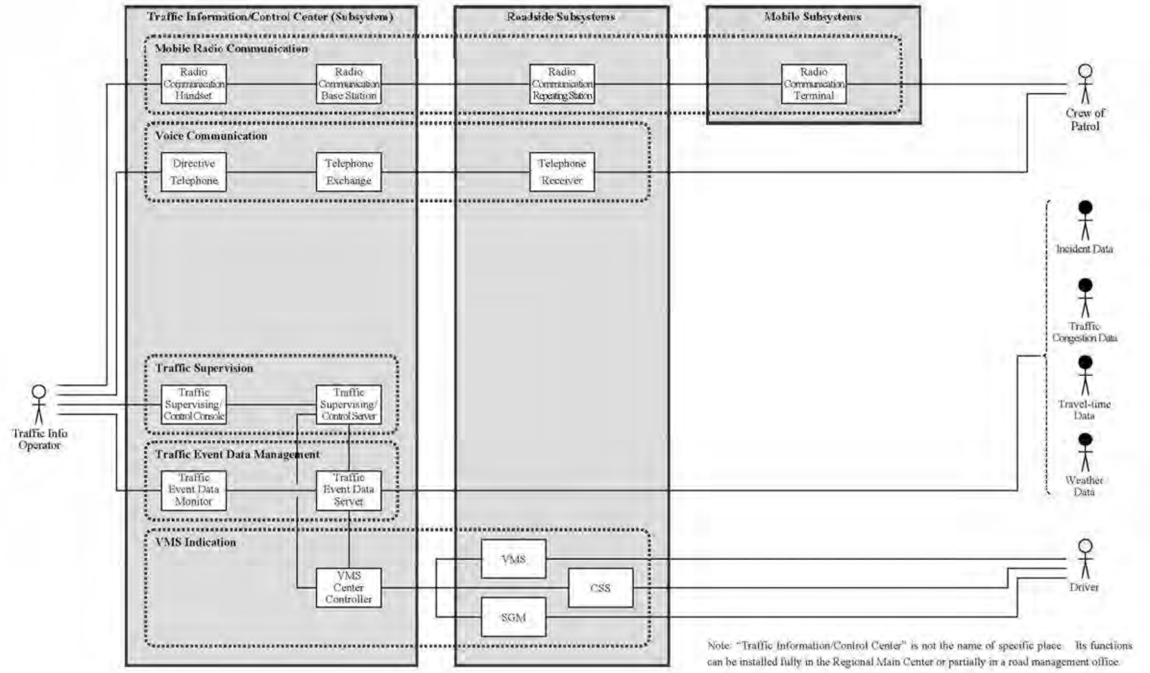
Figure 11.8 Weather Information by – (1) Weather Sensors



Note: "Traffic Information/Control Center" is not the name of specific place. Its functions can be installed fully in the Regional Main Center or partially in a road management office.

Source: ITS Integration Project (SAPI) Study Team

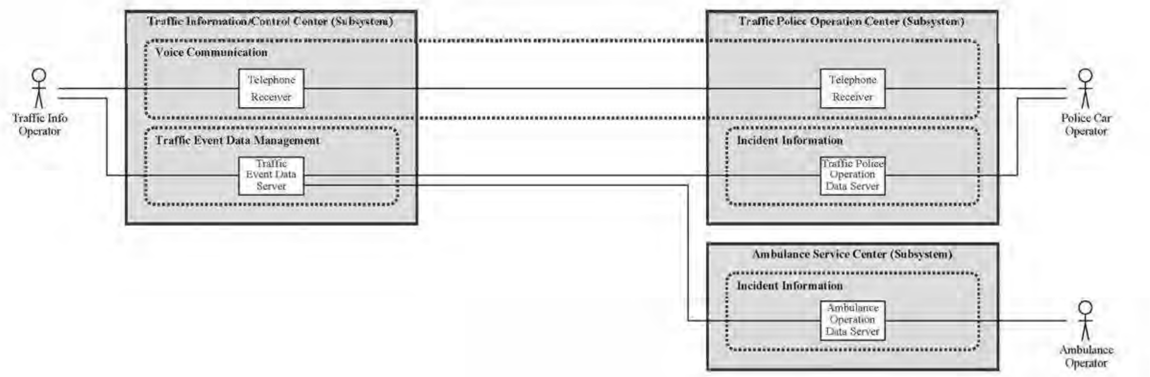
Figure 11.9 Traffic Control Assistance – (1) by Traffic Event Data



Note: "Traffic Information/Control Center" is not the name of specific place. Its functions can be installed fully in the Regional Main Center or partially in a road management office.

Source: ITS Integration Project (SAPI) Study Team

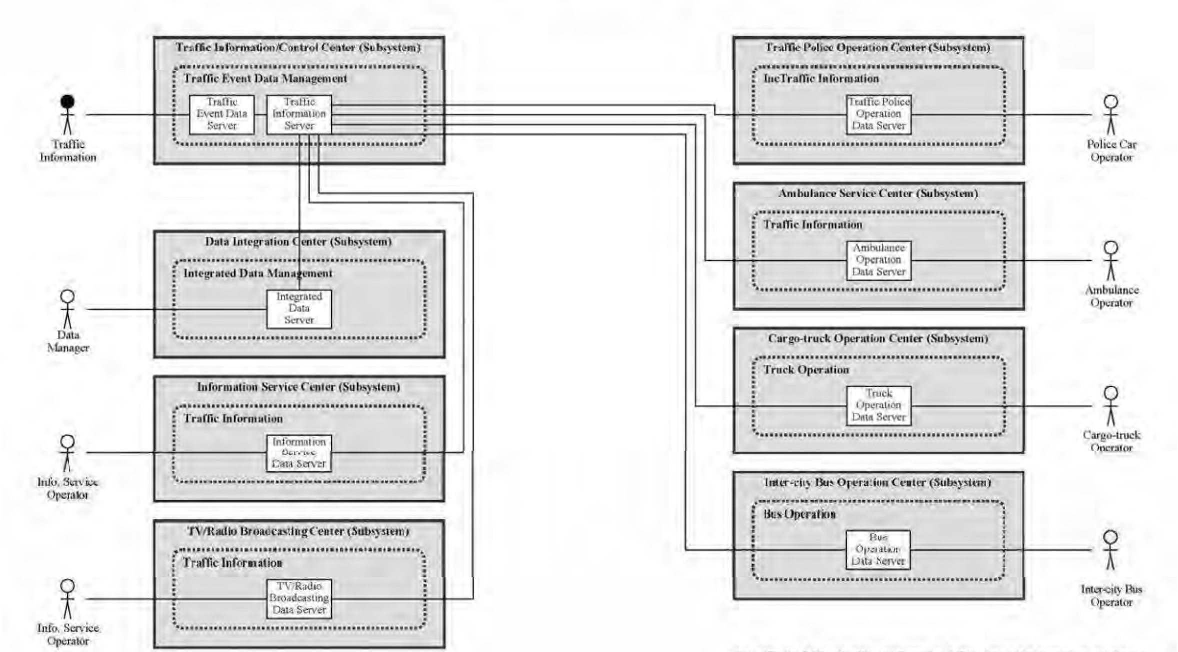
Figure 11.10 Center-to-Center Data Exchange – (1) for Incident Notification



Note: "Traffic Information/Control Center" is not the name of specific place. Its functions can be installed in the Regional Main Center or a road management office.

Source: ITS Integration Project (SAPI) Study Team

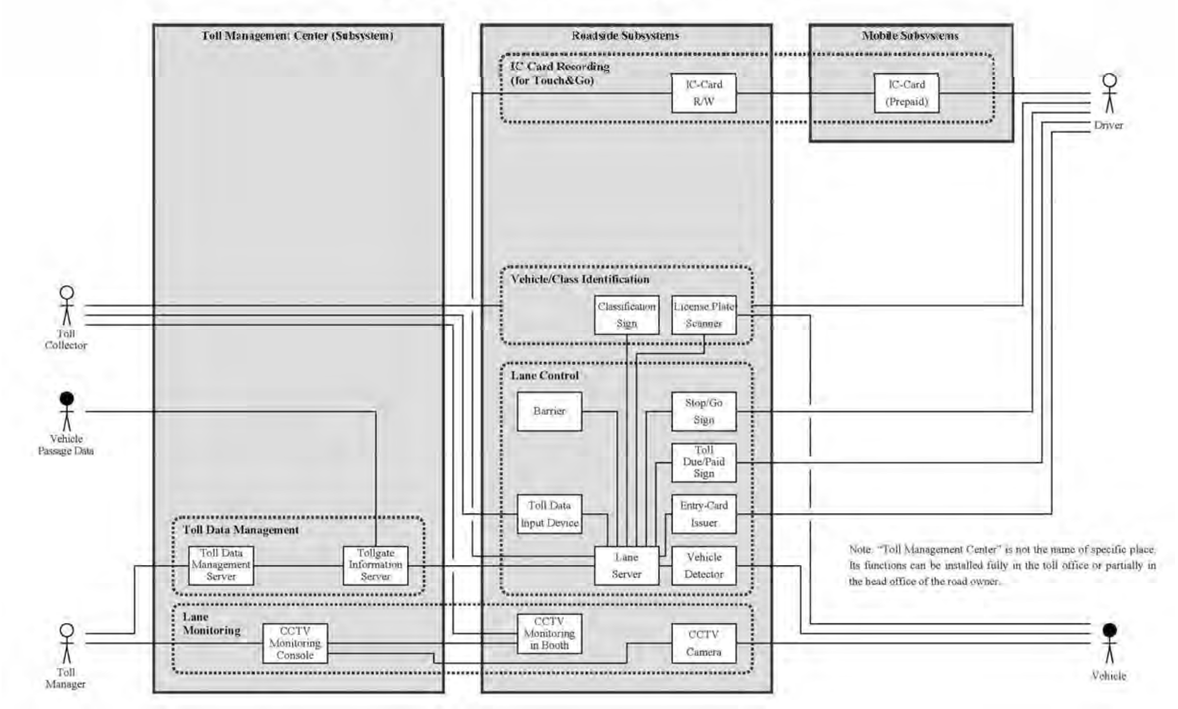
Figure 11.11 Center-to-Center Data Exchange – (2) for Traffic Information



Note: "Traffic Information/Control Center" and "Data Integration Center" are not the names of specific places. Their functions can be installed in the Regional Main Center.

Source: ITS Integration Project (SAPI) Study Team

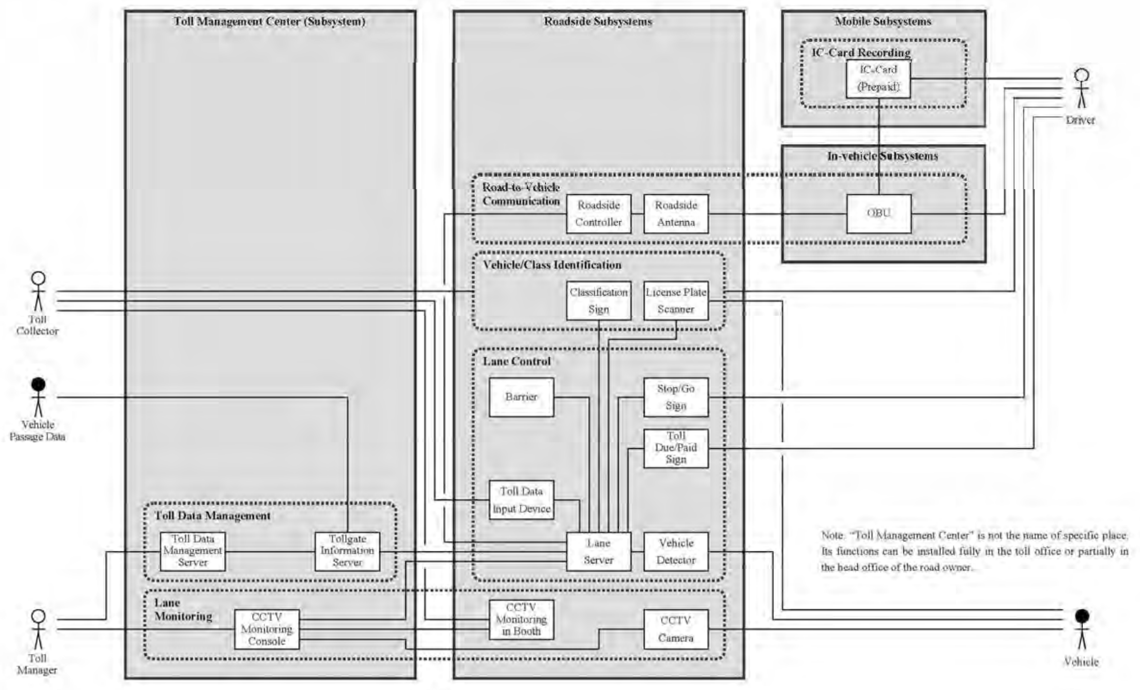
Figure 11.12 Toll Collection – (1) by Touch&Go/Manual



Note: "Toll Management Center" is not the name of specific place. Its functions can be installed fully in the toll office or partially in the head office of the road owner.

Source: ITS Integration Project (SAPI) Study Team

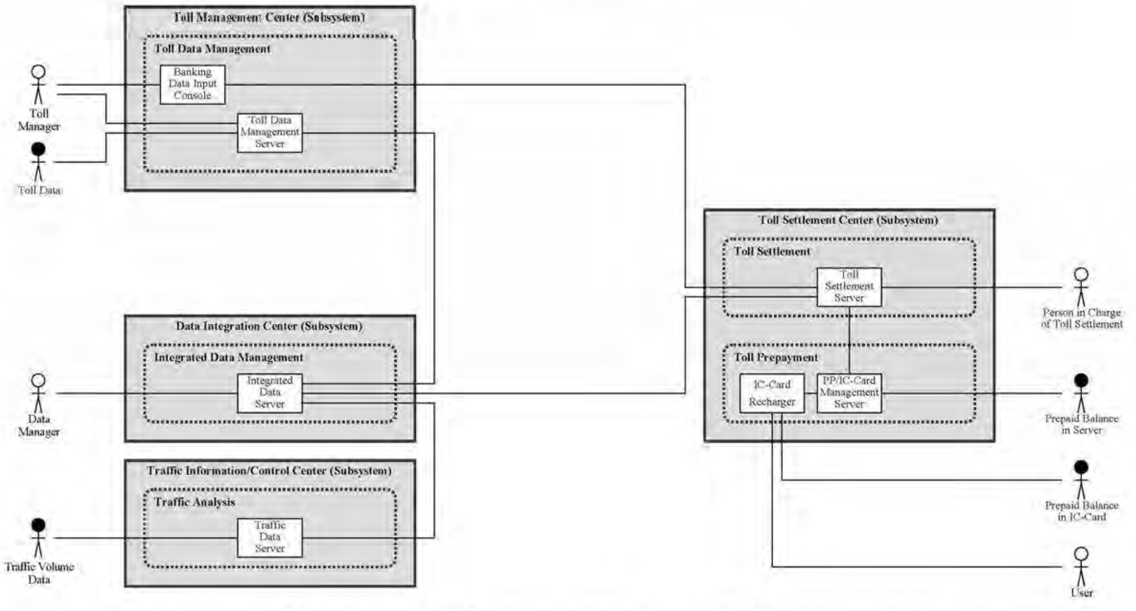
Figure 11.13 Toll Collection – (2) by ETC at Toll Island (2p-OBU)



Note: "Toll Management Center" is not the name of specific place. Its functions can be installed fully in the toll office or partially in the head office of the road owner.

Source: ITS Integration Project (SAPI) Study Team

Figure 11.14 Center-to-Center Data Exchange – (1) for Toll Settlement

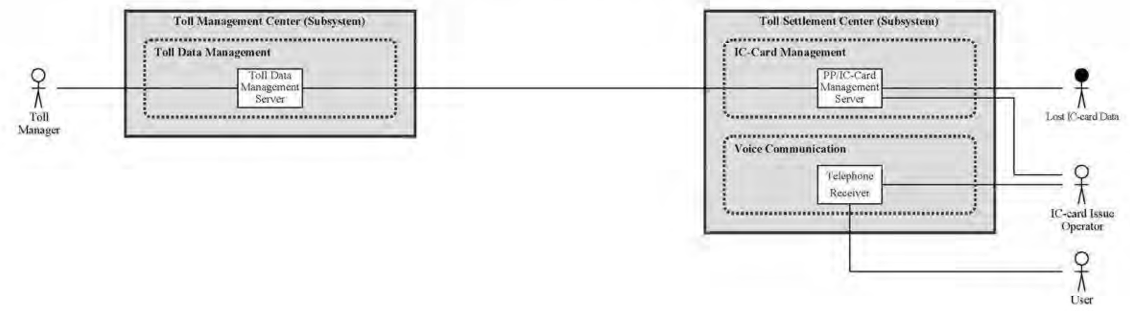


Note: "Toll Management Center" is not the name of specific place. Its functions can be installed fully in the toll office or partially in the head office of the road owner.

Note: "Traffic Information/Control Center" and "Data Integration Center" are not the names of specific places. Their functions can be installed in the Regional Main Center.

Source: ITS Integration Project (SAPI) Study Team

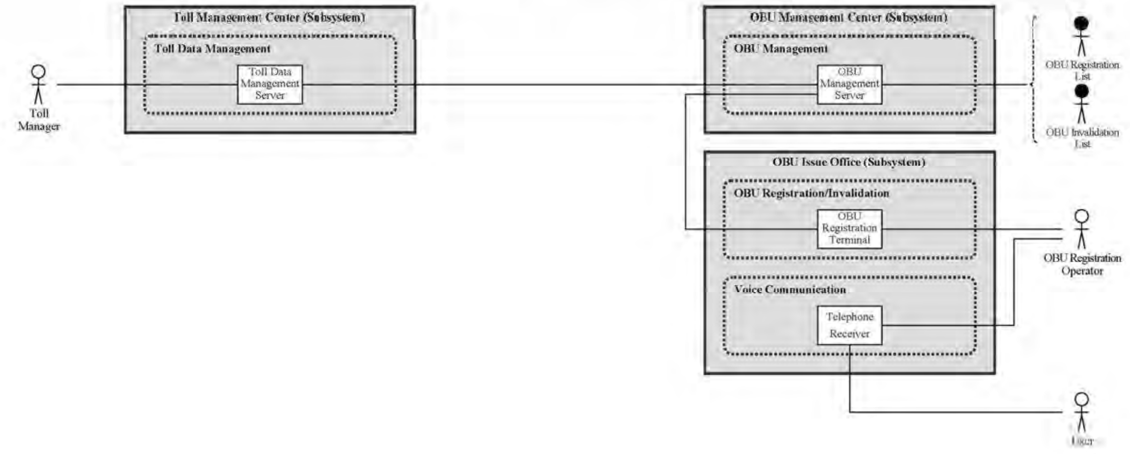
Figure 11.15 Center-to-Center Data Exchange – (2) for IC-card Operation



Note: "Toll Management Center" is not the name of specific place. Its functions can be installed fully in the toll office or partially in the head office of the road owner.

Source: ITS Integration Project (SAPI) Study Team

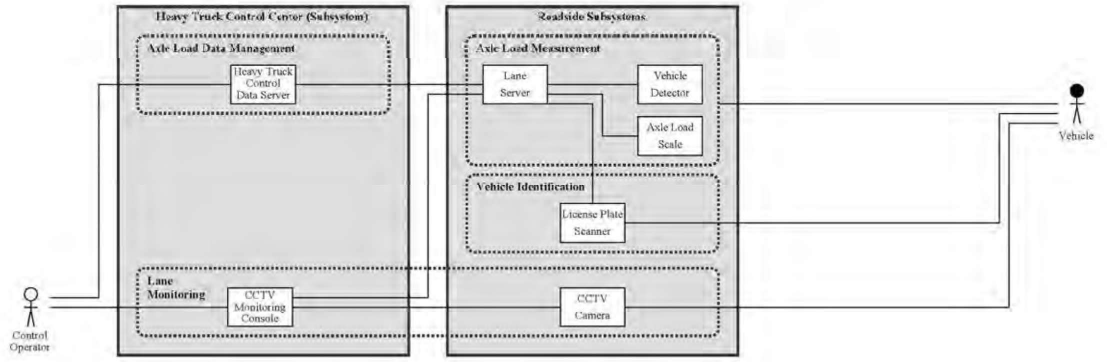
Figure 11.16 Center-to-Center Data Exchange – (3) for OBU Management



Note: "Toll Management Center" is not the name of specific place. Its functions can be installed fully in the toll office or partially in the head office of the road owner.

Source: ITS Integration Project (SAPI) Study Team

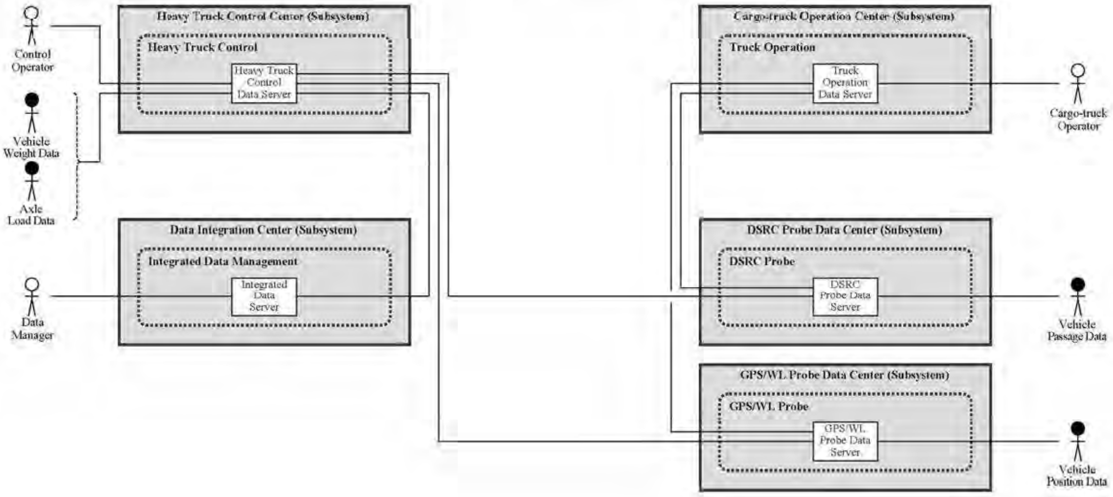
Figure 11.17 Vehicle Weighing – (1) by Axle Load Scale



Note: "Heavy Truck Control Center" is not the name of specific place. Its functions can be installed fully in a toll office or a road management office.

Source: ITS Integration Project (SAPI) Study Team

Figure 11.18 Center-to-Center Data Exchange – (1) for Heavy Traffic Control



Note: "Heavy Truck Control Center" is not the name of specific place. Its functions can be installed in a toll office or a road management office.

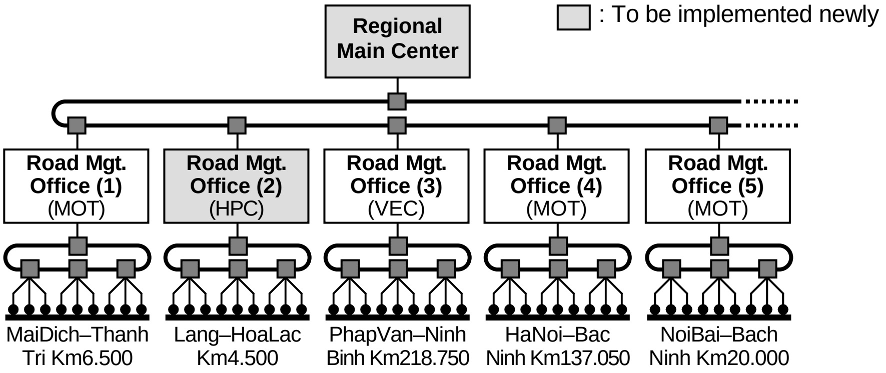
Source: ITS Integration Project (SAPI) Study Team

11.6.3 Center Equipment

1) Location of Northern Regional Main Center and Road Management Offices

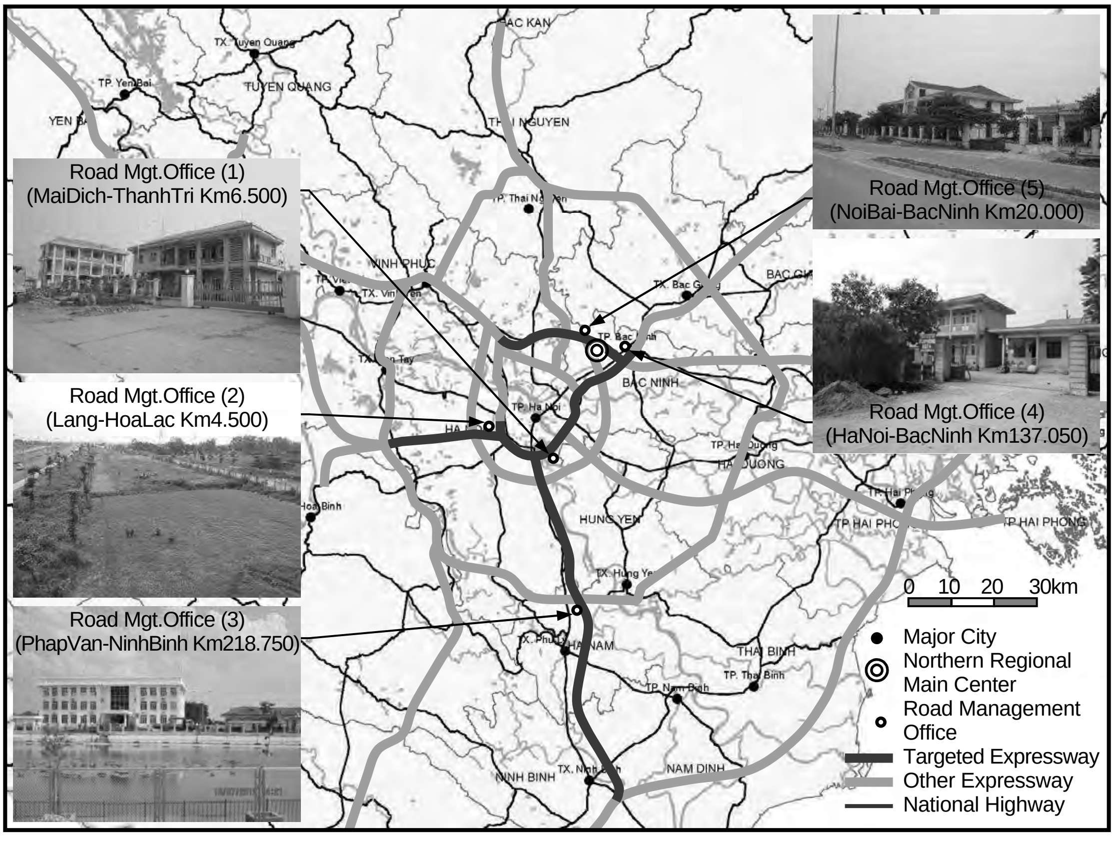
The structure and location of the Northern Regional Main Center and the road management offices are shown in the figures below. The center equipment for all of the Northern Regional Main Center and the road management offices needs to be implemented in the Project. The building construction only for the Northern Regional Main Center and the road management office of the Lang – Hoa Lac section is necessary in the Project.

Figure 11.19 Northern Regional Main Center and Road Management Offices



Source: ITS Integration Project (SAPI) Study Team

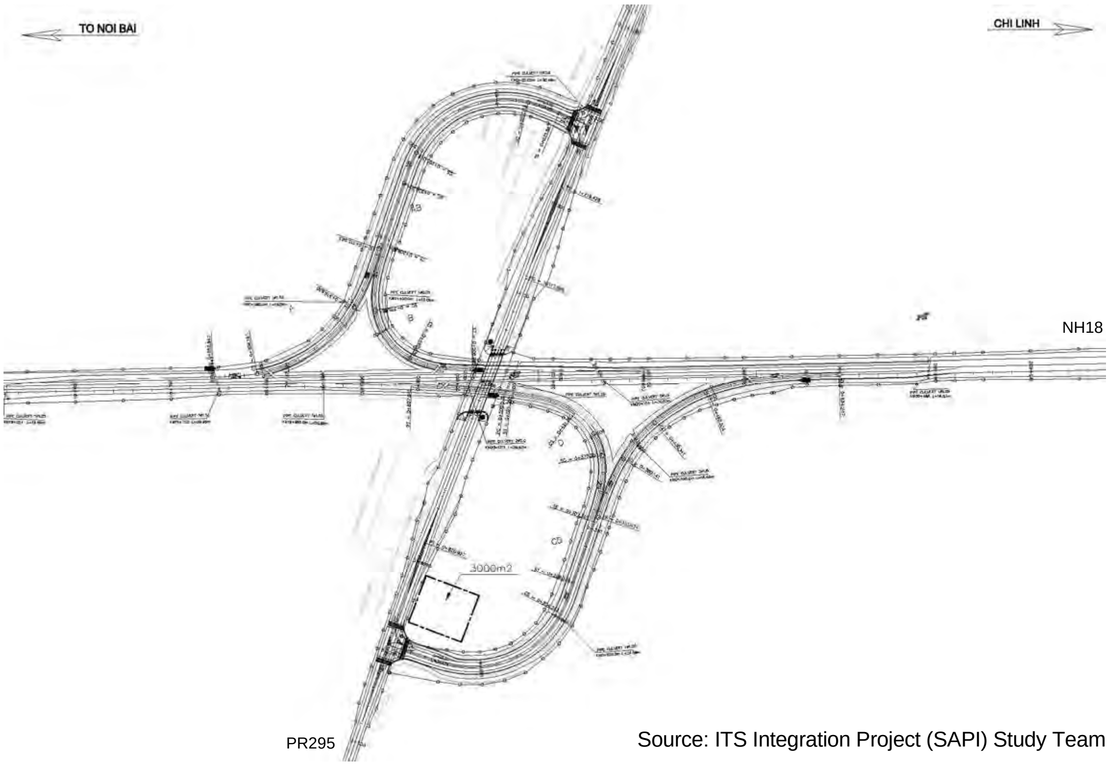
Figure 11.20 Location of Northern Regional Main Center and Road Management Offices



Source: ITS Integration Project (SAPI) Study Team

The Northern Regional Center, which requires the site of 3000 m^2, is to be constructed in the area surrounded by the ramps in the interchange between Noi Bai – Bac Ninh and the Provincial Road 295 in the Project as shown in the following figure.

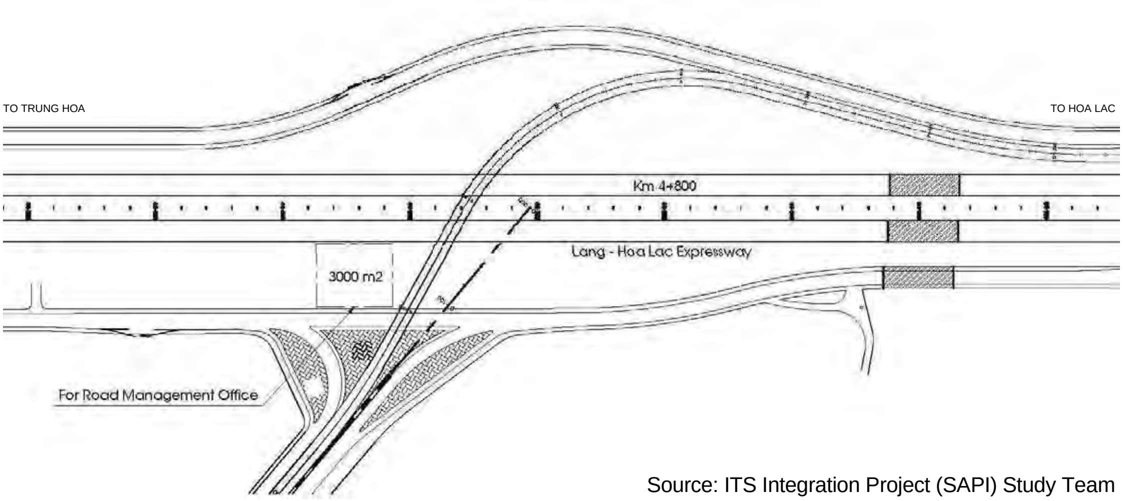
Figure 11.21 Location of Northern regional Main Center



Source: ITS Integration Project (SAPI) Study Team

The road management office of the Lang – Hoa Lac section, which requires the site of 3000 m^2, is to be constructed on the north side in the right of way of the road section at around KM 4+500.

Figure 11.22 Location of Road Management Office of Lang – Hoa Lac Section



Source: ITS Integration Project (SAPI) Study Team

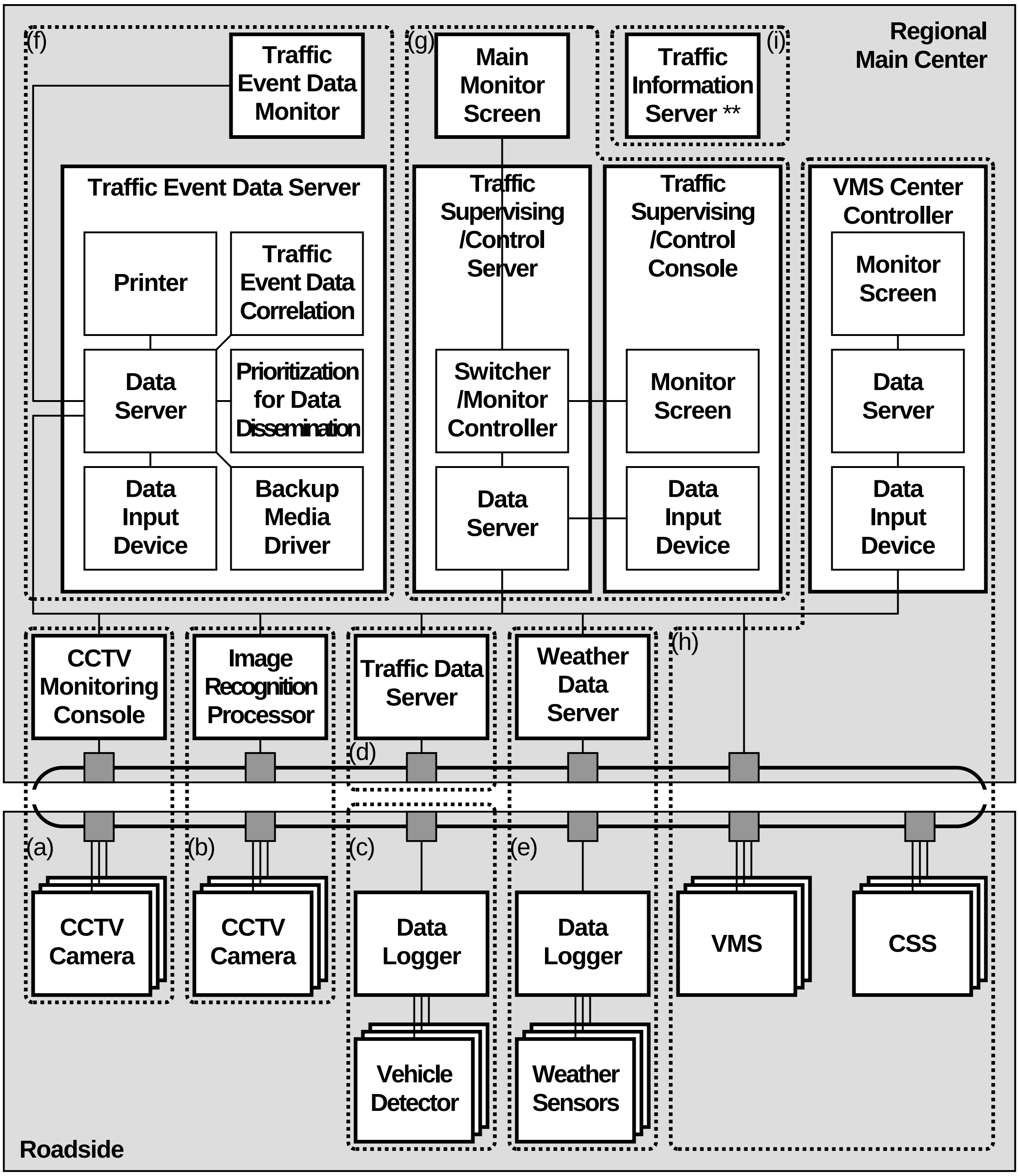
System architectures and the functional packages required for the Northern Regional Main Center and the road management offices are to be mentioned in the following.

2) Northern Regional Main Center

Traffic information/control is to be conducted totally from the Regional Main Center using the following functional packages:

(a) CCTV Monitoring
(b) Event Detection (by Image)
(c) Vehicle Detection
(d) Traffic Analysis
(e) Weather Monitoring
(f) Traffic Event Data Management
(g) Traffic Supervision
(h) VMS Indication
(i) Traffic Information

Figure 11.23 System Architecture for Northern Regional Main Center

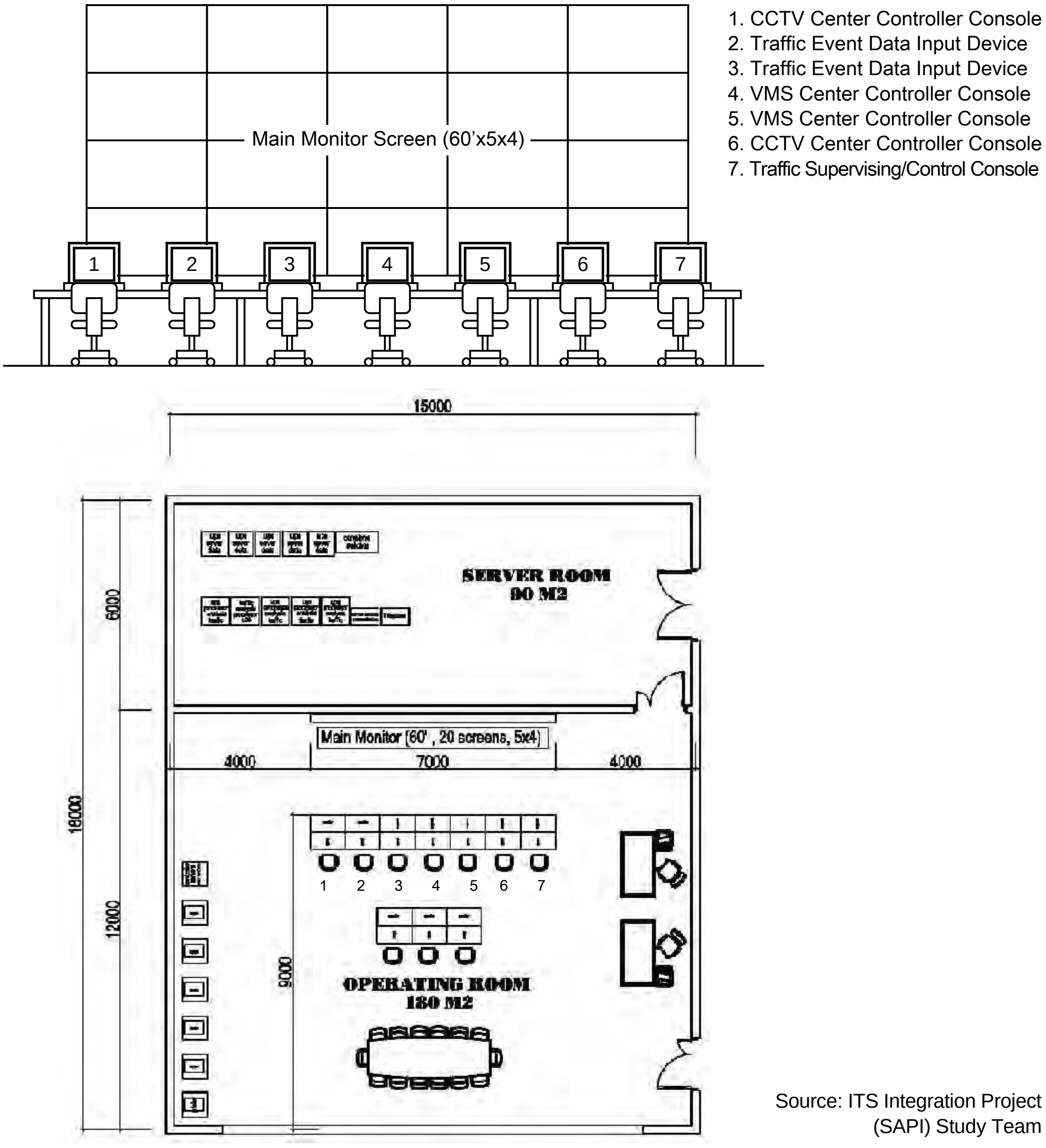


Note, ⬚ : Functional package, ** : Protected by a firewall for connecting to the Internet and stored data in it is to be copied from the traffic event data server.

Source: ITS Integration Project (SAPI) Study Team

Consequently, vehicle detectors, weather sensors and VMSs need to be controlled directly from the Regional Main Center for integrating traffic information dissemination. The center equipment for actualising these functions is to be installed in the Regional Main Center as shown in the figure below.

Figure 11.24 Equipment Overview in Regional Main Center

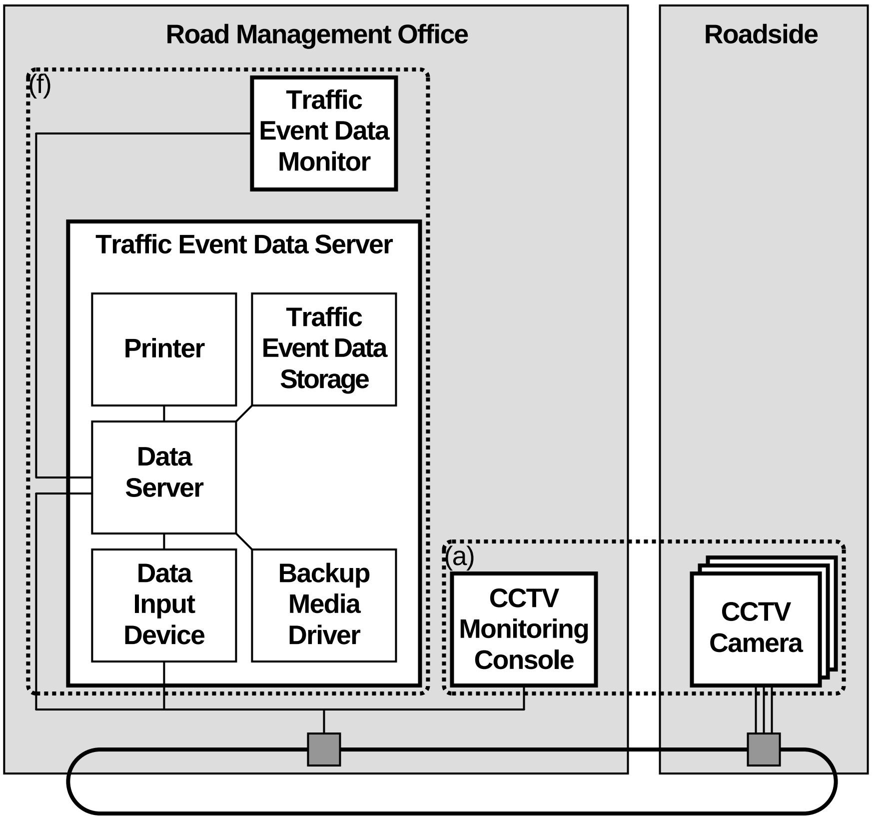


Source: ITS Integration Project (SAPI) Study Team

3) Road Management Office

A part of center equipment is to be installed in the road management offices for expressway operation. CCTV cameras are to be controlled and the traffic event data are to be input from the road management office as well for handling and clearing incidents. However, prioritisation of the traffic event data is to be done in the Regional Main Center and the result is to be sent directly to the VMS or CSS.

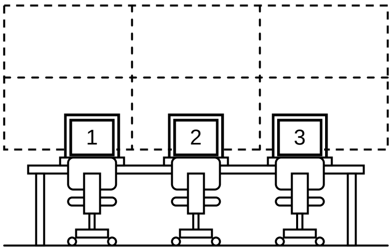
Figure 11.25 System Architecture for Road Management Office



Note: ⬚ : Functional package

Source: ITS Integration Project (SAPI) Study Team

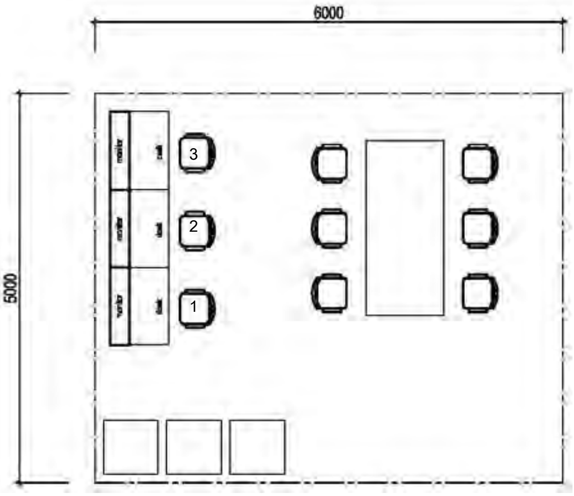
Figure 11.26 Equipment Overview in Road Management Office



1. Traffic Event Data Input Device
2. CCTV Monitoring Console**
3. CCTV Monitoring Console

**: A CCTV monitoring console can be replaced with the traffic supervising/control console in the case the main monitor screen is installed in the road management office.

Source: ITS Integration Project (SAPI) Study Team



Source: ITS Integration Project (SAPI) Study Team

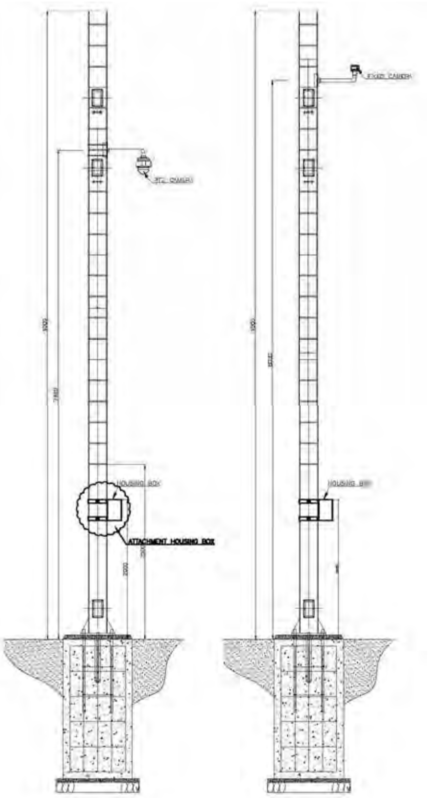
11.6.4 Roadside Equipment

In the Project, roadside equipment components below are to be installed for the 1st stage of stepwise implementation.

- CCTV camera (for monitoring and for event detection)
- Vehicle detector
- VMS (Variable Message Sign)
- CSS (Changeable Speed Limit Sign)
- ETC (Electronic Toll Collection)
- Touch&Go/manual
- Axle load scale

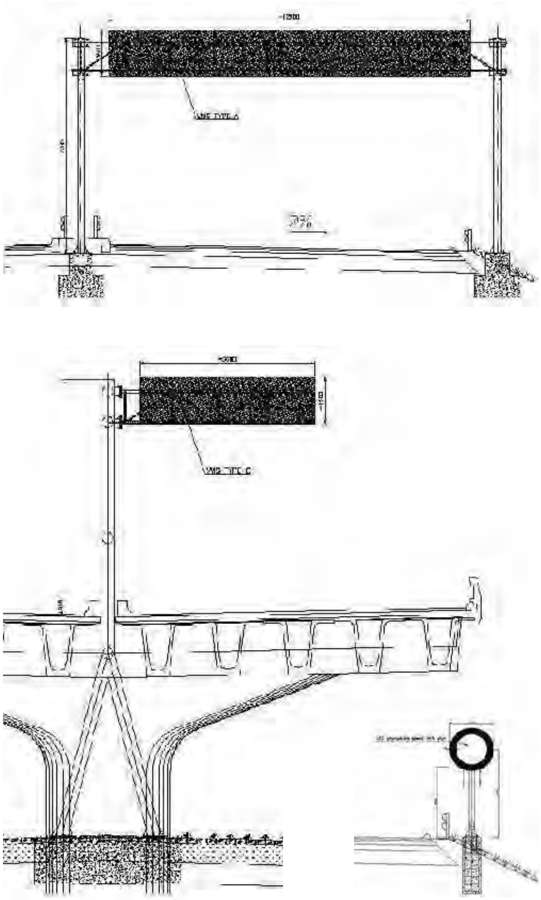
Typical installation of roadside equipment components are shown in the following figures and the arrangement on the road network is shown in the following tables.

Figure 11.27 Installation of CCTV Camera



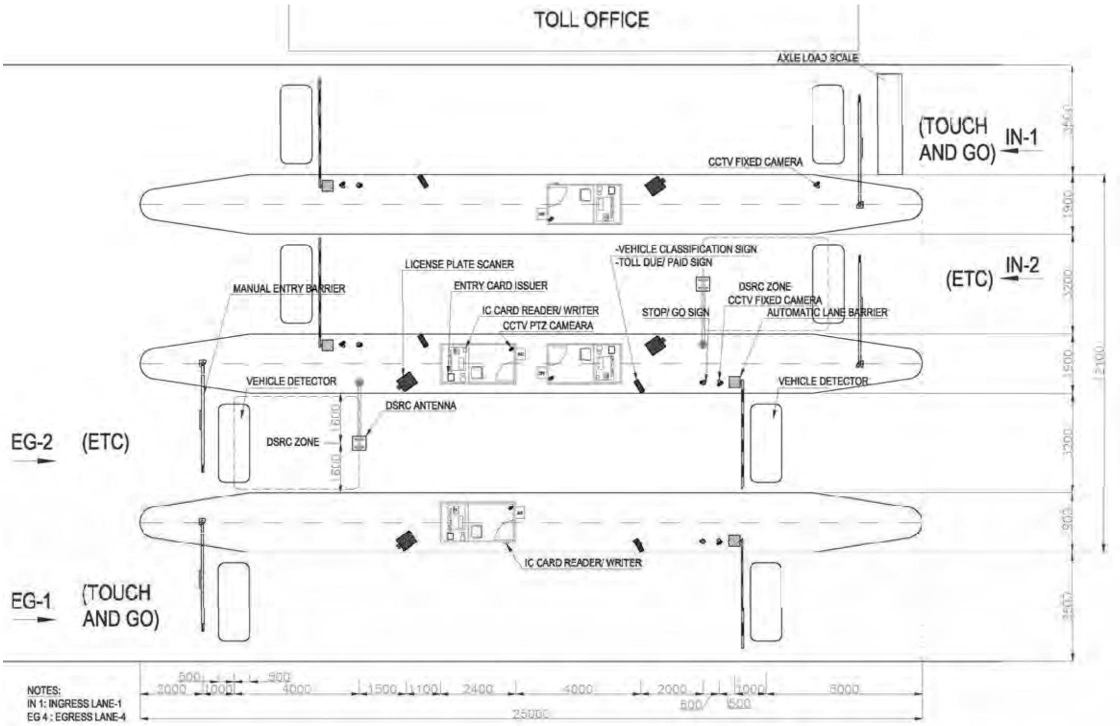
Source: ITS Integration Project (SAPI) Study Team

Figure 11.28 Installation of VMS/CSS



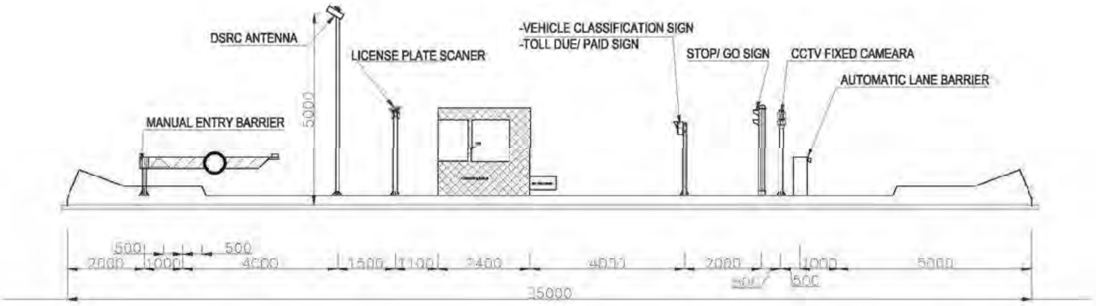
Source: ITS Integration Project (SAPI) Study Team

Figure 11.29 Installation of Roadside Equipment for Toll Collection



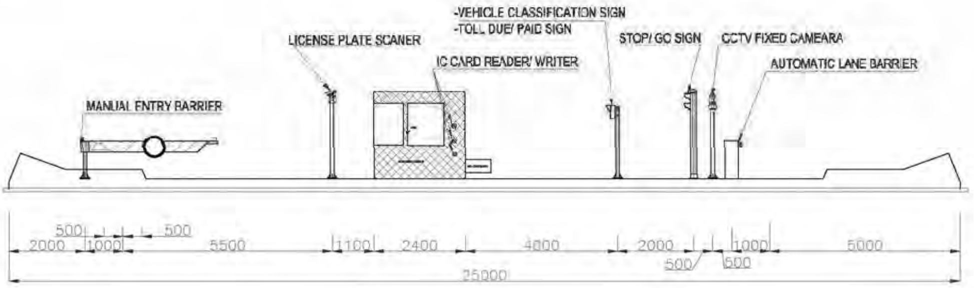
Source: ITS Integration Project (SAPI) Study Team

Figure 11.30 Installation of Roadside Equipment for ETC



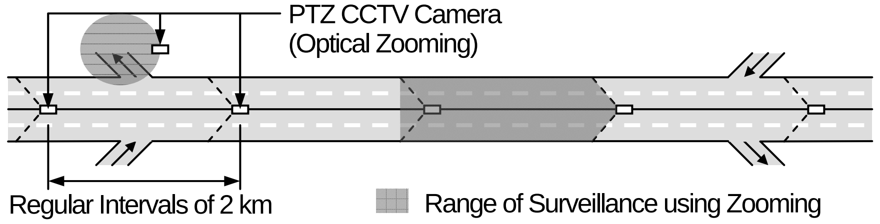
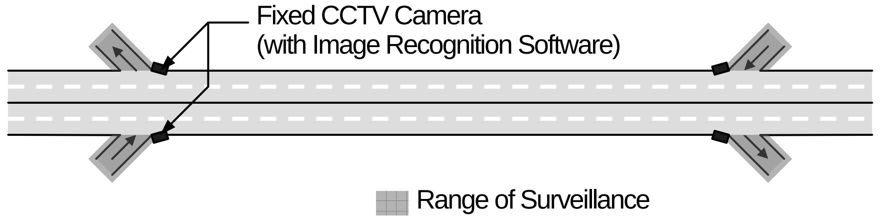
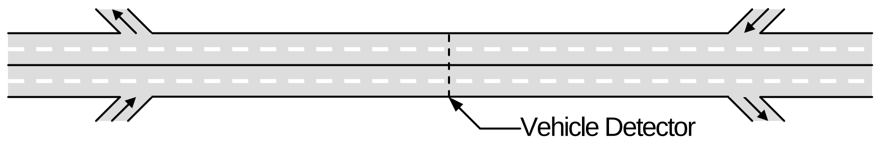
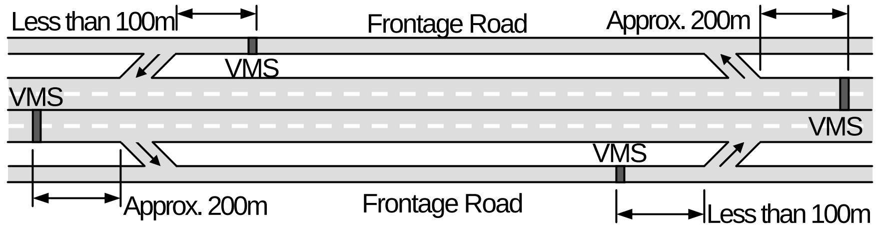
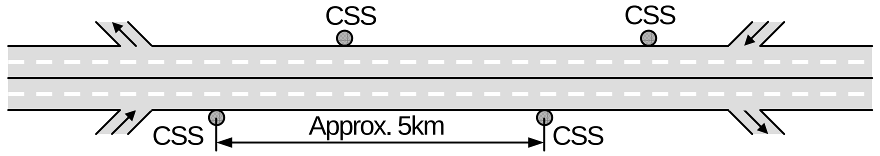
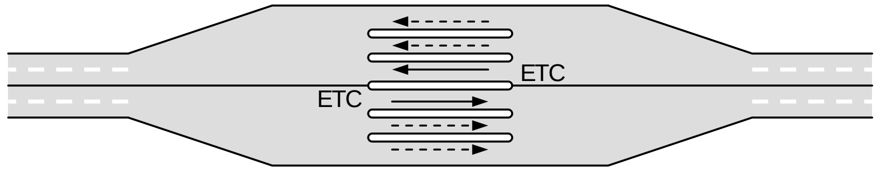
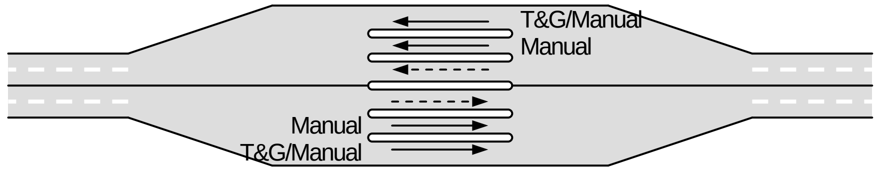
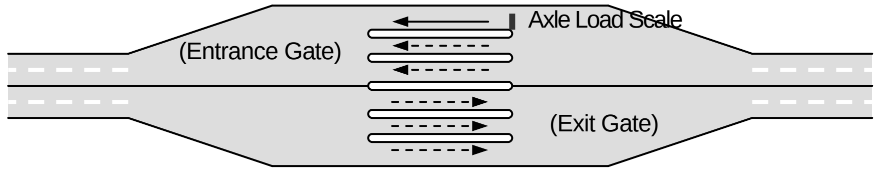
Source: ITS Integration Project (SAPI) Study Team

Figure 11.31 Installation of Roadside Equipment for Touch&Go/Manual



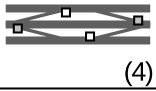
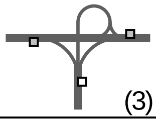
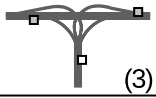
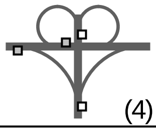
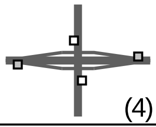
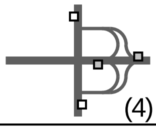
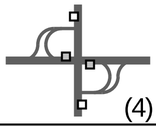
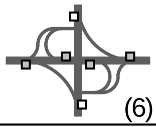
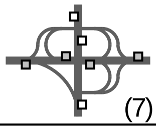
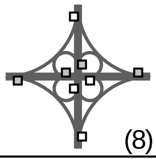
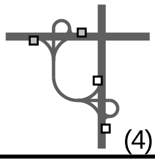
Source: ITS Integration Project (SAPI) Study Team

Table 11.1 Total Arrangement of Roadside Equipment Components by the Project

Arrangement of Roadside Equipment			Mai Dich–Thanh Tri Section	Lang–Hoa Lac Section	Phap Van–Cau Gie –Ninh Binh Section	Ha Noi–Bac Ninh Section	Noi Bai–Bac Ninh Section
1. PTZ Camera: for Monitoring		At regular intervals of 2 km (in practical use)	24 sets	38 sets	16 sets Excluding items to be installed by Grant and by 1st Stage ITS (design by Cadpro)	31 sets	48 sets
2. Fixed Camera: for Event Detection		At all ramps (in trial use)	10 sets Fully equipped with image recognition	20 sets	0 sets Excluding items to be installed by Grant and by 1st Stage ITS (designed by Cadpro)	27 sets	12 sets
3. Vehicle Detector:		At middle point between a pair of interchanges (in practical use)	14 sets	8 sets	12 sets	10 sets	6 sets
4. VMS: for Traffic Information		At 100 m back from the diverge to entrance gate and at 200 m back from the diverge to exit gate (in practical use)	18 sets	16 sets	18 sets Excluding items to be installed by Grant	18 sets	14 sets
5. CSS: for Speed Limitation		At regular intervals of 5 km (in practical use)	14 sets	9 sets	37 sets	10 sets	17 sets
6. ETC: for Toll Collection		At a median-side lane of the tollgate which has lanes more than two (in practical use)	2 sets	--	12 sets Excluding items to be installed by 1st Stage ITS (designed by Cadpro)	2 sets	2 sets
7. Touch&Go/Manual: for Toll Collection		At a roadside lane of all toll gates (in practical use)	8 sets	--	60 sets	8 sets	8 sets
8. Axle Load Scale: Overloading Regulation		At a roadside lane of entrance toll gates (in practical use)	2 sets	--	6 sets Excluding items to be installed by 1st Stage ITS (designed by Cadpro)	2 sets	2 sets

Source: ITS Integration Project (SAPI) Study Team

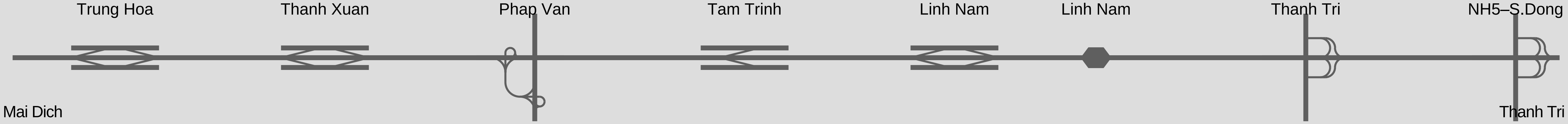
Table 11.2 Interchanges and VMS Arrangement

Type of Interchange/ Arrangement of VMS		Mai Dich–Thanh Tri Section	Lang–Hoa Lac Section	Phap Van–Cau Gie –Ninh Binh Section	Ha Noi–Bac Ninh Section	Noi Bai–Bac Ninh Section
Diamond	 (4)	3.5	3	3		
Trumpet	 (3)			1	2	1
Directional T	 (3)					
Half Clover	 (4)					
Diamond	 (4)					
Folded Diamond	 (4)	2		1		
Partial Cloverleaf	 (4)				1	1
6 Ramp Partial Cloverleaf	 (6)			1		
7 Ramp Partial Cloverleaf	 (7)				1	
Cloverleaf	 (8)		1		1	
Double Trumpet	 (4)	1				1

□ : VMS at entrance gate   : VMS at exit gate

Source: ITS Integration Project (SAPI) Study Team

Table 11.3 Arrangement of Roadside Equipment Components on Mai Dich – Thanh Tri Section

Arrangement of Roadside Equipment		Trung Hoa		Thanh Xuan		Phap Van		Tam Trinh		Linh Nam		Linh Nam		Thanh Tri		NH5–S.Dong
	Mai Dich															Thanh Tri
1. PTZ Camera: for Monitoring (in Practical Use)	6 sets		2 sets		8 sets		1 sets (+1 sets :Grant)		3 sets (+3 sets :Grant)				2sets (+2 sets :Grant)		2sets (+2 sets :Grant)	
						(+5 sets :Grant)								(+2 sets :Grant)		(+2 sets :Grant)
2. Fixed Camera: for Event Detection (in Trial Use)		4 sets fully equipped with image recognition		4 sets fully equipped with image recognition		2 sets fully equipped with image recognition (+6 sets :Grant)		(+2 sets :Grant)		(+4 sets :Grant)				(+2 sets :Grant)		(+2 sets :Grant)
3. Vehicle Detector (in Practical Use)	2 sets		2 sets		2 sets		2 sets		2 sets (+2 sets :Loop-coil)				2 sets		2 sets	
4. VMS: for Traffic Information (in Practical Use)		4 sets		4 sets		2 sets (+2 sets :Grant)		1 set (+1 set :Grant)		2 set (+2 sets :Grant)		1 set		2 set (+1 sets :Grant)		2 set (+2 sets :Grant)
5. CSS: for Speed Limitation (in Practical Use)	1 sets		2 sets		4 sets		2 sets		1 sets				2 sets		2 sets	
6. ETC: for Toll Collection (in Practical Use)												2 sets				
7. Touch&Go/ Manual: for Toll Collection (in Practical Use)												8 sets				
8. Axle Load Scale: for Overloading Regulation (in Practical Use)												2sets				

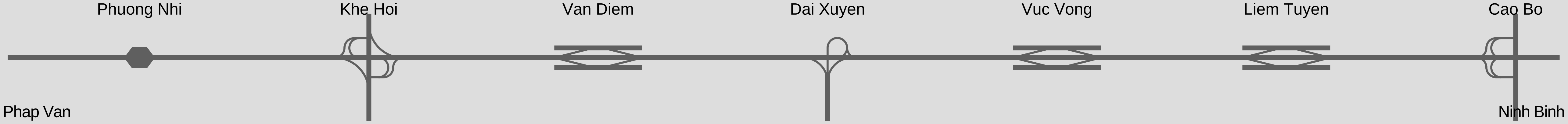
Source: ITS Integration Project (SAPI) Study Team

Table 11.4 Arrangement of Roadside Equipment Components on Lang – Hoa Lac Section

<table>
<tr><td>Arrangement of Roadside Equipment</td><td colspan="14"> </td></tr>
<tr><td rowspan="2">1. PTZ Camera: for Monitoring (in Practical Use)</td><td></td><td colspan="2"></td><td colspan="3">14 sets</td><td colspan="3">20 sets</td><td colspan="3">4 sets</td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td></td><td colspan="2"></td><td></td><td colspan="2"></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>2. Fixed Camera: for Event Detection (in Trial Use)</td><td colspan="2">8 sets</td><td colspan="2">2 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">2 sets</td><td></td></tr>
<tr><td>3. Vehicle Detector (in Practical Use)</td><td></td><td colspan="2"></td><td colspan="3">2 sets</td><td colspan="3">2 sets</td><td colspan="3">2 sets
(+2 sets: Loop-coil)</td><td colspan="2">2 sets</td></tr>
<tr><td>4. VMS: for Traffic Information (in Practical Use)</td><td colspan="2">5 sets</td><td colspan="2">1 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">2 sets</td><td></td></tr>
<tr><td>5. CSS: for Speed Limitation (in Practical Use)</td><td></td><td colspan="2"></td><td colspan="3">4 sets</td><td colspan="3">3 sets</td><td colspan="3">2 sets</td><td colspan="2"></td></tr>
<tr><td>6. ETC: for Toll Collection (in Practical Use)</td><td colspan="14"></td></tr>
<tr><td>7. Touch&Go/ Manual: for Toll Collection (in Practical Use)</td><td colspan="14"></td></tr>
<tr><td>8. Axle Load Scale: for Overloading Regulation (in Practical Use)</td><td colspan="14"></td></tr>
</table>

Source: ITS Integration Project (SAPI) Study Team

Table 11.5 Arrangement of Roadside Equipment Components on Phap Van – Cau Gie – Ninh Binh Section

Arrangement of Roadside Equipment	 Phap Van	Phuong Nhi		Khe Hoi		Van Diem		Dai Xuyen		Vuc Vong		Liem Tuyen		Cao Bo	Ninh Binh
1. PTZ Camera: for Monitoring (in Practical Use)	5 sets (+5 sets :Grant)		2 sets (+2 sets :Grant)		6 sets (+6 sets :Grant)		3 sets (+3 sets :Grant)		**		**		**		
		(+1 sets :Grant)		(+2 sets :Grant)		(+2 sets :Grant)		(+2 sets :Grant)		**		**		**	
2. Fixed Camera: for Event Detection (in Trial Use)				(+4 sets :Grant)		(+4 sets :Grant)		(+4 sets :Grant)		**		**		**	
3. Vehicle Detector (in Practical Use)			2 sets (+2 sets :Loop-coil)		2 sets		2 sets		2 sets		2 sets		2 sets		
4. VMS: for Traffic Information (in Practical Use)				3 sets (+1set :Grant)		4 sets		1 set		4 sets		4 sets		2 sets	
5. CSS: for Speed Limitation (in Practical Use)	3 sets		3 sets		6 sets		4 sets		4 sets		6 sets		11 sets		
6. ETC: for Toll Collection (in Practical Use)		2 sets		4 sets		4 sets		2 sets		**		**		**	
7. Touch&Go/ Manual: for Toll Collection (in Practical Use)		8 sets		16 sets		16 sets		8 sets		4 sets		4 sets		4 sets	
8. Axle Load Scale: for Overloading Regulation (in Practical Use)		1 sets		2 sets		2sets		1 set		**		**		**	

Note, ** :To be installed by other project as the 1st stage of ITS implementation (designed by Cadpro).

Source: ITS Integration Project (SAPI) Study Team

Table 11.6 Arrangement of Roadside Equipment Components on Ha Noi – Bac Ninh Section

<table>
<tr><td>Arrangement of Roadside Equipment</td><td colspan="17">
</td></tr>
<tr><td rowspan="2">1. PTZ Camera:
for Monitoring
(in Practical Use)</td><td></td><td colspan="3">12 sets</td><td colspan="3">4 sets</td><td colspan="3">2 sets</td><td colspan="3">4 sets</td><td colspan="3">8 sets</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td colspan="2"></td><td></td><td colspan="2"></td><td></td><td colspan="2"></td><td></td><td colspan="2"></td><td></td><td colspan="2">1 sets</td></tr>
<tr><td>2. Fixed Camera:
for Event Detection
(in Trial Use)</td><td colspan="2"></td><td></td><td colspan="2">7 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">8 sets</td><td></td><td colspan="2">4 sets</td></tr>
<tr><td>3. Vehicle Detector
(in Practical Use)</td><td></td><td colspan="3">2 sets</td><td colspan="3">2 sets</td><td colspan="3">2 sets</td><td colspan="3">2 sets</td><td colspan="3">2 sets
(+2 sets :Loop-coil)</td><td></td></tr>
<tr><td>4. VMS:
for Traffic Information
(in Practical Use)</td><td colspan="2"></td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">3 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">3 sets</td></tr>
<tr><td>5. CSS:
for Speed Limitation
(in Practical Use)</td><td></td><td colspan="3">2 sets</td><td colspan="3">2 sets</td><td colspan="3">2 sets</td><td colspan="3">2 sets</td><td colspan="3">2 sets</td><td></td></tr>
<tr><td>6. ETC:
for Toll Collection
(in Practical Use)</td><td colspan="2">2 sets</td><td colspan="15"></td></tr>
<tr><td>7. Touch&Go/ Manual:
for Toll Collection
(in Practical Use)</td><td colspan="2">8 sets</td><td colspan="15"></td></tr>
<tr><td>8. Axle Load Scale:
for Overloading Regulation
(in Practical Use)</td><td colspan="2">2 sets</td><td colspan="15"></td></tr>
</table>

Source: ITS Integration Project (SAPI) Study Team

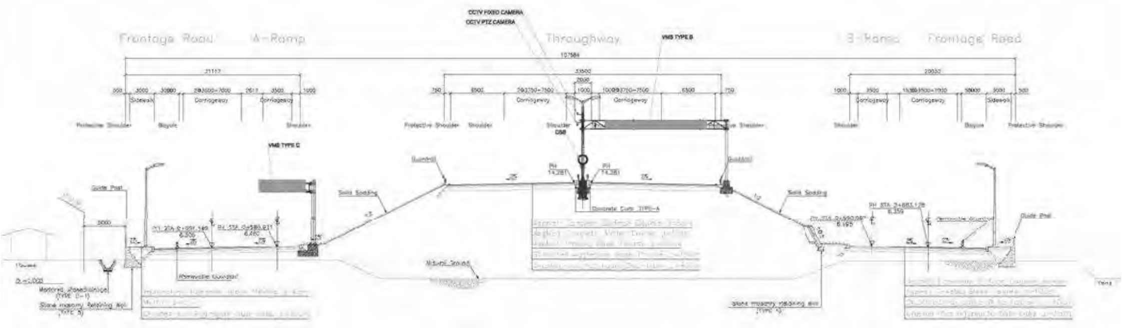
Table 11.7 Arrangement of Roadside Equipment Components on Noi Bai – Bac Ninh Section

<table>
<tr><td>Arrangement of Roadside Equipment</td><td colspan="13"> </td></tr>
<tr><td rowspan="2">1. PTZ Camera: for Monitoring (in Practical Use)</td><td colspan="2">4 sets</td><td colspan="3">10 sets</td><td colspan="3">12 sets</td><td colspan="3">4 sets</td><td colspan="2">14 sets</td></tr>
<tr><td></td><td colspan="2"></td><td></td><td colspan="2">2 sets</td><td></td><td colspan="2"></td><td></td><td colspan="2">2 sets</td><td></td></tr>
<tr><td>2. Fixed Camera: for Event Detection (in Trial Use)</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2"></td><td></td><td colspan="2">4 sets</td><td></td></tr>
<tr><td>3. Vehicle Detector (in Practical Use)</td><td colspan="2"></td><td colspan="3">2 sets</td><td colspan="3">2 sets</td><td colspan="3"></td><td colspan="2">2 sets
(+2 sets :Loop-coil)</td></tr>
<tr><td>4. VMS: for Traffic Information (in Practical Use)</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">4 sets</td><td></td><td colspan="2">2 sets</td><td></td><td colspan="2">4 sets</td><td></td></tr>
<tr><td>5. CSS: for Speed Limitation (in Practical Use)</td><td colspan="2"></td><td colspan="3">2 sets</td><td colspan="3">6 sets</td><td colspan="3">1 sets</td><td colspan="2">8 sets</td></tr>
<tr><td>6. ETC: for Toll Collection (in Practical Use)</td><td colspan="7"></td><td colspan="2">2 sets</td><td colspan="4"></td></tr>
<tr><td>7. Touch&Go/ Manual: for Toll Collection (in Practical Use)</td><td colspan="7"></td><td colspan="2">8 sets</td><td colspan="4"></td></tr>
<tr><td>8. Axle Load Scale: for Overloading Regulation (in Practical Use)</td><td colspan="7"></td><td colspan="2">2 sets</td><td colspan="4"></td></tr>
</table>

Source: ITS Integration Project (SAPI) Study Team

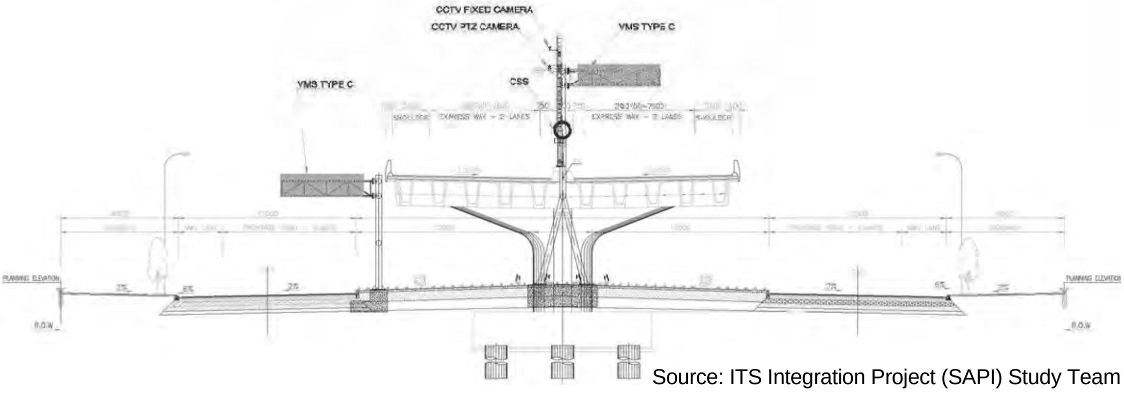
Typical cross sections of the installation of VMS, CSS and CCTV camera respectively at earthwork section, viaduct section and bridge section are shown in the following figures.

Figure 11.32 Typical Cross Section of Roadside Equipment Installation at Earthwork Section



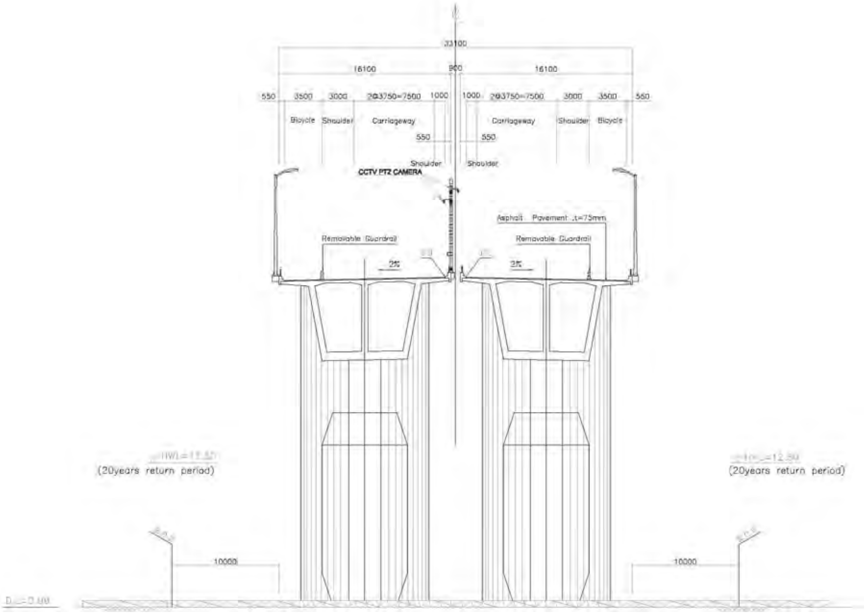
Source: ITS Integration Project (SAPI) Study Team

Figure 11.33 Typical Cross Section of Roadside Equipment Installation at Viaduct Section



Source: ITS Integration Project (SAPI) Study Team

Figure 11.34 Typical Cross Section of Roadside Equipment Installation at Bridge Section



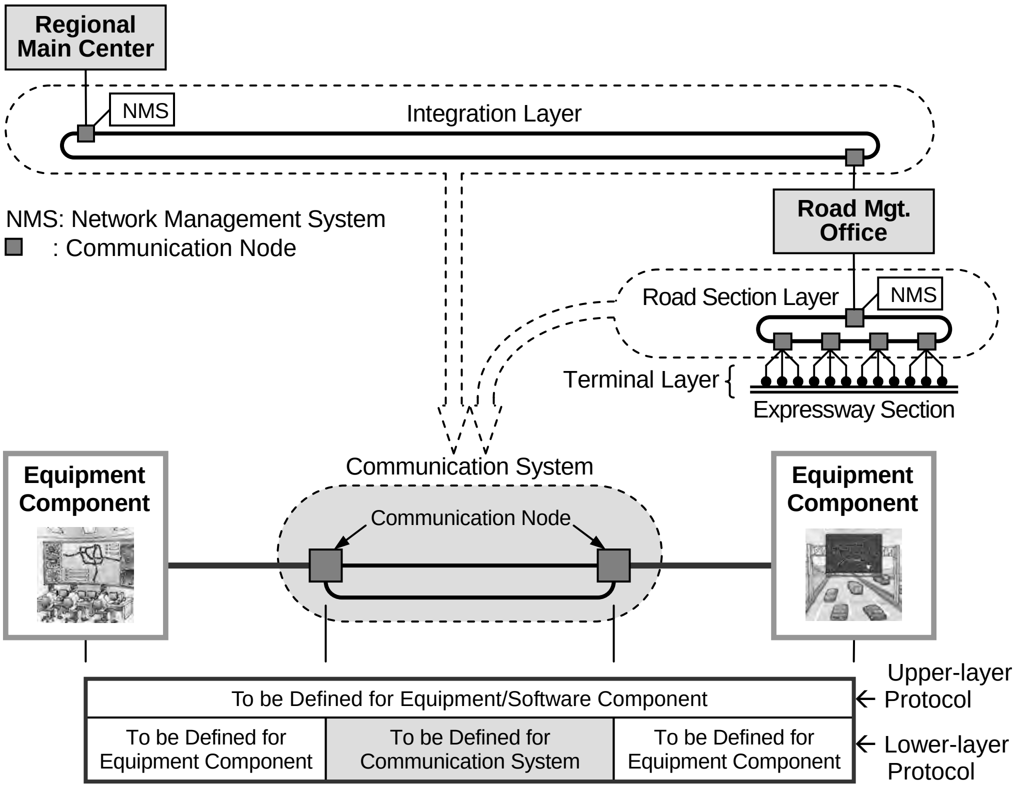
Source: ITS Integration Project (SAPI) Study Team

11.6.5 Communication System

In the Study, scope of communication system is defined for discussion as below. That is responding to the following features of wired communications to be used for ITS, and in the discussion of the Study, lower-layer protocol, which is to be used among nodes, is the most important subject:

- Upper-layer Protocol: To be unchanged continuously between a pair of equipment components, and to be discussed based on a logical system architecture
- Lower-layer Protocol: To be changed at a midway communication node and shared by many different applications (i.e. functional packages), and to be discussed based on a physical system architecture.

Figure 11.35 Scope of Communication System and Definitions of Communication Protocol



To be Defined for Equipment/Software Component		
To be Defined for Equipment Component	To be Defined for Communication System	To be Defined for Equipment Component

Source: ITS Integration Project (SAPI) Study Team

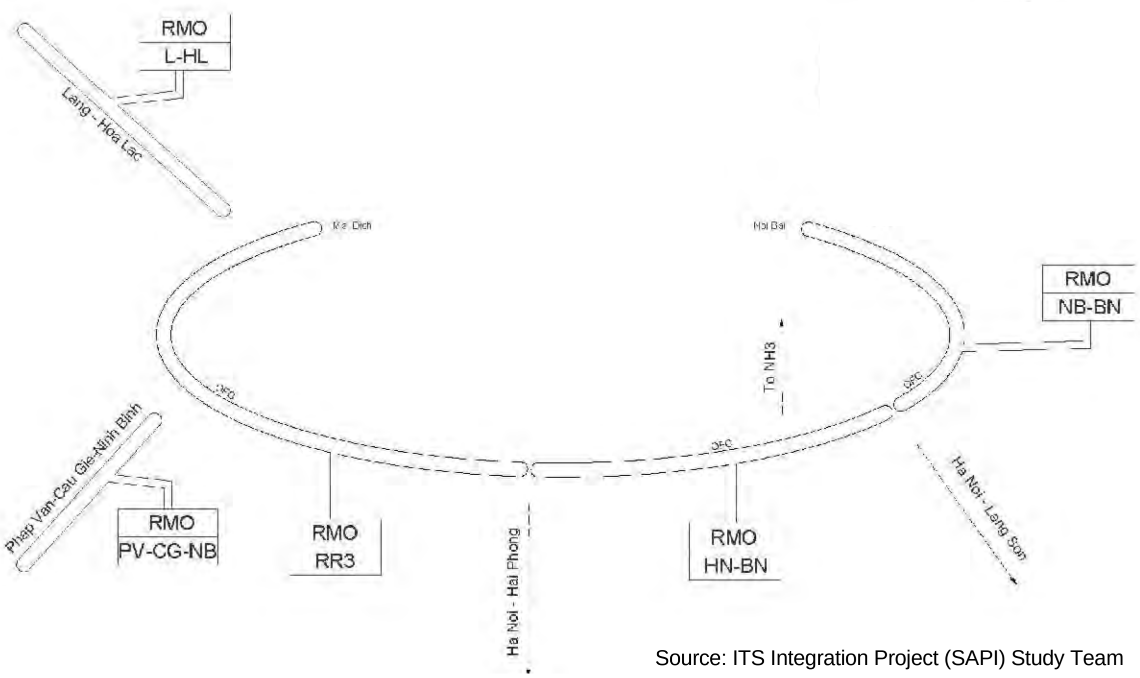
Discussion items on the communication system (only in the case wired) are as follows:

- Communication network layers
- Appropriate transmission system for ITS
- Applicable protocol
- IP version
- Network configuration overview for ITS integration project
- Equipment component of voice communication
- Numbering plan
- Directive telephone set
- Administrative telephone set

- Equipment component of mobile radio communication
- Radio communication system
- Speech quality
- Radio wave propagation
- Antenna supporting pole
- Equipment component of communication system
- Transmission distance
- Number of optical fiber cores
- Number of optical fiber cables
- Network management system.

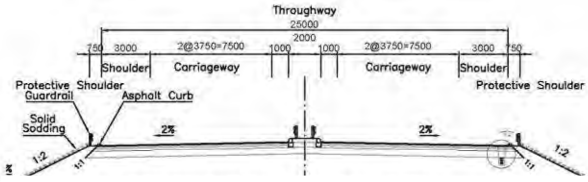
Communication network is to be implemented in ring shape along the expressway network as shown in the figure below.

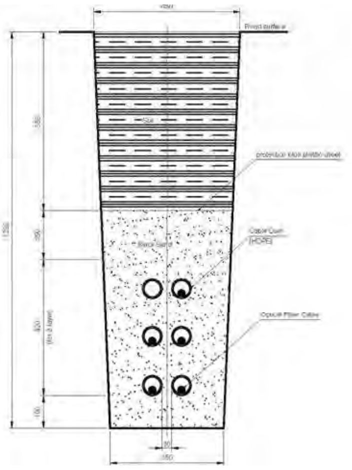
Figure 11.36 Outline of Communication Network



Source: ITS Integration Project (SAPI) Study Team

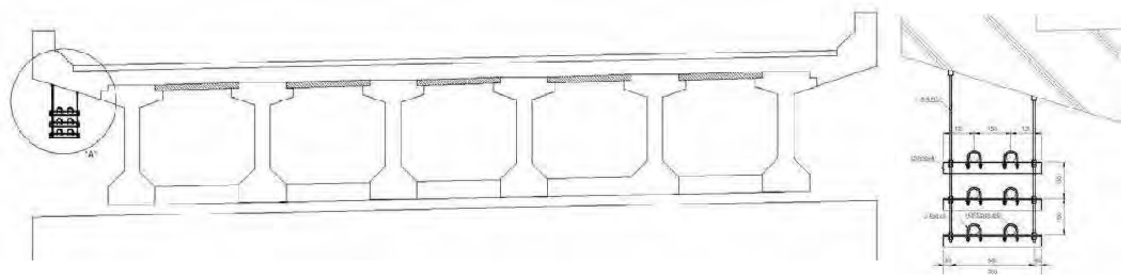
Figure 11.37 Installation of Communication Duct at Earth Section





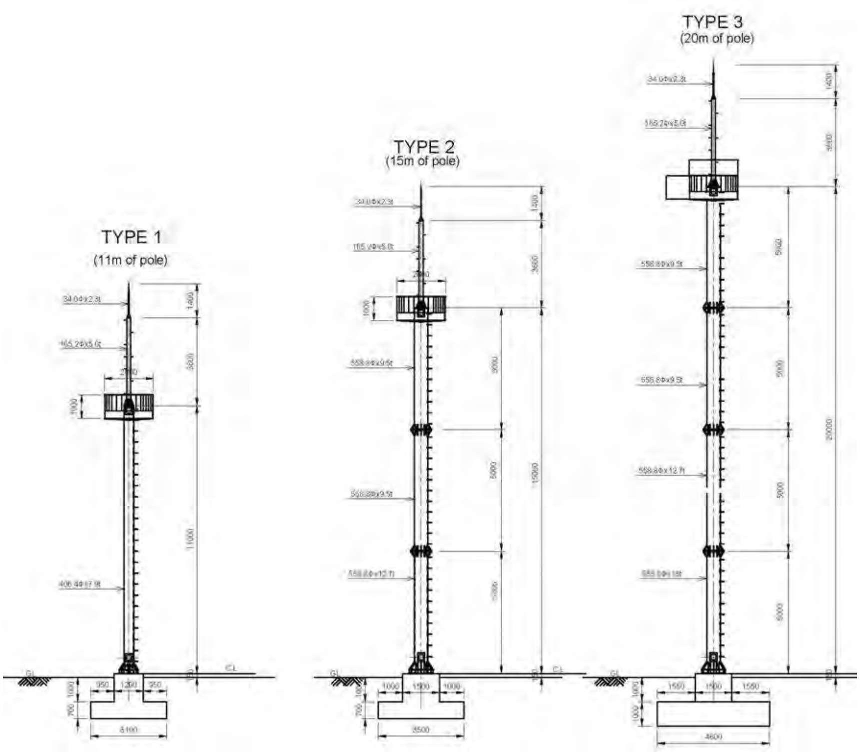
Source: ITS Integration Project (SAPI) Study Team

Figure 11.38 Installation of Communication Duct at Bridge Section



Source: ITS Integration Project (SAPI) Study Team

Figure 11.39 Installation of Radio Communication Antenna



Source: ITS Integration Project (SAPI) Study Team

11.7 Structures and Others

11.7.1 Communication Duct Design

The following discussion results are to be shown for the design of communication ducts.

- Plan arrangement
- Earthwork sections
- Box culverts and crossing pipes
- Bridge sections
- Chamber.

11.7.2 Base Structure Design

The following discussion results are to be shown for the design of base structures.

- Pole for CCTV
- Pole for changeable CSS
- Pole for weather observation equipment
- Gantry for VMS
- Tower for mobile radio communication
- Works for axle load scale.

11.7.3 Building Plan

(1) Northern regional main center

A building is to be constructed for the Northern Regional Main Center with the features below.

3-Storied Building	: 720 m^2 x3 (720 m^2 for Building Lot Area)
Structure	: SRC (Steel-framed Reinforced Concrete)
Foundation	: RC Pile Foundation
Parking/Passage Area	: 1500 m^2
Total Area	: 3000 m^2 (including Green Area)

(2) Road management office

Space of 30 m^2 is to be secured in all existing road management offices for ITS. A building is to be constructed for the Lang – Hoa Lac Expressway Section with the features below.

2-Storied Building	: 360 m^2 x2 (360 m^2 for Building Lot Area)
Structure	: SRC (Steel-framed Reinforced Concrete)
Foundation	: RC Pile Foundation
Parking/Passage Area	: 750 m^2
Total Area	: 3000m^2 (including Green Area)

(3) Toll office

Space of 20 m^2 is to be secured in all existing toll offices for ITS.

11.7.4 Electric Power Supply Plan/Design

The following discussion results are to be shown for the plan/design of power supply.

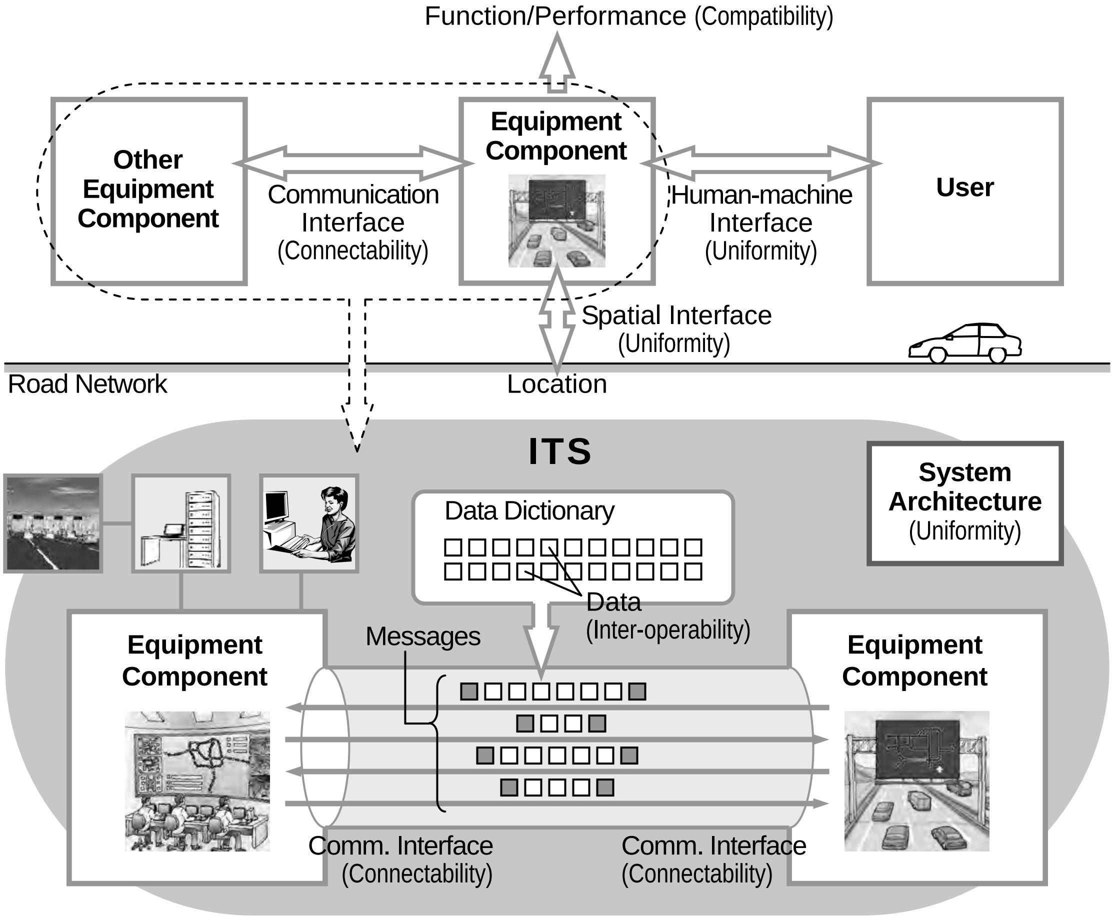
- Basic principle for design
- The survey on power supply status
- Responsibility demarcation point
- Power receiving capacity
- Voltage drop
- Northern Regional Main Center
- Road management office
- Toll office
- Roadside equipment

11.8 Summery of Specifications

1) Policy of Basic Design Specification

In the Study, wide selectivity on technologies is to be ensured for realizing the services of ITS by performance specifications. The specifications are defined onto equipment components through their attributes that can be verified externally such as functions, performance and interfaces. That is named as the Basic Design Specifications. In compliance with the results of the Basic Design, the detailed design specifications shall be prepared by the Contractor of the Project Implementation.

Figure 11.40 Performance Specifications on Equipment Component



Source: ITS Integration Project (SAPI) Study Team

Table 11.8 Specification Items to be Described for Equipment Component

Subject to be Specified /Property to be Secured		Specification Item	ITS Standards for Reference
System	Uniformity	System Architecture	Design Standards
Equipment Component	Compatibility	Functions/Performance	General Specification
Human-Machine Interface	Uniformity	Handling/Indication	General Specification
Communication Interface	Connectability	Protocol (Upper/Lower-Layer)	Comm. System Plan
Data	Interoperability	Message List	Message/Data Standards
		Data Dictionary	Message/Data Standards
Spatial Interface	Uniformity	Equipment Arrangement	Design Standards
		Dimensions/Installation	General Specification

Source: ITS Integration Project (SAPI) Study Team

Definition of the specification items of an equipment component, such as functions/performance, protocol and dimensions/installation are reasoned out based on the system architecture.

2) Requirements for Specification of Functional Packages and Other Items

As is evident from the foregoing figures, the system architectures of implementation packages consist of functional packages. Corresponding to the functional packages, the specifications are described, the quantities for the Project are calculated and the costs are estimated. The functional packages and other items for realizing the implementation packages aforementioned are shown in the table below.

Table 11.9 Functional Packages and Other Items for realizing Implementation Packages

Functional Packages and Other Items	Implementation Package								
	Incident Information	Traffic Congestion Information	Weather Information	Traffic Control Assistance	Center-to-Center Data Exchange for Traffic Information/Control	Toll Collection	Center-to-Center Data Exchange for Toll Collection/Management	Vehicle Weighing	Center-to-Center Data Exchange for Heavy Truck Control
Functional Packages									
(1) Voice Communication	XX			XX	XX				
(2) CCTV Monitoring	XX	XX							
(3) Event Detection (by Image)		XX							
(4) Vehicle Detection		XX							
(5) Traffic Analysis		XX							
(6) Weather Monitoring			XX						
(7) Traffic Event Data Management	XX	XX	XX	XX					
(8) Traffic Supervision	XX	XX	XX	XX					
(9) VMS Indication	XX	XX	XX	XX					
(10) Mobile Radio Communication				XX					
(11) Traffic Information					XX				
(12) Integrated Data Management					XX		XX		XX
(13) Tollgate Lane Monitoring						XX			
(14) Vehicle/Class Identification						XX			
(15) Lane Control						XX			
(16) Road-to-Vehicle Communication						XX			
(17) IC-card Recording						XX			
(18) Toll Data Management						XX	XX		
(19) OBU Management							XX		
(20) Axle Load Measurement								XX	
(21) Measurement Lane Monitoring								XX	
Communication System	XX	XX	XX	XX	XX	XX	XX	XX	XX
Communication Ducts	XX	XX	XX	XX	XX	XX	XX	XX	XX
Base Structures	XX	XX	XX	XX		XX		XX	

Source: ITS Integration Project (SAPI) Study Team

The requirements for the specification of functional packages and other items are listed in the following tables.

Table 11.10 Requirements for Specification of Functional Packages and Other Items (1)

Traffic Information/Control System	
(1) Voice Communication	
Requirements	Major Equipment Component
• To receive notification of incident occurrence promptly from road user and to identify the user's location on the expressway. • To receive report of current traffic conditions on the expressways and of incident occurrence promptly from the operators in the toll office. • To switch and connect the interactive voice and emergency directives among Regional Main Center, Road Management Offices and toll offices. • To send directives to the units concerned simultaneously and with top-priority at any time for clearing incidents and enforcing traffic regulations. • To receive notification of incident occurrence generally within 20 minutes, and to send road operation vehicles to the incident site generally within 1 hour. • To function 24 hours a day, 365 days a year.	Regional Main Center Directive Communication Console Administrative Telephone Road Management Office Directive Telephone Administrative Telephone Toll Office Directive Telephone Administrative Telephone
(2) CCTV Monitoring	
Requirements	Major Equipment Component
• To recognize incident occurrences on the road and their type, such as traffic accidents, breakdown vehicles, left obstacles, driving in the reverse direction, vandalism and natural disaster, by remote monitoring at the Main Center and road management office. • To recognize the severity of incidents through identifying types of vehicles involved (such as trucks, buses and sedans) by appearance. • To control roadside equipment remotely from the Main Center in real time and from road management office at a occurrence of incident. • To minimize load caused by data transmission including video image on the communication system. • To store the needed video images. • To print out the needed results. • To save implementation cost by utilizing internet technologies.	Roadside CCTV Camera Road Management Office CCTV Center Controller CCTV Monitoring Console Regional Main Center CCTV Center Controller CCTV Monitoring Console
(3) Event Detection (by Image)	
Requirements	Major Equipment Component
• Automatically and promptly to detect incident occurrences and their types, such as traffic accidents, breakdown vehicles, left obstacles, reverse driving, vandalism and natural disaster, by analyzing video image captured at roadside. • To measure number of vehicles and vehicle speed at a specific point on the road. • To notify the detected results automatically and promptly to the Main Center road and management office. • To monitor original video image remotely at the Main Center and road management office. • To identify the time and place of incident occurrence at the Main Center and road management office. • To minimize load caused by data transmission including video image on the communication system.	Roadside CCTV Camera Road Management Office Image Recognition Processor

Source: ITS Integration Project (SAPI) Study Team

Table 11.11 Requirements for Specification of Functional Packages and Other Items (2)

(4) Vehicle Detection	
Requirements	Major Equipment Component
• To measure number of vehicles, vehicle speed and vehicle length at a specific point on the road. • To notify the measured results automatically and promptly to the Main Center and road management office. • To identify the time and place of measured values at the Main Center road and management office.	Roadside Loop Coil Vehicle Detector CCTV Camera Road Management Office Image Recognition Processor
(5) Traffic Analysis	
Requirements	Major Equipment Component
• To calculate the traffic volume and ratio of heavy vehicle on expressway based on the results obtained from vehicle detection installed in appropriate points. • To calculate the average speed and traffic congestion status with the precision usable for traffic information provision and inflow regulation. based on the results obtained from vehicle detection installed in appropriate points: • To compile the calculation results and the measured results by vehicle detectors as statistic values for developing road improvement plans. • To store the calculation results and the measured results by vehicle detectors as the data for every 1 minute in a database.	Regional Main Center Traffic Analysis Processor ** Traffic Data Server **
(6) Weather Monitoring	
Requirements	Major Equipment Component
• To measure rainfall, wind speed, visibility, and air temperature. • Automatically and promptly to send the measured results to the Regional Main Center. • To allow identifying the time and place of measured values at the Regional Main Center. • To store the measured results as the data for every 5 minutes in a database. • Automatically and promptly to send a warning to the Regional Main Center in case that a measured result is beyond the limit defined in advance.	Roadside Rain Gauge Wind Sensor Visibility Sensor ** Thermometer Regional Main Center Weather Data Server **
(7) Traffic Event Data Management	
Requirements	Major Equipment Component
• To generate information in the form of traffic event from the results of CCTV monitoring, event detection, traffic analysis and weather monitoring. • To generate the traffic event including traffic accidents, reverse driving, broken-down vehicle, left obstacle, natural disaster, vandalism, construction work, bad weather and congestion. • To generate the traffic event including traffic restriction such as closure and speed limitation. • To identify the generated events by kilo-meter post of the road sections and date/time. • To correlate a traffic event to its causal traffic event. • To set priorities on generated/correlated traffic events by their classes. • To indicate the categorized events in Vietnamese and English. • To store the categorized events as the data for every 5 minutes in a database. • To function 24 hours a day, 365 days a year.	Road Management Office Traffic Event Data Monitor Traffic Event Data Server Regional Main Center Traffic Event Data Monitor Traffic Event Data Server

Source: ITS Integration Project (SAPI) Study Team

Table 11.12 Requirements for Specification of Functional Packages and Other Items (3)

(8) Traffic Supervision	
Requirements	Major Equipment Component
• To allow inputting the data necessary for generating/managing information for traffic control. • To indicate the road network to be operated and managed by the road operator. • To indicate the information categorized as traffic events with specific time/place of their occurrences for operators in the Main Center and road management office. • To function 24 hours a day, 365 days a year.	Road Management Office Monitor Screen Data Input Terminal
	Regional Main Center Traffic Supervising/Control Console Traffic Supervising/Control Server
	Mobile Mobile Data Input Terminal
(9) VMS Indication	
Requirements	Major Equipment Component
• To disseminate information in the form of traffic events which includes traffic accidents, reverse driving, broken-down vehicle, left obstacle, natural disaster, vandalism, construction work, bad weather, congestion and traffic restriction. • To provide information according to the priority by the distances and the traffic volume to the sites of generated traffic events. • To indicate information in Vietnamese and English. • To indicate text information for the drivers to read in their vehicles at the maximum speed 120 km/h. • To update the indicated information every 5 minutes.	Roadside VMS Type A VMS Type B VMS Type C CSS
	Regional Main Center VMS Center Controller
(10) Mobile Radio Communication	
Requirements	Major Equipment Component
• Promptly to receive reports of current traffic conditions on the expressways and of incidents from the operators in the toll office. • To send directives to the units concerned simultaneously for clearing incidents and enforcing traffic regulations. • To operating 24 hours a day, 365 days a year.	Road Management Office Radio Communication Console Base Station for Radio Communication
	Mobile Radio Communication Terminal
(11) Traffic Information	
Requirements	Major Equipment Component
• To disseminate information on traffic and road condition of the expressway network to the Internet Users. • To disseminate information based on the traffic event data stored in the server. • To disseminate information, which includes the contents of incidents, traffic conditions, traffic congestion, bad weather, construction works and traffic restrictions. • To allow operators to control the type of data and frequency for disseminating information.	Regional Main Center Traffic Information Server
(12) Integrated Data Management	
Requirements	Major Equipment Component
• To integrate the recorded data for traffic information/control, toll collection and vehicle weighing. • To integrate the data sets of incident, traffic volume, traffic congestion, bad weather, construction work, traffic restriction, traffic event, hourly toll collection and axle load management into a form of historical data records. • To sort/display/print-out the historical data records in the form of list, table and graph. • To search/calculate values required for checking validity of toll revenue in comparison with traffic data.	Regional Main Center Integrated Data Server

Source: ITS Integration Project (SAPI) Study Team

Table 11.13 Requirements for Specification of Functional Packages and Other Items (4)

Automated Toll Collection/Management System	
(13) Tollgate Lane Monitoring	
Requirements	Major Equipment Component
• To monitor vehicles passing through a tollgate lane, in the toll booth and toll office, and to identify their type such as truck, bus and sedan. • To monitor toll payment/receipt transaction between a driver and a toll collector in the toll office. • To store the needed video images. • To print out the needed results.	Roadside CCTV Camera (Fix Type) Toll Booth/Roadside CCTV Monitoring in Booth Toll Office CCTV Monitoring Console
(14) Vehicle Identification	
Requirements	Major Equipment Component
• To identify the classes of vehicles passing through a tollgate lane, such as trucks, buses and sedans. • To identify the vehicles passing through a tollgate lane by their license number plate and to store the results.	Roadside License Plate Scanner Image Recognition Processor Toll Office Lane Server
(15) Lane Control	
Requirements	Major Equipment Component
• To generate/process the data appropriate for collecting tolls based on the data sent from IC-card and OBU, the results of vehicle class identification and the regulated toll rate system. • To secure an average service-time by non-stop less than 4.5 sec/vehicle and by one-stop less than 9.0 sec/vehicle. • To notify a driver, in case of prepaid balance shortage for required toll amount, the necessity to recharge prepaid balance before next time of system usage including the amount of shortage. • To block the vehicles without normal completion of toll collection. • To generate/store identification data of the vehicles without normal completion of toll collection. • To allow toll collector to collect the proper toll manually in case the registered vehicle type of OBU is obviously judged as error compared with the visually checked one.	Roadside Vehicle Detector Entry-Card Issuer Toll Due/Paid Sign Stop/Go Sign Barrier Toll Booth Lane Data Input Device Toll Office Lane Server
(16) Road to Vehicle Communication	
Requirements	Major Equipment Component
• To transmit the data recorded in OBU and IC-card for collecting toll and the results of processing the data. • To secure an average non-stop service-time of less than 4.5 sec/vehicle. • To secure undisturbed conditions despite disturbance/tapping from outside and to restrict the error ratio to less than 1%.	In-Vehicle OBU Roadside Roadside Antenna/Controller
(17) IC Card Recording	
Requirements	Major Equipment Component
• To notify the data for collecting toll and the results of processing the data. • To allow to secure an average service-time by one-stop collection of less than 9.0 sec/vehicle. • To make the payment promptly and credibly, without being disturbed by outside noise or eavesdropping. • To allow prepayment and storing prepaid balance in the IC-card.	Roadside IC-Card Reader/Writer

Source: ITS Integration Project (SAPI) Study Team

Table 11.14 Requirements for Specification of Functional Packages and Other Items (5)

(18) Toll Data Management	
Requirements	Major Equipment Component
• To store all transaction data between OBU and roadside equipment for toll collection in a database. • To generate the data of forms for toll management and to store them in a database. • To function 24 hours a day, 365 days a year.	Toll Office Toll Management Server Toll Management Office Toll Management Server
(19) OBU Management	
Requirements	Major Equipment Component
• To write the information (such as OBU ID, Date of issue, License number, Vehicle class) of a vehicle which is equipped with OBU. • To write the information credibly and securely when it is written into OBU. • To provide a unique ID for any OBU which is registered any place in the country. • To transmit the OBU ID which is registered, to Toll Management Server of each Road operator.	OBU Issue Office OBU Registration Terminal OBU Management Center OBU Management Server
Vehicle Weighing System	
(20) Axle Load Measurement	
Requirements	Major Equipment Component
• To measure the number of axles and axle loads of vehicles in motion and investigate overloading. • To notify the detection of overloaded vehicle to the operator. • To generate/store identification data of overloaded vehicles. • To show and to print out the needed results.	Roadside Axle Load Scale Toll Office Heavy Truck Control Data Server
(21) Measurement Lane Monitoring	
Requirements	Major Equipment Component
• To monitor vehicles passing through a tollgate lane, in the toll booth and toll office, and identifying their type such as truck, bus and sedan. • To monitor toll payment/receipt transaction between a driver and a toll collector in the toll office. • To store the needed video images. • To show and to print out the needed results.	Roadside CCTV Camera Toll Office CCTV Monitoring Console
Communication System	
Requirements	Major Equipment Component
• To exchange data including video images among roadside equipment on the expressways, the Main Center and road management offices. • To transmit interactive voice communications between Main Center, road management offices and toll management offices. • To transmit directives to the units concerned simultaneously and with top-priority at any time for clearing incidents and enforcing traffic regulations. • To identify location of problems that occur on communication network and of recovering from them by automatic switching network. • System shall be capable of functioning 24 hours a day, 365 days a year.	Regional Main Center L3SW Road Management Office L3SW Toll Office L2SW

Source: ITS Integration Project (SAPI) Study Team

Table 11.15 Requirements for Specification of Functional Packages and Other Items (6)

Communication Ducts	
Requirements	Major Equipment Component
• To secure the space/route for installing ducts and chambers for building communication network continuously through the earthwork sections and the bridge sections. • To secure the sufficient quality of the material of ducts and chambers for building/maintaining communication network continuously through the earthwork sections and the bridge sections.	Roadside HDPE Pipe Cement Fine Aggregate Coarse Aggregate Reinforcing Bar Spacer for Ducts
Base Structures	
Requirements	Major Equipment Component
• To provide stable support for installing roadside equipment; such as CCTV camera, weather sensors, VMS, CSS and antenna for radio communication even under the condition of strong wind. • To keep the roadside equipment in the original/proper position keeping the structure clearance of the road and in the original/ proper direction for radio communication.	Roadside Structural Steel Cement Fine Aggregate Coarse Aggregate Reinforcing Bar

Source: ITS Integration Project (SAPI) Study Team

The basic design specifications of the functional packages and other items are shown in Appendix-5 and the specifications of electric power supply are shown respectively in the functional packages and other items. The specifications of buildings shall be prepared in the detailed design to be conducted complementarily after the Study.

11.9 Quantities

Quantities of the project are shown in the table below categorized by equipment components.

Table 11.16 Quantity Table of Project

1. Traffic Information/Control System *

Item No.	Equipment Component	Unit	Q'ty (a)
(2)	**CCTV Monitoring**		
	Roadside		
	CCTV Camera (PTZ type for Outside)	set	157
	Road Management Office		
	CCTV Center Controller	set	4
	CCTV Monitoring Console	set	4
	Regional Main Center		
	CCTV Center Controller	set	1
	CCTV Monitoring Console	set	1
(3)	**Event Detection (by Image)**		
	Roadside		
	CCTV Camera (Network Camera (Fix type for Image Recognition)	set	69
	Image Recognition Processor	set	3
(4)	**Vehicle Detection**		
	Roadside		
	Loop Coil Vehicle Detector	set	10
	CCTV Camera Data Exchange for Vehicle Detection	set	50
	Image Recognition Processor	set	50
(5)	**Traffic Analysis**		
	Regional Main Center		
	Traffic Analysis Processor	set	1
	Traffic Data Server	set	1
(6)	**Weather Monitoring**		
	Roadside		
	Rain-Gauge	each	4
	Wind Sensor	each	4
	Visibility Sensor	each	4
	Thermometer	each	4
	Regional Main Center		
	Weather Data Server	set	1
(7)	**Traffic Event Data Management**		
	Road Management Office		
	Traffic Event Data Monitor	set	4
	Traffic Event Data Server	set	4
	Regional Main Center		
	Traffic Event Data Monitor	set	1
	Traffic Event Data Server	set	1
(8)	**Traffic Supervision**		
	Road Management Office		
	Monitor Screen	set	4
	Data Input Terminal	set	4
	Regional Main Center		
	Traffic Supervising/Control Console	set	1
	Traffic Supervising/Control Server	set	1
	Mobile		
	Moblie Data Input Terminal (each Road Management Office x 2)	set	8
(9)	**VMS Indication**		
	Roadside		
	VMS-type A	set	36
	VMS-type B	set	36
	VMS-type C	set	12
	CSS	set	87
	Regional Main Center		
	VMS Center	each	1

(11)	**Traffic Information**		
	Regional Main Center		
	Traffic Information Server	set	1

2. Automated Toll Collection/Management System **

Item No.	Equipment Component	Unit	Q'ty (a)
(13)	**Tollgate Lane Monitoring**		
	Roadside		
	CCTV Camera (Fix Type)	set	94
	Toll Booth/Roadside		
	CCTV Monitoring in Booth	set	94
	Toll Management Office		
	CCTV Monitoring Console	set	10
(14)	**Vehicle Identification**		
	Roadside		
	License Plate Scanner	set	94
	Image Recognition Processor	set	94
	Toll Office		
	Lane Server	set	94
(15)	**Lane Control**		
	Roadside		
	Vehicle Detector	set	188
	Entry-Card Issuer	set	44
	Toll Due/Paid Sign	set	94
	Stop/Go Sign	set	94
	Barrier	set	94
	Toll Booth		
	Toll Data Input Device	set	94
(16)	**Road to Vehicle Communication**		
	In-Vehicle		
	OBU	set	5,000
	Roadside		
	Roadside Antenna/Controller	set	18
(17)	**IC-Card Recording**		
	Roadside		
	IC-Card Reader/Writer	set	84
(18)	**Toll Management**		
	Toll Office		
	Toll Management Server	set	10
	Toll Management Center		
	Toll Management Server	set	1
(19)	**OBU Management**		
	OBU Issue Office		
	OBU Registration Terminal	set	10
	OBU Management Center		
	OBU Management Server	set	1
(12)	**Integrated Data Management**		
	Regional Main Center		
	Integrated Data Management	set	1
	Integrated Data Server	set	1

3. Vehicle Weighing System

Item No.	Equipment Component	Unit	Q'ty (a)
(20)	**Axle Load Measurement**		
	Roadside		
	Axle Load Scale	set	12
	Toll Office		
	Heavy Truck Control Data Server	set	10
(21)	**Measurement Lane Monitoring**		
	Roadside		
	CCTV Camera and Control Equipment	set	12
	Toll Office		
	CCTV Monitoring Console	set	10

4. Communication system ***

Item No.	Equipment Component	Unit	Q'ty (a)
	Communication System (Center/Roadside)		
	Optical Fiber Cables		
	Optical Fiber Cable (Duct Cable) – 42,28,24,etc.	km	340
	Regional Main Center		
	L3SW	set	1
	Road Management Office		
	L3SW	set	4
	Node		
	L2SW	set	13
(1)	**Voice Communication**		
	Regional Main Center		
	Directive Communication Console	set	1
	Administrative Telephone	set	20
	Road Management Office		
	Directive Telephone and Console	set	40
	Administrative Telephone	set	80
	Toll Office		
	Directive Telephone and Console	set	20
	Administrative Telephone	set	60
(10)	**Mobile Radio Communication**		
	Road Management Office		
	Base Station for Radio Communication	set	16
	Radio Communication Console at Road Management Office	set	5
	Mobile		
	Radio Communication Terminal	set	50

5. Communication Ducts

Item No.	Equipment Component	Unit	Q'ty (a)
	Communication Ducts		
	Duct for Earthwork section	km	101
	Duct for Bridge Attachment	km	22
	Cable Chamber	Each	779

6. Buildings

Item No.	Equipment Component	Unit	Q'ty (a)
	Building Construction		
	Northern Regional Main Center	m^2	2160
	Road Management Office for Lang – Hoa Lac	m^2	720

7. Electric Power Supply (Back-up)

Item No.	Equipment Component	Unit	Q'ty (a)
	Electric Power Supply (Back-up)		
	Back-up Power Supply Facilities	Set	31

Note, * : Traffic Information/Control System excluding the following Functional Packages:
(1) Voice Communication
(10) Mobile Radio Communication
(12) Integrated Data Management
** : Automated Toll Collection/Management System including the following Functional Packages:
(12) Integrated Data Management
*** : Communication system including the following Functional Packages:
(1) Voice Communication
(10) Mobile Radio Communication

Source: ITS Integration Project (SAPI) Study Team

11.10 Project Costs

Required cost of the Project is estimated as shown in the table below.

Table 11.17 Project Cost

No.	Category	Foreign Currency (Million JPY)	Local Currency (Billion VND)	Total in JPY (Million JPY)	Total in VND (Billion VND)
1	Traffic Information /Control *	1,430	235	2,315	614
2	Automated Toll Collection/Management **	900	59	1,122	298
3	Vehicle Weighing	66	18	134	36
4	Communication System ***	900	54	1,104	293
5	Communication Ducts	36	131	531	141
6	Building	0	21	77	21
7	Back-up Power Supply	0	14	52	14
8	Subtotal (1+2+3+4+5+6+7)	3,332	532	5,335	1,416
9	Consulting Service	328	18	396	105
10	Subtotal (8+9)	3,660	550	5,731	1,522
11	Price Escalation	160	109	570	151
12	Physical Contingency	381	66	629	167
13	Subtotal (10+11+12)	4,202	725	6,931	1,840
14	Tax (10%, to be paid by LC)	0	184	693	184
15	Grand Total (13+14)	4,202	909	7,624	2,024

Exchange Rate (February 2012) 1US$ = JPY 81.68, 1US$ = VND20835

Note, * : Traffic Information/Control System excluding the following Functional Packages:
(1) Voice Communication
(10) Mobile Radio Communication
(12) Integrated Data Management

** : Automated Toll Collection/Management System including the following Functional Packages:
(12) Integrated Data Management

*** : Communication system including the following Functional Packages:
(1) Voice Communication
(10) Mobile Radio Communication

Source: ITS Integration Project (SAPI) Study Team

12. Project Implementation Plan

12.1 General

The following items are to be discussed for the Project Implementation Plan in this chapter:

- Organization analysis (on project implementation and system operation)
- Packages for Implementing Project
- Project Implementation Schedule
- Important points for implementation
- Training program
- Financial Schedule.

12.2 Organizational Analysis

1) Project Implementation Organizations

The project is to be implemented by the following organizations:

- VEC (Vietnamese Expressway Corporation) for project implementation
- Expressway management organization in MOT (Ministry of Transport) for budget execution.

(1) MOT (Ministry of Transport)

a) Existing Organization Structure

The Ministry of Transport is the Government's agency which is in charge of nationwide state management of road, railway, inland waterway, maritime and civil aviation transport; and of public services as stipulated by law. The Ministry of Transport has the responsibility for the implementation of tasks and powers as stipulated in Decree No. 178/2007/ND-CP dated 3rd December 2007 by the Government on functions, powers, duties, and organizational structure of ministries and ministerial level agencies. The organization structure of MOT is shown in the figure in the following page.

b) Capability of Project Implementation

MOT has much experience in the budget execution for the expressway construction projects and the projects for implementation of other infrastructure.

The departments in MOT responsible for expressway O&M are:

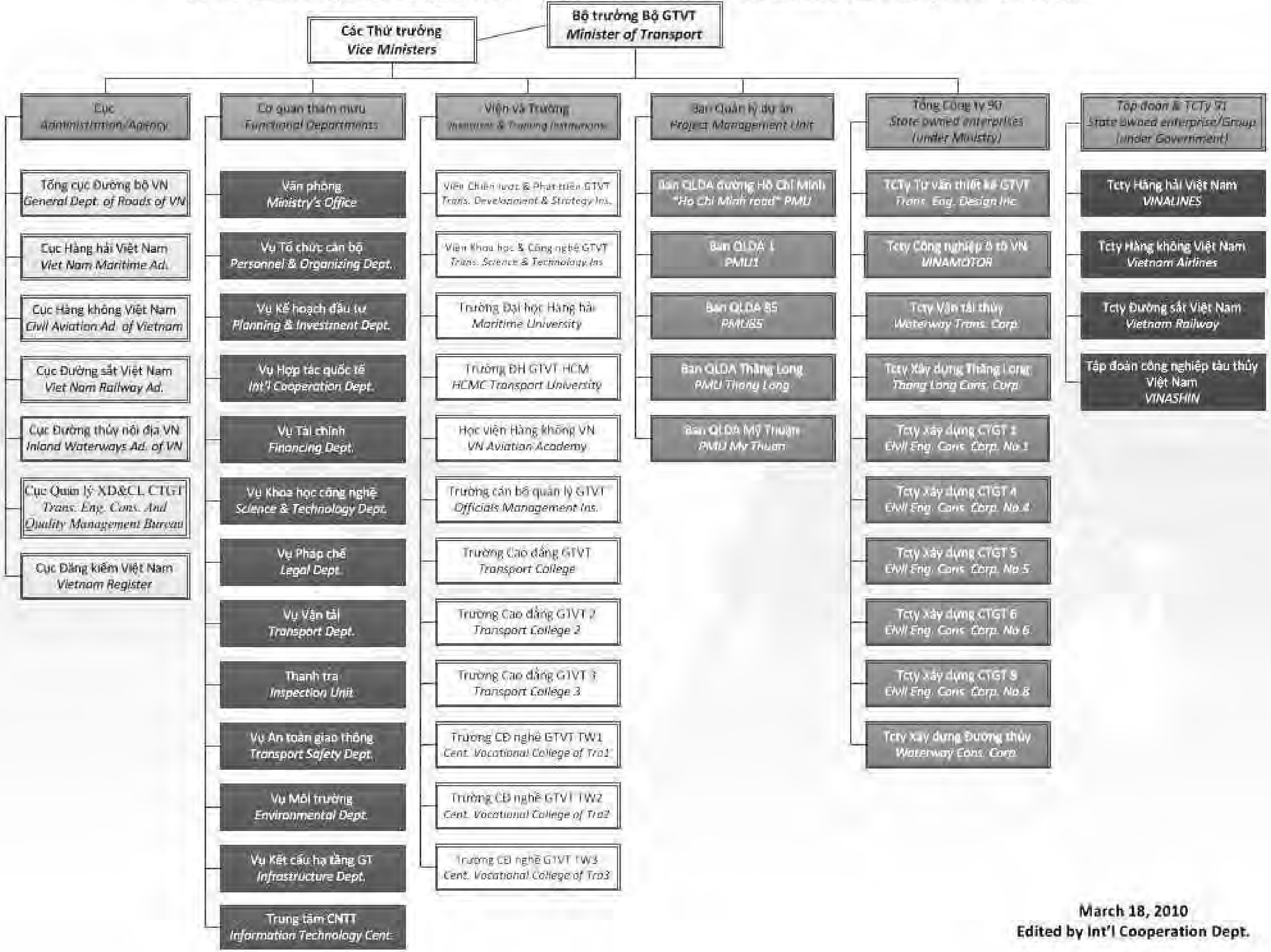
- Department of Transport Infrastructure
- Department of Planning & Investment

The departments in MOT responsible for ITS are:

- Department of Science & Technology
- Department of Transport Infrastructure
- Information Technology Center

In addition, the Expressway Management Office which is responsible for both expressway O&M and ITS is set up in MOT in 1st April 2011 and is transferred to DRVN in 26th April 2012.

Figure 12.1 Organization Chart of MOT



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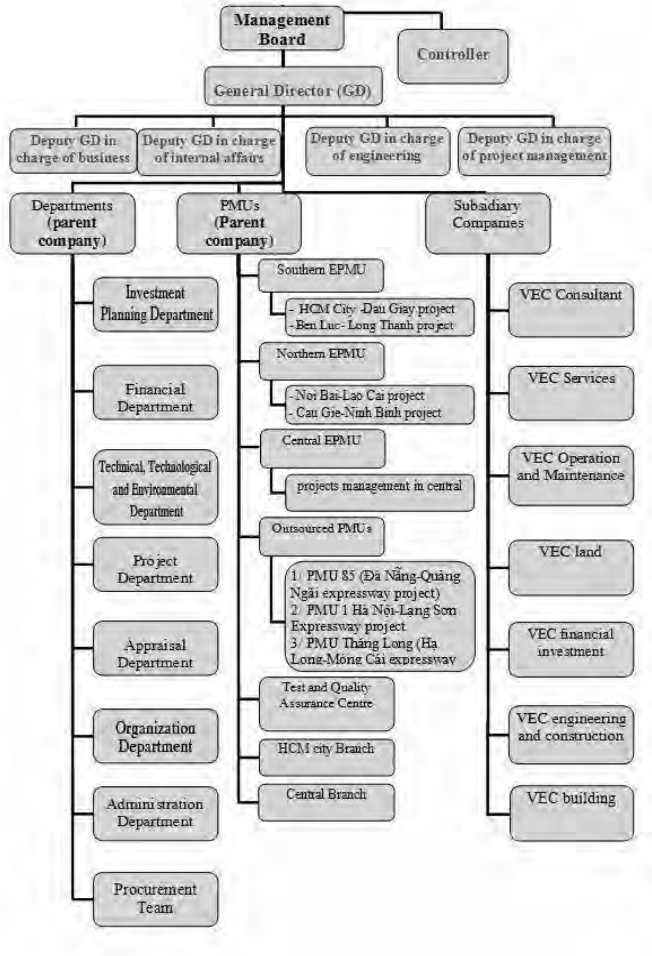
(2) VEC (Vietnamese Expressway Corporation)

a) Existing Organization Structure

VEC is established on 1st September, 2004, the Prime Minister issued the document No.1245/ CP-DMDN on approving the establishment of VEC with major business of investment, development and management, maintenance of national expressway system. After being founded, VEC has always received guidance from the Prime Minister, the Ministries, especially the Ministry of Transport, and more favourable conditions to create capital, specific policies and mechanisms...Besides, the company has built a team of qualified staff is highly experienced in the management of investment projects of high speed road, so in five years the company has not stopped completely improved and developed.

The organization structure of VEC is shown in the figure below.

Figure 12.2 Organization Chart of VEC



The investment planning department, the project department and the technical, technological and environmental department are responsible for project implementation. VEC has 25 IT engineers and the technical, technological and environmental department is responsible for system operation.

b) Capability of Project Implementation

VEC has experiences in the expressway construction including ITS implementation for the following sections:

- Phap Van – Cau Gie – Ninh Binh Expressway
- Long Thanh – Dau Giay Expressway
- Noi Bai – Lao Cai Expressway.

VEC has 25 of university-educated information/communication engineers who have enough capability to operate ITS.

2) System Operation Organizations

The system is to be operated by the following organizations from immediately after the system implementation:

- Expressway management organization in MOT
- VEC
- Bank
- OBU Management Center.

(1) Expressway Management Organization in MOT

a) Roles

The roles below are to be fulfilled by the Expressway Management Organization in MOT for system operation. Details of the roles and operation framework are shown in Appendix 2.

- Ownership/funding/management of the Regional Main Center
- Regulation on hardware/software in compliance with the ITS Standards
- Issue of permission for enforcing serious traffic restrictions such as road closure
- Exchange monitored information/data of traffic conditions/events
- Integrated management on the data from toll collection/management, traffic information/ control and heavy truck control (including overloading regulation)
- Development of inspection and budget plan of road improvement/maintenance
- Check of the validity of toll revenue in comparison with the data of traffic
- Evaluation of road operator’s achievement in the expressway operation.

b) Capability of System Operation

MOT has experience in the management of expressway operation for the following sections:

- HCMC – Trung Luong Expressway (based on the Decision No.195/QD-BGTVT)
- Cau Gie – Ninh Binh Expressway (based on the Decision No. 2451/QD-BGTVT).

MOT has experience in the management of overloading regulation based on the Circular No.07/2010/TT-BGTVT.

c) Needed Training

Preparatory for the training, basic information on the specific operation of equipment components is to be provided by the operation manuals provided by the contractor.

Training on the following items are to be provided for the manager in the Regional Main Center using the installed systems in the Project:

- Proper monitoring and judging gravity of incident using roadside equipment of Traffic Information/Control System
- Proper operation of data management and exchange among expressway operators using Traffic Information/Control System
- Proper operation of incident clearance in cooperation with related organizations using Traffic Information/Control System
- Proper operation of information dissemination by VMS in cooperation with related expressway sections using Traffic Information/Control System.
- Proper integrated management on data from Traffic Information/Control, Toll Collection and Axle Load Measurement.

Details of the training program including trainees are shown in Section 12.6 and Appendix 2.

(2) VEC, DRVN, HPC

a) Roles

The roles below are to be fulfilled by VEC for system operation. Details of the roles and operation framework are shown in Appendix 2.

Road Owner:

- Ownership/funding/maintenance of road structure/facilities of an expressway section other than ITS
- Ownership/funding of facilities of ITS of an expressway section
- Submission of the application for utilization of radio frequency
- Toll collection/management of an expressway section
- Charge for toll fare
- Transfer of transaction data/status and assistance for toll enforcement.

Road Operator (in Regional Main Center):

- Member dispatch for operation of the Regional Main Center
- Acquisition of information through the special call number or sensors of ITS
- Maintenance of hardware/software of ITS.

Road Operator (in Each Expressway Section):

- Traffic information/control of an expressway section
- Dispatch of a patrol crew to the incident site
- Judgement on the gravity of incident and enforcement of the traffic restrictions
- Input a traffic event data at the road management office or roadside and checking of them
- Assistance of toll collection of an expressway section
- Operation of mobile radio communication for patrol and road-to-vehicle communication for ETC
- Overloading regulation of an expressway section
- Operation/maintenance of hardware/software of ITS.

b) Capability of System Operation

VEC has the following experiences in the expressway operation in the section of Cau Gie – Ninh Binh based on the Decision No. No. 2451/QD-BGTVT:

- Expressway operation preparing the special telephone number 19001838
- Cooperation with expressway police and ambulance for incident clearance
- Toll collection by manual
- Overloading regulation.

They established a road management office for expressway operation at Vuc Vong.

c) Organizations of Northern Regional Main Center and Road Management Offices

The system installed by the Project is to be utilized for the expressway operation. For this purpose, the offices for expressway operation need to be integrated and cooperated. The organization of the offices for operation of the expressway sections in the Project Area is illustrated in the following page, which includes the Northern Regional Main Center and five road management offices.

The Northern Regional Main Center is owned and managed by the Expressway Management Organization in MOT and comprises the units of center operators, system maintenance, administration and others under the General Manager.

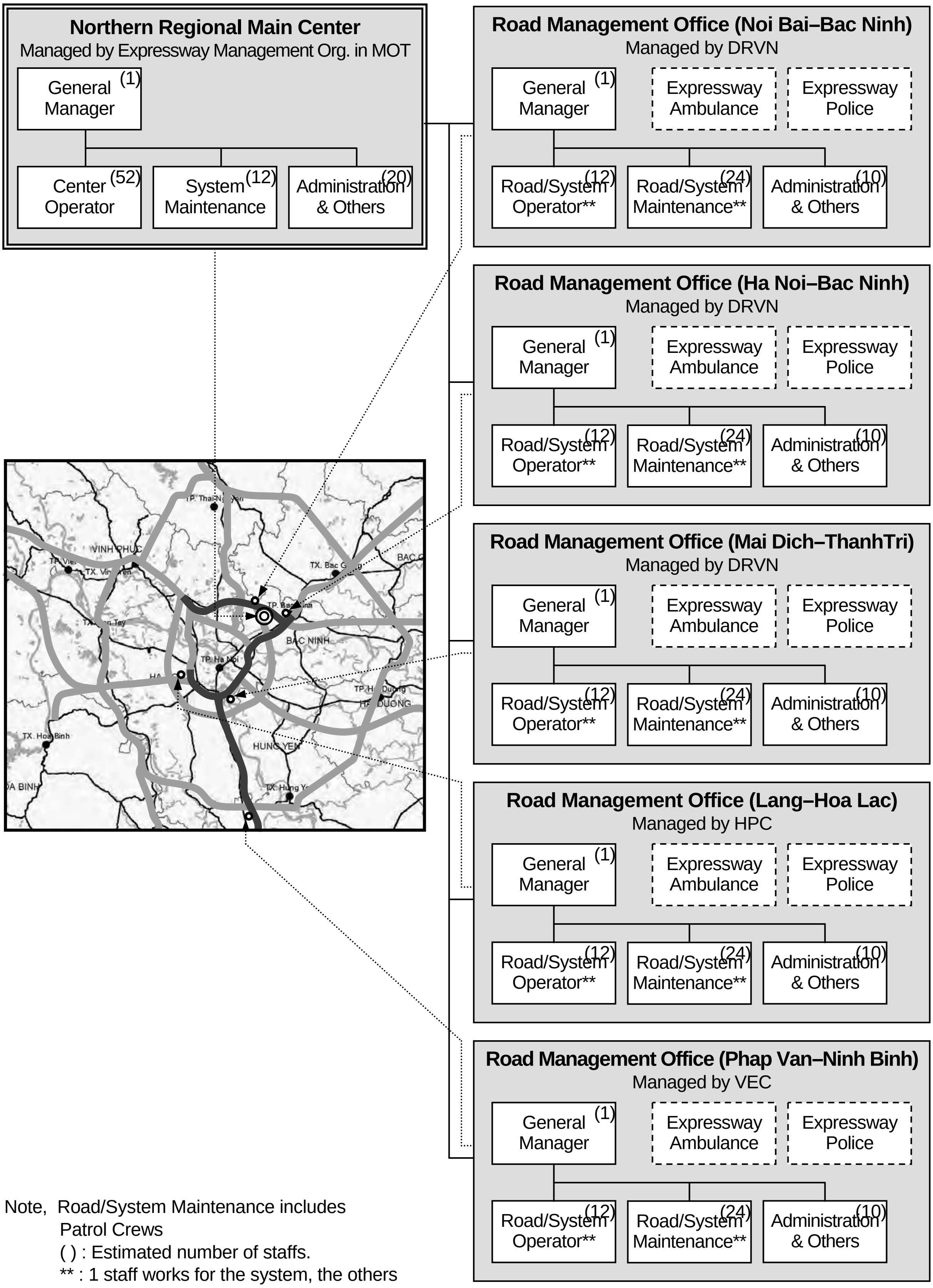
Each road management office is owned and managed by the road owner and comprises the units of system operators, Road/system maintenance, under the General Manager. The expressway sections in the Project Area are operated respectively by the Road Owners as shown below.

- VEC: Phap Van – Cau Gie – Ninh Binh
- RMU-2: Mai Dich – Thanh Tri, Ha Noi – Bac Ninh and Noi Bai – Bac Ninh
- HPC: Lang – Hoa Lac.

In the road management office, the unit of road/system maintenance includes the patrol crews. The patrol crews are to perform the activities in a team with the expressway police and the expressway ambulance.

Discussion results and details of the framework of expressway operation using ITS are shown in Chapter 5 and respective roles of the Expressway Management Organization in MOT and the road owners are mentioned in Chapter 6 and Appendix-2.

Figure 12.3 Organizations of Northern Regional Main Center and Road Management Offices



Note, Road/System Maintenance includes
Patrol Crews
( ) : Estimated number of staffs.
** : 1 staff works for the system, the others work for road and traffic using ITS

Source: ITS Integration Project (SAPI) Study Team

d) Needed Training

Preparatory for the training, basic information on the specific operation of equipment components is to be provided by the operation manuals provided by the contractor.

Training on the following items are to be provided for the operators in the Regional Main Center and road management offices and the patrol crews using the installed traffic information/control system in the Project:

- Proper monitoring and judging gravity of incident using roadside equipment of Traffic Information/Control System
- Proper operation of data management and exchange among expressway operators using Traffic Information/Control System
- Proper operation of incident clearance in cooperation with related organizations using Traffic Information/Control System
- Proper operation of information dissemination by VMS in cooperation with related expressway sections using Traffic Information/Control System.

Training on the following items are to be provided for the toll operators and the toll managers in the toll offices using the installed toll collection system in the Project:

- Proper tollgate lane operation for toll collection under usage of ETC and Touch&Go System
- Proper operation of handling the vehicle with balance shortage or without OBU in ETC Lane
- Proper operation of IC-card issuance/invalidation and toll settlement in cooperation with a bank
- Proper operation of OBU registration/invalidation in cooperation with related organizations

Training on the following item is to be provided for the measurement operators and the traffic inspectors in the toll offices using the installed axle load measurement system in the Project:

- Proper lane operation for overloading regulation under usage of Axle Load Measurement System.

Training on the following item is to be provided for the operators and the maintenance crews in the Regional Main Center and road management offices, and the toll operators and the measurement operators in the toll offices using the installed system in the Project:

- Proper/prompt recovery work of the system by identifying fault location on the communication network of ITS.

Details of the training program including trainees are shown in Section 12.6 and Appendix 2.

(3) Bank

Toll settlement among different road owners is to be operated a bank or an organization permitted by the State Bank (as the case of Decision No.5190/NHNN-TT).

a) Roles

The roles below are to be fulfilled by the Bank for system operation. Details of the roles and operation framework are shown in Appendix 2.

- IC-card issue/recharge/management service
- Reception of claim for invalidation of an IC-card from a user
- Generation/distribution of IC-card validation list and assistance for toll enforcement.

b) Capability of System Operation

The banks have sufficient experiences in the IC-card issue/recharge/management service for the bank account of the user and in the payment settlement including fees for public services. They have experiences in the toll collection for several sections of the arterial road as well. For example, Vietin Bank provide toll collection service using ETC at many tollgates including the followings:

- Can Tho Bridge Tollgate (Can Tho City)
- Luong Met Tollgate (Lang Son Province)
- South of Gie Bridge Tollgate (Ha Nam Province)
- Phu My Bridge Tollgate (HCM City)
- Tan Son Nhat Airport Tollgate (HCM City)
- Da Nang Airport Tollgate (Da Nang City)
- Dong Xoai Tollgate (Binh Phuoc Province).

c) Needed Training

Training on the following item is to be provided for the operators in the Bank connecting their system to the installed system in the Project:

- Proper operation of IC-card issuance/invalidation and toll settlement.

(4) OBU Management Center

a) Roles

The roles below are to be fulfilled by the OBU Management Center for system operation. Details of the roles and operation framework are shown in Appendix 2.

- OBU registration/management service
- Generation/distribution of OBU registration/invalidation list and assistance for toll enforcement.

b) Capability of System Operation

It is recommended to set up the OBU Management Center in the Vietnam Register, which is in charge of vehicle registration.

c) Needed Training

Preparatory for the training, basic information on the specific operation of equipment components is to be provided by the operation manuals provided by the contractor.

Training on the following item is to be provided for the operators in the OBU Management Center using the installed system in the Project:

- Proper operation of OBU registration/invalidation in cooperation with related organizations.

12.3 Packages for Implementing Project

The Project is to be implemented in the following three packages:

Package-1: The systems for traffic information/control and electric power supply, which are located mainly in the Northern Regional Main Center, the road management offices and roadside, and in addition communication system and communication ducts.

Package-2: The systems for toll collection/management and vehicle weighing, which are located mainly in the toll offices and the tollgates and need specific operation framework or legal system, and in addition the system for integrated data management and electric power supply.

Package-3: Buildings and the system for electric power supply for the Northern Regional Main Center and the road management office of Lang – Hoa Lac.

The functional packages and other items included in each package for implementing the Project are shown in the table below.

Table 12.1 Functional Packages and Other Items in Package for Implementing Project

Functional Packages and Other Items		Package-1	Package-2	Package-3
Traffic Information /Control System	(1) Voice Communication	XX		
	(2) CCTV Monitoring	XX		
	(3) Event Detection (by Image)	XX		
	(4) Vehicle Detection	XX		
	(5) Traffic Analysis	XX		
	(6) Weather Monitoring	XX		
	(7) Traffic Event Data Management	XX		
	(8) Traffic Supervision	XX		
	(9) VMS Indication	XX		
	(10) Mobile Radio Communication	XX		
	(11) Traffic Information	XX		
	(12) Integrated Data Management		XX	
Automated Toll Collection /Management System	(13) Tollgate Lane Monitoring		XX	
	(14) Vehicle/Class Identification		XX	
	(15) Lane Control		XX	
	(16) Road-to-Vehicle Communication		XX	
	(17) IC-card Recording		XX	
	(18) Toll Data Management		XX	
	(19) OBU Management		XX	
Vehicle Weighing System	(20) Axle Load Measurement		XX	
	(21) Measurement Lane Monitoring		XX	
Other Items	Communication System	XX		
	Communication Ducts	XX		
	Buildings			XX
	Power Supply	XX	XX	XX

Source: ITS Integration Project (SAPI) Study Team

12.4 Project Implementation Schedule

The following implementation items are to be performed in "the Study for Assistance of ITS Integration Project implementation over National Highway No.3 and Hanoi Metropolitan Area".

- Feasibility Study
- EIA Study
- Basic Design

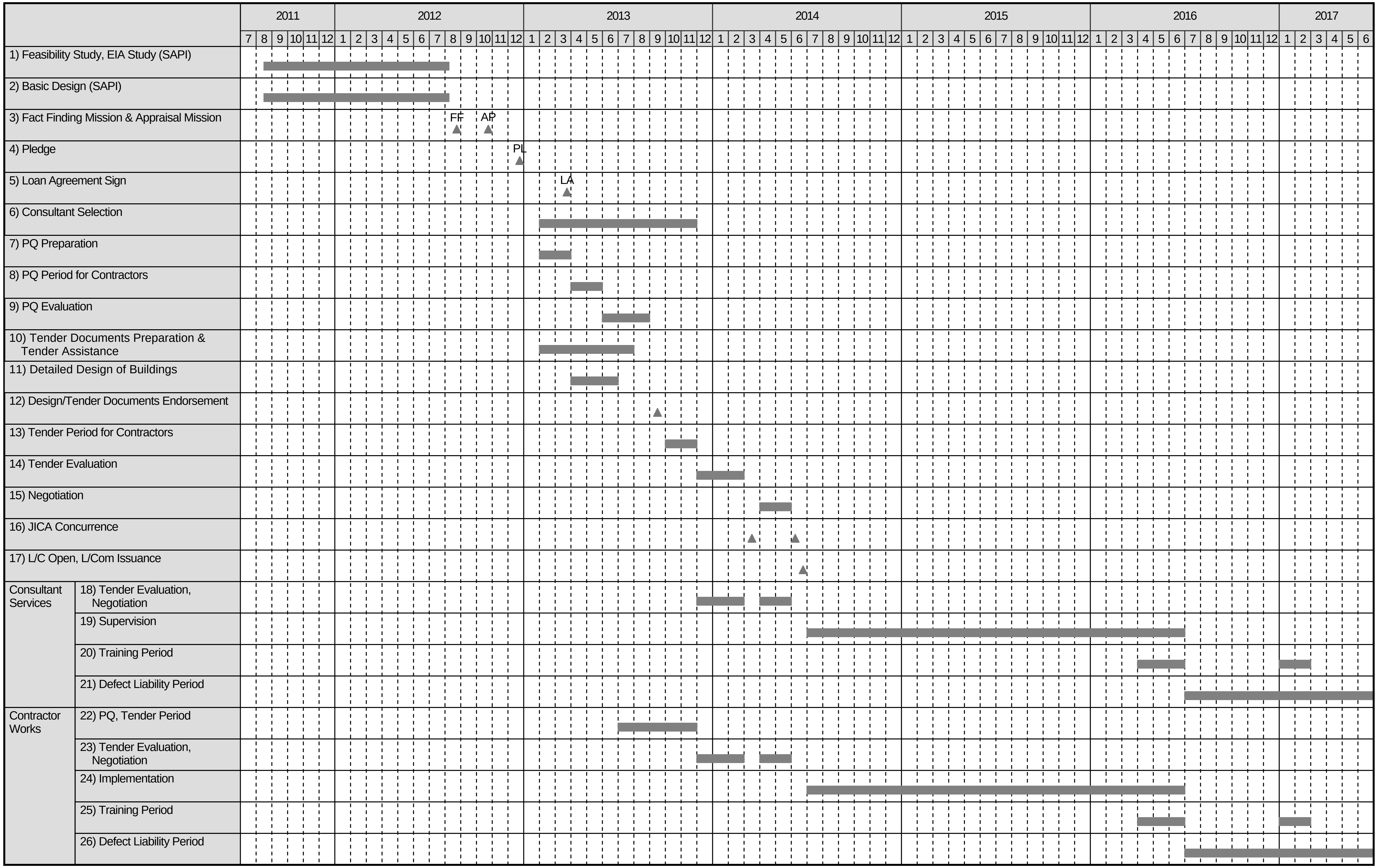
Additionally, the items below are to be completed in advance of the project implementation.

- Appraisal mission
- Loan agreement sign
- Consultant selection
- Tender documents preparation and tender assistance
- Detailed Design of Buildings
- Design and tender documents endorsement
- PQ for Contractors
- Tender process for Contractors

The tender period for the Contractors is to be 2 months from October in 2013 and the Project Implementation Period is to be 2 years from July in 2014. Additionally, the Defect Liability Period is to be secured for a year after the Implementation Period.

The project implementation schedule is shown in the figure in the following page.

Figure 12.4 Project Implementation Schedule



Source: ITS Integration Project (SAPI) Study Team

12.5 Important Points for Installation

The following important points are noted for the installation of equipment components:

- The installation work shall include equipment component's unloading at port, customs clearance, inland/domestic transportation, equipment component installation, software installation, set up, configuration, testing/inspection and commissioning. Initial instruction, hand-over of the equipment components and submission of all required documents such as drawings, data and manuals prepared for execution of the Project shall be considered as the part of the installation work.
- The unloading, transportation and installation shall be performed with due care but without any physical shocks or water immersion to the equipment components.
- The Contractor shall prepare the detailed equipment component layout drawings after due consideration of the existing facilities, the space for maintenance and heat dissipation through detailed design based on the actual conditions and the results of topographical survey. The detailed layout drawing shall include cabling and wiring diagram.
- The Contractor shall give due consideration to the construction gage of road, the sight clearance for drivers and the needed lighting for maintenance in preparation of the detailed layout drawing of roadside equipment.
- The equipment components shall be mounted on the fixed stable base structures at roadside or the fixed stable racks in the buildings. Especially at roadside, the equipment components shall be fixed/secured against high wind.
- Communication cables and electric cables shall be bundled and arranged appropriately in accordance with the detailed layout drawing.
- The testing/inspection shall be performed totally as a functional package which includes several equipment components installed in a dz or at roadside and a communication network for making connection among them. The testing/inspection shall be performed including software as a equipment component.
- Necessary materials shall be painted and finished in accordance with the relevant standards, codes and regulation. Paint quality and method of application shall conform to appropriate standards and be able to withstand ambient conditions.
- The equipment components shall be protected from the lightning strike and electrical surge. The earth resistance shall be maximum 10 ohm, and common earthing protection shall be applied to the switching equipment components bonding with the grounding of the lightning protection system and other grounding facilities installed within a short distance.
- The security/safeguard system to restrict unauthorized people from entering into the job site shall be provided during installation work.

12.6 Training Program

1) Objectives

The objectives of the training are shown below, which are to be specified for individual training items based on the manuals. Further discussion and the list of manuals to be provided by the contractor are shown in Appendix 2.

(1) Training on Traffic Control of Expressway

The objective of this training is basic knowledge transfer for the operator of traffic information/ control system responding to the occurrences of incidents for first stage, and enhancement of capability of traffic control for second stage through the process of obtaining advice from traffic control expert during actual traffic control operation in rainy season.

(2) Training on System Operation/Maintenance

The objective of this training is basic knowledge transfer for the responsible staff of system operation and maintenance. The targets are the traffic information/control system, the automated toll collection system and the vehicle weighing system.

(3) Training on Lane Operation

The objective of this training is basic knowledge transfer for the responsible staff on the lane operation for toll collection and vehicle weighing. The target includes the drivers who are not familiar to pass the toll gate and how to prevent the passage of fraudulence driver.

2) Training Schedule

It is recommended to implement 1 to 2 months for the first stage after completion of ITS Integration Project. For the second stage, it is recommended to implement approximately 1.5 month during incident prone period such as rainy season.

3) Training Items/Contents

The training program is shown below. As for the program (1) to (4), it is planned mainly for the subjects for traffic control staff, and for the program (5) to (9), it is planned mainly for lane operation staff. As for the program (10) to (11), it is planned for the system maintenance staff.

The second stage training is planned for further skill enhancement for traffic control staff. The training is to be implemented on the job training basis with obtaining advice from traffic control expert. This stage trainee should master the program (1) to (3) shown in the following table in advance at least.

Table 12.2 Training Items/Contents

Training Items	Contents of Program
(1) Proper monitoring and judging gravity of incident using roadside equipment of Traffic Information/ Control System	- Explanation on Expressway Operation Framework using ITS - Instruction by manual on the basic knowledge of Traffic Control System such as information/data collection, information/data processing, information dissemination, and implementation of related exercise - Instruction by manual on the method of event judgement, event recording, and record management, and implementation of related exercise - Instruction on utilization method of data generated by image recognition function using CCTV camera, and implementation of related exercise - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs
(2) Proper operation of data management and exchange among expressway operators using Traffic Information/ Control System	- Explanation on Expressway Operation Framework using ITS - Instruction by manual on traffic event data management and exchange, and implementation of related exercise - Instruction by manual on event category, event class, criteria of enforcing traffic regulation, and how to make data correlation, and implementation of related exercise - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs
(3) Proper operation of incident clearance in cooperation with related organizations using Traffic Information/ Control System	- Explanation on Expressway Operation Framework using ITS - Instruction by manual on information distributing procedure and method among related organizations based on the event category which is generated by Traffic Information/Control System, and implementation of related exercise - Instruction on operation of information dissemination equipment components such as VMS controller based on the confirmation result among related organization, and implementation of related exercise - Instruction by manual on record of communication between related organization, record of operation of information dissemination equipments, and implementation of related exercise - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs

Training Items	Contents of Program
(4) Proper operation of information dissemination in cooperation with related expressway sections using Traffic Information/ Control System	- Explanation on Expressway Operation Framework using ITS - Instruction by manual on information distributing procedure and method among related organizations based on the event category which is generated by Traffic Information/Control System, and implementation of related exercise - Instruction on operation of information dissemination equipment components such as VMS controller based on the confirmation result among related organization, and implementation of related exercise - Instruction by manual on record of communication between related organization, record of operation of information dissemination equipments, and implementation of related exercise - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs
(5) Proper tollgate lane operation for toll collection under usage of ETC and Touch&Go System	- Instruction of skill on vehicle guidance to the lane of ETC, Touch&Go, and manual at toll gates. - Instruction of skill on proper handling for fraudulence vehicle - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs
(6) Proper operation of handling the vehicle with balance shortage or without OBU under usage of ETC System	- Instruction of skill on identifying and stopping vehicle with balance shortage or without OBU under usage of ETC System going into lane. - Instruction of skill on futher processing of fraudulence vehicle - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs
(7) Proper operation of IC-card issuance/ invalidation and toll settlement in cooperation with a bank	- Instruction of skill on managing IC-card issuance information in cooperation with a bank. - Instruction of skill on managing IC-card invalidation information in cooperation with a bank. - Instruction of skill on toll settlement in cooperation with a bank - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs

Training Items	Contents of Program
(8) Proper operation of OBU registration/ invalidation in cooperation with related organizations	- Instruction of skill on managing OBU registration information in cooperation with related organization. - Instruction of skill on managing OBU invalidation information in cooperation with related organization. - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs
(9) Proper lane operation for overloading regulation under usage of Axle Load Scale	- Instruction of skill on heavy truck guidance to the axle load scale lane at toll gates. - Instruction of skill on proper handling for fraudulence vehicle - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs
(10) Proper integrated management on data from Traffic Information/Control, Toll Collection and Vehicle Weighing	- Instruction on data formation, data storage and implementation of related exercise - Instruction on utilization method of data from Traffic Information/Control, Toll Collection and Vehicle Weighing and implementation of related exercise - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs
(11) Proper/prompt recovery work of the system by identifying fault location on the communication network of ITS	- Confirmation of maintenance manual and various types of forms handed over by the contractor or manufacturer of each delivered equipment component - Instruction by manual on monitoring various types of equipment components, maintenance work in normal operation time, periodical check & cleaning work, and preparation of record of maintenance activities, and implementation of related exercise using installed equipment components - Instruction on trouble shooting method such as recovery method, and deletion method of outlier data when system failure or fault occurs during normal operation and monitoring conditions of the system, and implementation of related exercise using installed equipment components - Instruction on trouble shooting method such as fault location and investigation method, recovery method of failure when IP network system failure or fault is detected, and implementation of related exercise using installed equipment components - Review of manuals or related format according to the training above if necessary - Guidance for technology transfer from trained staff to other staffs

Source: ITS Integration Project (SAPI) Study Team

4) Target Trainees

The trainees and related training item of each trainee is shown below.

Table 12.3 Trainees for Training Items

Training Items	Trainee	
(1) Proper monitoring and judging gravity of incident using roadside equipment of Traffic Information/Control System	Regional Main Center	- Manager - Operator
	Road management office	- Manager - Operator - Patrol crews
(2) Proper operation of data management and exchange among expressway operators using Traffic Information/ Control System	Regional Main Center	- Manager - Operator
	Road management office	- Manager - Operator - Patrol crews
(3) Proper operation of incident clearance in cooperation with related organizations using Traffic Information/Control System	Regional Main Center	- Manager - Operator
	Road management office	- Manager - Operator - Patrol crews
(4) Proper operation of information dissemination by VMS in cooperation with related expressway sections using Traffic Information/Control System	Regional Main Center	- Manager - Operator
(5) Proper tollgate lane operation for toll collection under usage of ETC and Touch&Go System	Toll office	- Toll manager - Toll collector
(6) Proper operation of handling the vehicle with balance shortage or without OBU in ETC Lane	Toll office	- Toll manager - Toll collector
(7) Proper operation of IC-card issuance/ invalidation and toll settlement in cooperation with a bank	Toll office	- Toll manager - Toll operator
	Bank	- Operator
(8) Proper operation of OBU registration/ invalidation in cooperation with related organizations	Toll office	- Toll manager - Toll operator
	OBU Management Center	- Operator
(9) Proper lane operation for overloading regulation under usage of Axle Load Scale	Toll office	- Traffic inspector - Measurement operator
(10) Proper integrated management on data from Traffic Information/Control, Toll Collection and Vehicle Weighing	Regional Main Center	- Manager
(11) Proper/prompt recovery work of the system by identifying fault location on the communication network of ITS	Regional Main Center	- Operator - Maintenance crews
	Road management office	- Operator - Maintenance crews
	Toll office	- Toll operator - Measurement operator

Source: ITS Integration Project (SAPI) Study Team

12.7 Financial Schedule

(1) Necessary Cost

Based on the Project cost (Case 2), the basic assumptions, and the financing plan, the following financial examination is made:

- Estimation of project cost including contingencies (price and physical), and interest during construction (IDC) / commitment charge
- Tabulation on loans
- Estimation of operation and maintenance costs
- Estimation of amount of required fund after operation

(2) Project Cost including Contingencies

a) Basic Assumptions

The following assumptions are made:

Implementation Schedule

The investment is scheduled from year 2014 to 2015, and the commencement of operation is year 2016. The share percentages of investment cost disbursement are 30% and 70% respectively for the first and the second one year, respectively.

Price and Physical Contingencies

The price contingency rate is:

- Foreign currency portion: 1.6%
- Local currency portion 6.9%
- The rate physical contingency is 10%.

No contingencies are assumed for the cost item of project administration cost.

Tax

Except the cost item of project administration cost, the costs are assumed to include the tax portion of 10% as VAT.

b) Project Cost including Contingencies

As a result, the project cost after contingencies and before financial charge such as interest during construction/commitment charge is estimated.

(3) Financing Plan

a) Financing Scheme

The assumed financing sources are JICA's Loan (STEP), and JICA's Loan for Consulting Services, and the government counterpart fund. Regarding JICA Loans, no re-lending scheme is assumed.

The financing plan by cost item and by funding sources is assumed as follows:

- JICA's Loan (STEP) is applied for the cost item of construction
- JICA's Loan for consulting services is applied for the cost item of consulting services

- The government counterpart fund will be used for the cost items of project administration cost and tax.

b) Assumed Loan Conditions

The loan conditions are:

JICA's Loan (STEP):

- Interest rate: 0.20%
- Total repayment 40 years (Grace period: 10 years and net repayment of 30 years)
- Commitment charge: 0.10% on un-disbursed balance.

JICA's Loan for Consulting Services:

- Interest rate: 0.01%
- Total repayment 40 years (Grace period: 10 years and net repayment of 30 years)
- Commitment charge: 0.10% on un-disbursed balance.

(4) Estimated Project Cost including IDC & Commitment Charge

Based on the above assumptions of financing plan, the total project cost including interest during construction (IDC) and commitment charge is estimated as shown in the following table:

Table 12.4 Estimated Project Cost after Contingencies and IDC

(Million Yen)

	FC			LC			Total		
	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others
Construction	3,332	3,332	0	2,003	2,003	0	5,335	5,335	0
Consulting Services	328	328	0	68	68	0	396	396	0
(Subtotal)	3,660	3,660	0	2,071	2,071	0	5,731	5,731	0
Price Escalation **	160	160	0	410	410	0	570	570	0
Physical Contingency	381	381	0	249	249	0	629	629	0
(Subtotal)	4,202	4,202	0	2,729	2,729	0	6,931	6,931	0
Tax (10%) ***	0	0	0	693	0	693	693	0	693
(Subtotal)	4,202	4,202	0	3,423	2,729	693	7,624	6,931	693
Land Acquisition	0	0	0	0	0	0	0	0	0
Project Administration	0	0	0	176	0	176	176	0	176
(Subtotal)	4,202	4,202	0	3,599	2,729	870	7,800	6,931	869
IDC **	10	10	0	0	0	0	10	10	0
Commitment Charge **	8	8	0	0	0	0	8	8	0
(Grand Total)	4,220	4,220	0	3,599	2,729	870	7,818	6,949	869

Source: Estimated by ITS Integration Project (SAPI) Study Team

Note, Tax and project administration are to be paid by local currency (LC) and IDC and commitment charge are to be paid by foreign currency (FC)

** : Values calculated by using compound interest for 30% of cost disbursement for the first one year and 70% for the second one year

*** : Values calculated approximately by using 10% for all costs.

In the table above, the factor of price escalation is separated from the estimated subtotal in order to show the yearly variation of price escalation in Table 12.6.

(5) Tabulation of Cash Flow

a) Assumption on Operation and Maintenance Costs for ITS

Based on the engineering study results, the unit value of operation and maintenance (O&M) costs (except replacement cost of equipment) for ITS per kilometer is estimated to be 2.33 million yen per annum as below.

Table 12.5 Operation and Maintenance Cost for ITS

Items	Cost (Million Yen/year/km)	Remarks
Personel Cost for Traffic Control	0.77	Northern Regional Main Center Center Operator +System maintenance: (13+3) x4 teams Each of 5 Road Management Offices System Operator +System Maintenance: (1+1) x4 teams OBU Registration: 1
Spare Equipment Components & Software License	0.68	Spare Parts, Data Base Software, etc.
Maintenance Support by Supplier	0.33	10% of Software Cost
Telephone & Communication	0.05	Northern Regional Main Center and 5 Road Management Offices
Electric Power Supply	0.51	Northern Regional Main Center and 5 Road Management Offices
Total	2.33	

Note: 1 Yen is assumed at 265 VND

Source: Estimated by ITS Integration Project (SAPI) Study Team

The distance kilometer of the target road network is 188 km, and the annual total O&M costs for ITS are estimated to be 438 million yen. The O&M costs for ITS are assumed to increase in line with the escalation rate of 2.66% per annum, which is the assumed weighted average rate with the escalation rate of 6.9% in local currency portion (at 20% in assumed share) and escalation rate of 1.6% in foreign currency portion (at 80% in assumed share).

b) Assumption on Replacement Cost of Equipment

The replacement cost of equipment is assumed to be required cost during operation period other than the above O&M costs for ITS. The unit value of replacement cost of equipment of ITS per kilometer is estimated to be 1.64 million yen per annum, and the annual total costs are estimated to be 309 million yen. Regarding the replacement cost of equipment, it is assumed that the unit price escalation will be compensated by the cost reduction through technological innovation.

c) Tabulation on Cash Flow

Based on the afore-mentioned estimation results regarding cost items, the tabulation on cash flow is made for years during the loan repayment period.

In the cash flow tabulation, the item of required fund after operation is assumed to compensate the amounts of out-flow items of loan repayment, loan interest payment, O&M costs for ITS and replacement cost of equipment.

As a result, the amount required as a fund after operation is examined, which is equivalent to be, for example, approximately 808 million yen in the year 2016, as shown in the following table:

Table 12.6 Tabulation of Cash Flow

Year	In-Flow								Out-Flow						In-Flow minus Out-Flow
	Loan				Counterpart Fund			(Total) (Million Yen)	Invest	Loan Repay	Interest Pay	O/M Costs for ITS	Replace Cost of Equipment	(Total) (Million Yen)	
	(Disbursed)	(IDC)	(C.C.)	(Total Disbursed)	Equity	Required Fund after Operation	(Total)								
2014	2,027.72	1.90	5.92	2,035.54	255.57		255.57	2,291.11	2,291.11					2,291.11	0.00
2015	4,903.63	8.39	2.45	4,914.47	613.56		613.56	5,528.04	5,528.04					5,528.04	0.00
2016						808.30	808.30	808.30			13.01	486.54	308.75	808.30	0.00
2017						821.24	821.24	821.24			13.01	499.48	308.75	821.24	0.00
2018						834.53	834.53	834.53			13.01	512.77	308.75	834.53	0.00
2019						848.17	848.17	848.17			13.01	526.41	308.75	848.17	0.00
2020						862.17	862.17	862.17			13.01	540.41	308.75	862.17	0.00
2021						876.55	876.55	876.55			13.01	554.79	308.75	876.55	0.00
2022						891.30	891.30	891.30			13.01	569.54	308.75	891.30	0.00
2023						906.45	906.45	906.45			13.01	584.69	308.75	906.45	0.00
2024						1,153.46	1,153.46	1,153.46		231.67	12.80	600.25	308.75	1,153.46	0.00
2025						1,168.99	1,168.99	1,168.99		231.67	12.36	616.21	308.75	1,168.99	0.00
2026						1,184.95	1,184.95	1,184.95		231.67	11.93	632.60	308.75	1,184.95	0.00
2027						1,201.30	1,201.30	1,201.30		231.67	11.45	649.43	308.75	1,201.30	0.00
2028						1,218.18	1,218.18	1,218.18		231.67	11.06	666.71	308.75	1,218.18	0.00
2029						1,235.48	1,235.48	1,235.48		231.67	10.63	684.44	308.75	1,235.48	0.00
2030						1,253.26	1,253.26	1,253.26		231.67	10.19	702.65	308.75	1,253.26	0.00
2031						1,271.51	1,271.51	1,271.51		231.67	9.76	721.34	308.75	1,271.51	0.00
2032						1,290.27	1,290.27	1,290.27		231.67	9.33	740.52	308.75	1,290.27	0.00
2033						1,309.53	1,309.53	1,309.53		231.67	8.89	760.22	308.75	1,309.53	0.00
2034						1,329.32	1,329.32	1,329.32		231.67	8.46	780.44	308.75	1,329.32	0.00
2035						1,349.64	1,349.64	1,349.64		231.67	8.02	801.20	308.75	1,349.64	0.00
2036						1,370.52	1,370.52	1,370.52		231.67	7.59	822.52	308.75	1,370.52	0.00
2037						1,391.97	1,391.97	1,391.97		231.67	7.16	844.39	308.75	1,391.97	0.00
2038						1,413.99	1,413.99	1,413.99		231.67	6.72	866.86	308.75	1,413.99	0.00
2039						1,436.62	1,436.62	1,436.62		231.67	6.29	889.91	308.75	1,436.62	0.00
2040						1,459.86	1,459.86	1,459.86		231.67	5.86	913.59	308.75	1,459.86	0.00
2041						1,483.73	1,483.73	1,483.73		231.67	5.42	937.89	308.75	1,483.73	0.00
2042						1,508.24	1,508.24	1,508.24		231.67	4.99	962.83	308.75	1,508.24	0.00
2043						1,533.42	1,533.42	1,533.42		231.67	4.55	988.45	308.75	1,533.42	0.00
2044						1,559.28	1,559.28	1,559.28		231.67	4.12	1,014.74	308.75	1,559.28	0.00
2045						1,585.83	1,585.83	1,585.83		231.67	3.69	1,041.73	308.75	1,585.83	0.00
2046						1,613.11	1,613.11	1,613.11		231.67	3.25	1,069.44	308.75	1,613.11	0.00
2047						1,641.12	1,641.12	1,641.12		231.67	2.82	1,097.89	308.75	1,641.12	0.00
2048						1,669.89	1,669.89	1,669.89		231.67	2.39	1,127.09	308.75	1,669.89	0.00
2049						1,699.44	1,699.44	1,699.44		231.67	1.95	1,157.07	308.75	1,699.44	0.00
2050						1,729.78	1,729.78	1,729.78		231.67	1.52	1,187.85	308.75	1,729.78	0.00
2051						1,760.95	1,760.95	1,760.95		231.67	1.08	1,219.45	308.75	1,760.95	0.00
2052						1,792.95	1,792.95	1,792.95		231.67	0.65	1,251.88	308.75	1,792.95	0.00
2053						1,825.60	1,825.60	1,825.60		231.67	0.00	1,285.18	308.75	1,825.60	0.00
(Total)	6,931.35	10.29	8.37	6,950.01	869.14	50,290.92	51,160.06	58,110.07	7,819.14	6,950.01	299.02	31,309.40	11,732.49	58,110.07	

Source: Estimated by ITS Integration Project (SAPI) Study Team

(6) Balance of Toll Revenue and O&M Costs

a) Assumption on Operation and Maintenance Costs for Road

Based on the engineering study results, the unit value of operation and maintenance (O/M) costs (except replacement cost of equipment) for the road per kilometer is estimated to be 4.0 million yen per annum.

The distance kilometer of the target road network is 188 km, and the annual total O&M costs for ITS are estimated to be 438 million yen. The O&M costs for ITS are assumed to increase in line with the escalation rate of 2.66% per annum, which is the assumed weighted average rate with the escalation rate of 6.9% in local currency portion (at 20% in assumed share) and escalation rate of 1.6% in foreign currency portion (at 80% in assumed share).

b) Estimation of Traffic and Toll Revanue

Unit toll rates are defined by the Circular No.14/2012/TT-BTC of MOF.

Table 12.7 Unit Toll Rates

(VND)	PC	Bus	Truck
Toll Rate	1000	1000	2200

Source: Estimated by ITS Integration Project (SAPI) Study Team

Estimated numbers of vehicles and toll revenues for 2015 and 2020 are shown in the table below.

Table 12.8 Estimation of Traffic and Toll Revenue

Vehicle-km (Case 2) (1000 vehicles-km/day)	2015			2020		
	PC	Bus	Truck	PC	Bus	Truck
Mai Dich - hanh Tri (Ring Road 3)	435.80	181.40	386.60	757.60	255.80	501.60
Lang - Hoa Lac	578.04	73.34	381.05	550.18	68.36	362.11
Hanoi - Bac Ninh (NH No.1)	253.80	90.60	202.00	323.60	104.40	262.20
Noi Bai - Bac Ninh (NH No.18)	168.42	28.71	196.14	271.08	45.93	291.27
Phap Van - Cau Gie	286.70	481.90	286.65	457.55	602.35	358.60
Cau Gie - Ninh Binh	500.43	845.11	518.52	1107.99	1502.44	961.77
Total	2223.19	1701.06	1970.96	3468.00	2579.28	2737.55

Toll Revenue for each class, mil.VND/year	811464.35	620886.90	1582680.88	1265820.00	941437.20	2198252.65
Total, mil.VND/year	3015032.13			4405509.85		
Total, mil.Yen/year	11377.48			16624.57		

Note: 1 Yen is assumed at 265 VND, PC: Passenger car.

Source: Estimated by ITS Integration Project (SAPI) Study Team

c) Balance of Toll Revenue and O&M Costs

Based on the afore-mentioned estimation results regarding cost items, the balance of toll revenue and O&M costs is made for years 2020 and 2025. Toll revenue in 2025 is estimated adding the same increase as that from 2015 to 2020 to the value in 2020, as shown in the following table:

Table 12.9 Balance of Toll Revenue and Operation and Maintenance Costs

Year	Toll Revenue		Road	ITS					Balance	Ratio
		for Operator (x30%) (a)	O&M Costs (b)	Loan Rapay	Interest Ray	O&M Costs	Replace of Equipment	Sub-total (c)	(a)-(b)-(c)	((b)+(c)) /(a)
2014										
2015	11377.48	3413.24								
2016			924.90		13.01	486.54	308.75	808.30		
2017			974.02		13.01	499.48	308.75	821.24		
2018			1025.74		13.01	512.77	308.75	834.53		
2019			1080.20		13.01	526.41	308.75	848.17		
2020	16624.57	4987.37	1137.56		13.01	540.41	308.75	862.17	2987.64	0.40
2021			1197.97		13.01	554.79	308.75	876.55		
2022			1261.58		13.01	569.54	308.75	891.30		
2023			1328.57		13.01	584.69	308.75	906.45		
2024			1399.11	231.67	12.8	600.25	308.75	1153.47		
2025	21871.66	6561.50	1473.41	231.67	12.36	616.21	308.75	1168.99	3919.10	0.40

Unit: million Yen/Year
Source: Estimated by ITS Integration Project (SAPI) Study Team

According to the estimated results for the years 2020 and 2025 in the table, the total O&M costs for road and ITS can be covered by 40% of the toll revenue, which is to be shared for the operator.

13. Review of ITS Basic Plan for New National Highway No.3

13.1 General

1) Outline of New National Highway No.3 (Ha Noi – Thai Nguyen Expressway)

Executing Agency:	Project Management Unit No.2 (PMU2)
Road Operator:	Directorate for Roads of Vietnam (DRVN)
Beginning Point:	Ninh Hiep (Intersection with the new NH1A to the north of Phu Dong Bridge), Gia Lam district, Hanoi city
Ending Point:	The point connecting to beginning of Thai Nguyen bypass, Tan Lap ward, Thai Nguyen province
Total Length:	61.313 km
Location Map:	See **Figure 13.1**
Source of Finance:	JICA loan
Stage of Construction:	Under construction
Design Speed:	100 km/h
Access Control:	Open system
Traffic Volume:	See **Table 13.1**

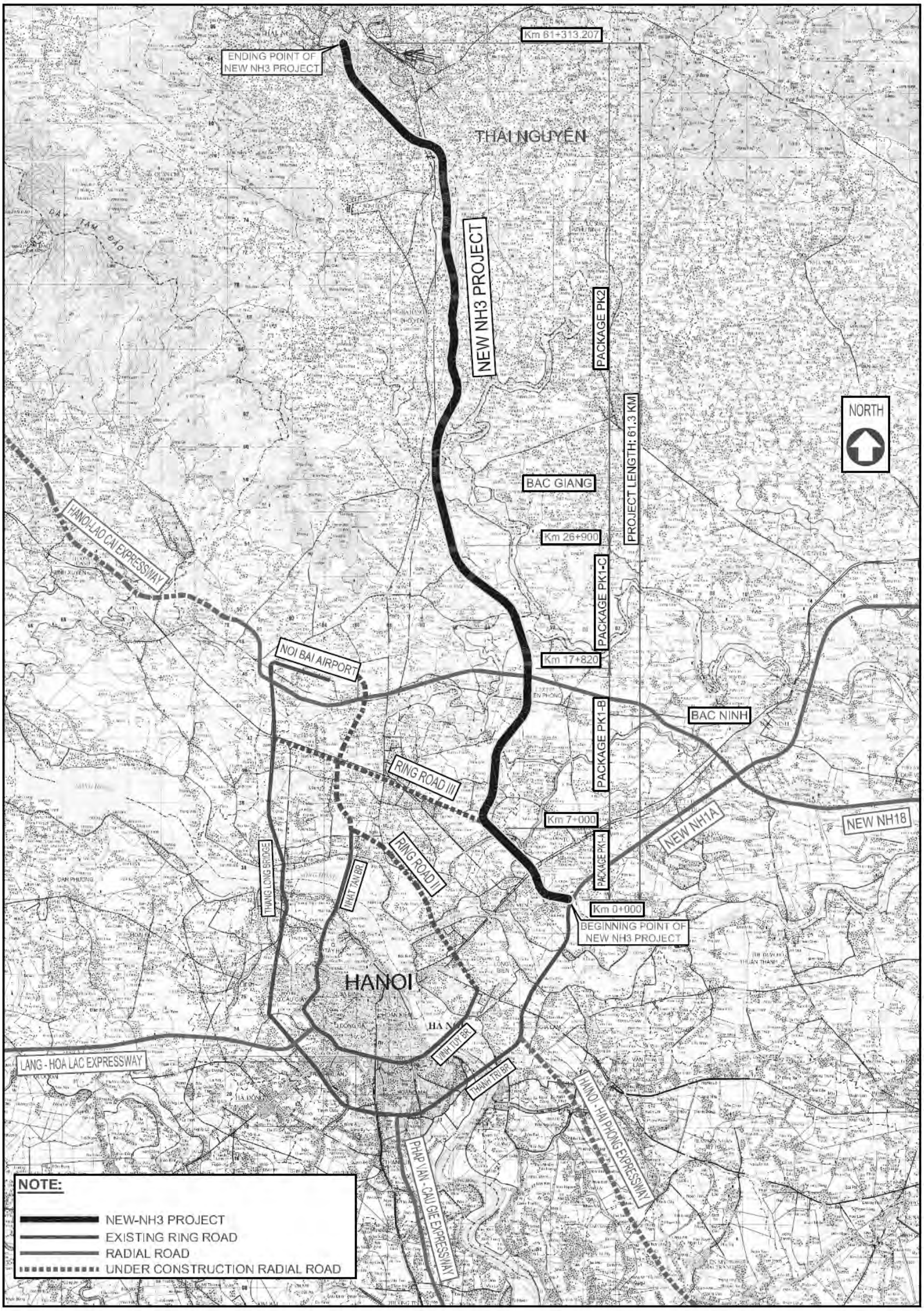
Table 13.1 Traffic Demand Forecast on NH-3 (PCU)

	2004 (actual)	2006 (actual)	2010	2013	2020	2030
Km 0	17,000	20,400	28,900	36,100	60,900	121,700
Km 16	12,900	15,500	22,000	27,500	46,400	92,800
Km 18	7,100	8,500	12,100	15,200	25,600	51,500
Km 19+450		10,000	14,200	17,800	30,100	60,700
Km 24+500 (to Hanoi)	8,200	9,900	14,000	17,500	29,500	58,900
Km 24+500 (to Thai Nguyen)	9,200	11,000	15,600	19,500	32,900	65,800
Km 24+700		12,400	17,600	22,000	37,000	73,700
Km 33+500	6,100	7,300	10,400	13,000	22,000	44,100
Km 42	6,400	7,700	10,900	13,600	23,000	46,100
Km 46+700	6,000	7,200	10,200	12,800	21,600	43,400
Km 56		10,600	15,000	18,700	31,600	62,900
Km 60	7,000	8,400	12,000	15,000	25,300	50,600

Source: Consultant of the New NH3 Project

Details of discussion are shown in Appendix-6.

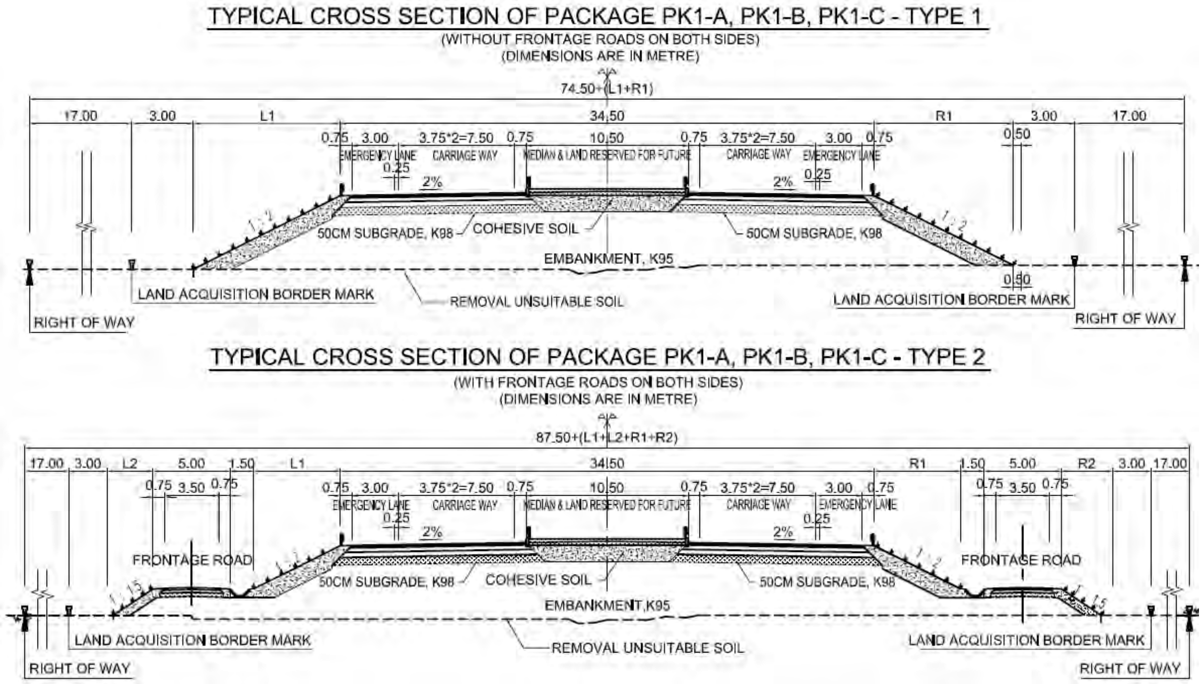
Figure 13.1 Location Map of New National Highway No.3



Source: Consultant of the New NH3 Project

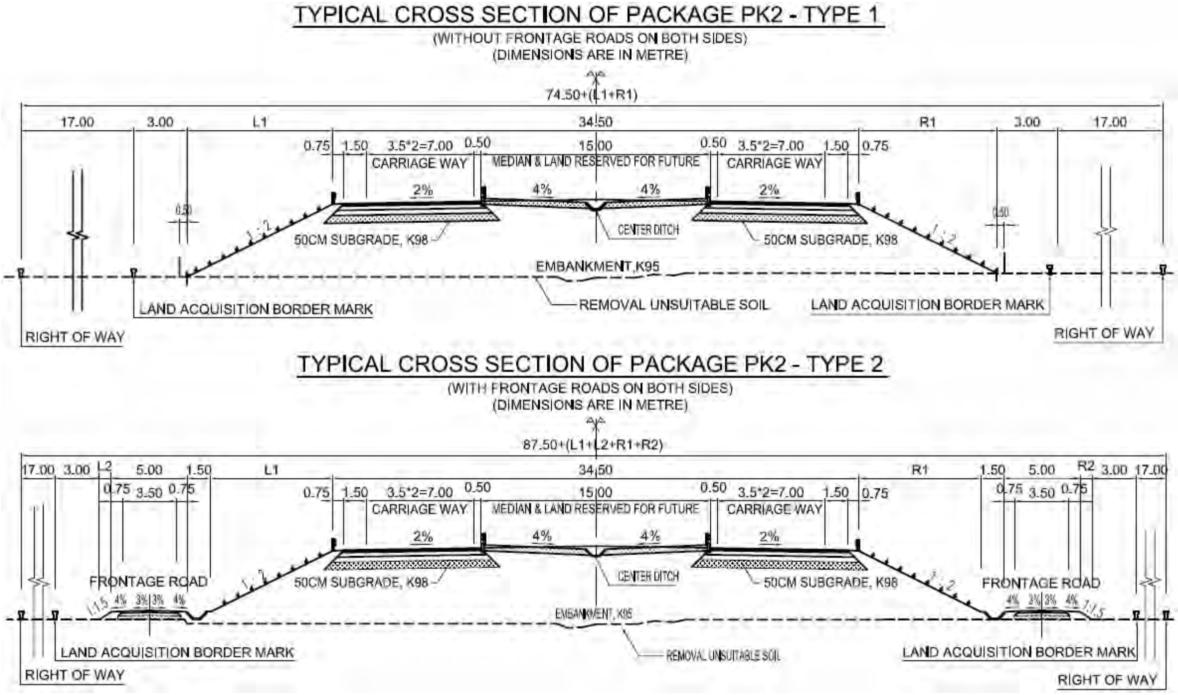
Implementing Package:	Package 1-A	Gia Lam–Dong Anh section (KM0+000–KM7+000)
	Package 1-B	Dong Anh–Yen Phone section (KM7+000–KM17+820)
	Package 1-C	Yen Phone–Soc Son section (KM17+820–KM26+900)
	Package 2	Soc Son–Thai Nguyen section (KM26+900–KM61+313.21)
	Package 3-A	Toll Plaza, Operation Office, Michi no Eki
	Package 3-B	Traffic Information System, ETC (ITS)
	Package 3-C	O&M Equipment
Typical Cross Section:	See **Figure 13.2** and **Figure 13.3**	

Figure 13.2 Typical Cross Section of Package1



Source: Consultant of the New NH3 Project

Figure 13.3 Typical Cross Section of Package2



Source: Consultant of the New NH3 Project

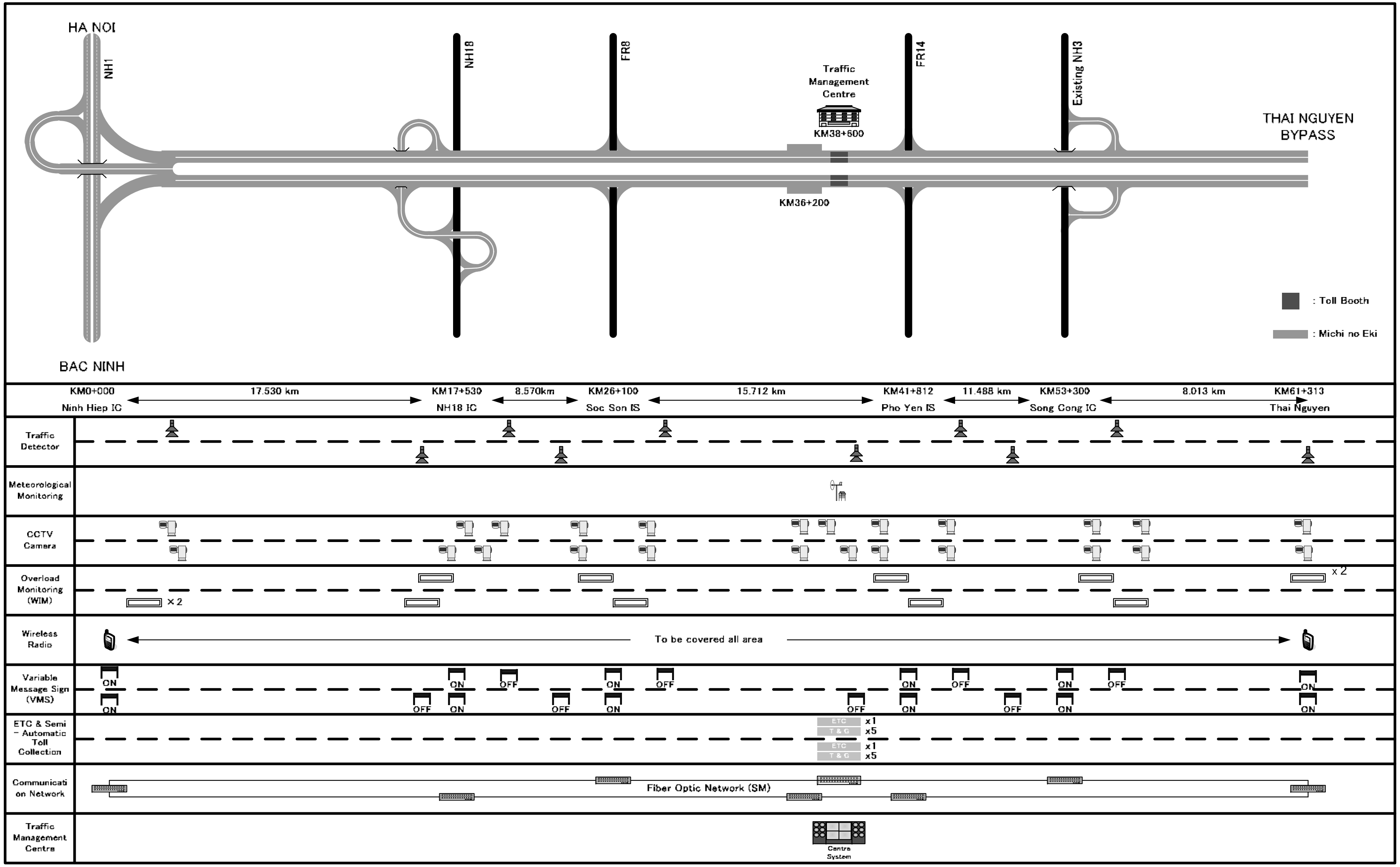
Present ITS Plan:	See **Table 13.2** and **Figure 13.4**

Table 13.2 Outline of Present ITS Implementation Package on the New National Highway No.3

No	ITS Package/Facilities	Location Plan	Unit	Quantity	Major Technical Specifications
1	Vehicle Detector System	One each between Interchanges	sets	20	Ultrasonic type detector
2	Weather Monitoring System	Road Management Office	set	1	Anemometer, Thermometer, Rainfall gage and Visibility meter
3	CCTV Monitoring System	Merging and diverging points, Tollgate, Michi-no-eki	sets	24	Digital IP Camera with pan-tilt and zoom functions (PTZ Camera)
4	Vehicle Weighing System	Merging lanes	sets	13	WIM (Weigh-in-motion) type sensor
5	Mobile Radio Communication System	Base Station: Road Management Office Vehicle Mounted Unit: 20 Mobile Unit: 20	set	1	VHF or UHF exclusive mobile communications
6	Variable Message Sign System	Upstream of each entering points, Upstream of each exit points (except beginning and ending points)	sets	20	High Intensity LED Type
7	Traffic Management System	Located at km 38+600 (Road Management Office)	lot	1	- CCTV Control Unit, NVR Server, Operator Console, Monitoring TV - Traffic Detector Processing Server (Traffic Data Server) - VMS Control Unit (VMS Center Controller) - Meteorological Processing Server (Weather Data Server) - WIM Processing Server (Heavy Truck Control Data Server) - Traffic Management Server, Facility Management Server - Large Display Panel with LDP Controller, etc.
8	Toll Collection System	Toll Barrier: Located at km 38+600	lot	1	-
		Semi-Automatic Toll Collection System	lanes	10	Barcode Ticket
		Electronic Toll Collection (ETC) System	lanes	2	5.8GHz Active type DSRC
9	Communication System (Fiber Optic System, Telephone Exchange)	Fiber Optic Node: each interchange, RMO, Michi-no-eki	sets	8	Gigabit/10Gigabit Ethernet
		Fibre Optic Cable: median of main carriageway	km	124	Fiber optic cable: SM (single mode) fibre cable
		Telephone Exchange: Road Management Office	lot	1	IP-PBX
10	Electrical Facility	Each interchange, Road Management Office, Michi-no-eki	lot	1	Commercial power with backup power supply (generator, UPS, etc.)

Source: Consultant of the New NH3 Project

Figure 13.4 Present ITS Location Map of the New National Highway No.3



Source: Consultant of the New NH3 Project

2) Objective of the Review Works

A draft ITS basic plan for the New National Highway No.3 (Ha Noi - Thai Nguyen Expressway, called as the New NH3) was prepared by the consultant of the New NH3 project and submitted to PMU2, executing agency of the New NH3, on April 2011. The draft ITS basic plan for the New NH3 was basically developed in accordance with the draft ITS standards which have been prepared under the project named "the Study for Supporting ITS Standards & Operation Plan Development in VIETNAM" financed by JICA. However, there have been still discrepancies between ITS introduction policies of previous draft ITS basic plan for the New NH3 and the draft ITS standards.

On the other hand, designing and construction of expressway is underway nationwide in Vietnam. In the Ha Noi Metropolitan Area, road network consist of the New NH3 and expressways in radial directions and Ring Road No.3 bundles them is to be constructed by around 2013, and ITS introduction is under discussion for realizing efficient road operation. Additionally, in Vietnam, expressway network being constructed by sections funded by different donors, it has become an important issue how operate such sectioned road network and ITS in integrated form.

In such situation, ITS operation framework, key policies on system and the draft ITS standards are shown as the results of "the Study for Supporting ITS Standards & Operation Plan Development in VIETNAM" (called as the JICA previous study) conducted following VITRANSS2; however, these results have not been formulated and integration on ITS has not been established. Consequently, it has become critically important to establish a procedure for integrating ITS introduced over different road sections and to show the way to utilize ITS for expressway operation and for addressing potential problems in the metropolitan area.

Under such circumstance, "the Study for Assistance of ITS Integration Project implementation over National Highway No.3 & Hanoi Metropolitan Area financed by JICA" is carried out to integrate and secure compatibility of ITS over the whole Ha Noi Metropolitan Area achieving following items:

(1) Evaluation of the ITS Integrated Project and development of a specific plan for project implementation,

(2) Consensus building on the specific plan with parties concerned in Vietnam, and

(3) Conforming ITS of new National Highway No.3 to previous study results and the developed specific plan.

This Chapter focuses on the review results of ITS basic plan of the New NH3.

13.2 Comparison between Previous ITS Basic Plan for New NH3 and JICA Draft ITS Standard

Previous ITS basic plan for the New NH3 was studied to identify the discrepancies with JICA draft ITS Standard. The comparison of ITS implementation polices between the previous ITS basic plan for the New NH3 and JICA draft ITS Standard with comments is shown in **Table 13.3**.

Major findings of differences on ITS implementation plan to be modified are listed as below.

- Arrangement plan of CCTV camera (**Section 13.4 1**)
- Type of vehicle detection sensor (**Section 13.4 2**)
- Arrangement plan of axle road scale (**Section 13.4.3**)
- Functions, system components and future transition plan of traffic management system (**Section 13.3**)

Table 13.3 Comparison of ITS Implementation Plan between Previous New NH3 ITS Basic Plan and JICA Draft ITS Standard

ITS Facilities	Previous ITS Basic Plan for the New NH3	JICA Draft ITS Standard	Comments
CCTV Camera	**(1) Arrangement Plan** CCTV camera will be installed at **diverting and merging points near interchange only**.	**(1) Arrangement Plan** Two (2) criteria for CCTV camera arrangement are shown in the draft ITS Standard. - **Arrange PTZ Camera with 2 km spacing between two cameras** - Arrange PTZ Camera with 2 km spacing between two cameras and fixed CCTV Camera for event detection	**To be reviewed**
	(2) Type of CCTV camera Digital IP Camera with pan-tilt and zoom functions (PTZ Camera)	**(2) Type of CCTV camera** Digital IP Camera with pan-tilt and zoom functions (PTZ Camera)	Acceptable
Vehicle Detection	**(1) Arrangement Plan** One (1) traffic detector sensor in each section between interchanges and/or intersections at initial stage.	**(1) Location plan** Four (4) criteria for vehicle detector arrangement are shown in the draft ITS Standard. - At midway point between a pair of interchanges on the expressway - At a small spacing (e.g. 500m) continuously along the expressway - At a small spacing (e.g. 500m) in congestion-prone section on the expressway - At 2km spacing continuously along the expressway	Acceptable
	(2) Sensor Type **Ultrasonic type detector**	**(2) Sensor Type** Three (3) alternatives for type of vehicle detector are proposed in the draft ITS Standard. - Loop-coil type detector - Ultrasonic type detector - **Image recognition type detector**	**To be reviewed**
Mobile Radio Communication	**(1) Type** Mobile radio communication using exclusive frequency (VHF or UHF) will be used for road management.	**(1) Type** Mobile radio communication using exclusive frequency (VHF or UHF) will be used for road management.	Acceptable
Variable Message Sign (VMS)	**(1) Arrangement Plan** Entrance and exit to/from main road	**(1) Arrangement Plan** Entrance, junction and exit to/from main road	Acceptable
Weather Monitoring	**(1) Arrangement Plan** One (1) location (New NH3 Road Management Office)	**(1) Arrangement Plan** Two (2) locations per 80km	Acceptable
	(2) Measurement item (Sensor Type) Rain gauge, anemometer, visibility sensor and thermometer	**(2) Measurement item (Sensor Type)** Rain gauge, anemometer, visibility sensor and thermometer	Acceptable

ITS Facilities	Previous ITS Basic Plan for the New NH3	JICA Draft ITS Standard	Comments
Traffic Management System	**(1) Hierarchical Structure for Expressway Operation (Road Management Office)** One (1) road management office including toll office at KM38+600	**(1) Hierarchical Structure for Expressway Operation** - Roadside Equipment and Toll Offices: A toll office is located at a tollgate, which includes two or more tollbooths. - Road Management Offices: One or more road management offices need to be set up on an expressway section. (The intervals of the management office on the expressway network shall be less than 80km.) - Regional Main Centers The Regional Main Centers need to be set up in the principal cities such as Ha Noi, Da Nang and HCMC.	Acceptable
	(2) Functions and Roles of Road Management Office 1) Surveying current traffic conditions on the New NH3 2) Controlling toll offices on the New NH3 3) Controlling communication nodes on the New NH3 4) **Traffic monitoring on the New NH3** 5) **Traffic control on the New NH3** 6) **Traffic information dissemination on the New NH3**	**(2) Functions and Roles of Road Management Offices and Regional Main Centers** [Road Management Offices] 1) Surveying current traffic conditions on the expressway in their jurisdictions 2) Controlling toll offices in their jurisdictions 3) Controlling communication nodes in their jurisdictions [Regional Main Centers] 1) Traffic monitoring 2) Traffic control 3) Traffic information dissemination 4) Integration of road management offices	Acceptable

ITS Facilities	Previous ITS Basic Plan for the New NH3	JICA Draft ITS Standard	Comments
	(3) Configuration of traffic management system Following traffic management system will be introduced in the New NH3 road management office for traffic information/ control, road management and monitoring of the New NH3. 1) CCTV Control Unit, NVR Server, Operator Console, Monitoring TV 2) Traffic Detector Processing Server (Traffic Data Server) 3) Radio Communication Base Station with Hand-set 4) VMS Control Unit (VMS Center Controller) 5) Meteorological Processing Server (Weather Data Server) 6) WIM Processing Server (Heavy Truck Control Data Server) 7) Traffic Management Server 8) Facility Management Server 9) Large Display Panel with LDP Controller 10)System Clock Server and Operator Console	**(3) Configuration of traffic management system** [Road Management Offices] 1) CCTV Monitoring Console with CCTV Center Controller 2) Traffic Event Data Server with Traffic Event Data Monitor 3) Data Input Terminal 4) Radio Communication Base Station with Hand-set [Regional Main Centers] 1) CCTV Monitoring Console with CCTV Center Controller 2) Traffic Data Server with Traffic Analysis Processor 3) Weather Data Server 4) Traffic Event Data Server with Traffic Event Data Monitor 5) Traffic Supervising/Control Server with Console 6) VMS Center Controller 7) Traffic Information Server 8) Heavy Truck Control Data Server	**To be reviewed**
Toll Collection System	**(1)Toll Charging Principle (Access Control)** Open System	**(1)Toll Charging Principle (Access Control)** Closed or Open System	Acceptable
	(2)Toll Rate Principle Flat tariff system	**(2)Toll Rate Principle** Distance Based or Flat tariff system	Acceptable
	(3)Type of ETC System (Road-to-vehicle communication for ETC) Active DSRC type	**(3)Type of ETC System (Road-to-vehicle communication for ETC)** The most appropriate road-to-vehicle communication for ETC shall be selected among following three methods; - Active DSRC - Passive DSRC - RF-Tag	Acceptable
Emergency Telephone (Incident Notification)	**(1) Emergency Telephone** Not planned (Incident notification is made by using mobile phone at initial stage.)	**(1) Emergency Telephone** Two (2) procedures for incident notification are shown in the draft ITS Standard. - Using emergency telephone - Using mobile phone	Acceptable
Vehicle Weighing System	**(1) Location Plan** **At each entering lane**	**(1) Location Plan** **At closely back from exit tollgate**	**To be reviewed**

ITS Facilities	Previous ITS Basic Plan for the New NH3	JICA Draft ITS Standard	Comments
Power Supply System	**(1) Power Supply to ITS Facilities** From power receiving panel procured by ITS package with following emergency power supply system - Diesel Engine Generator - Uninterruptible Power Supply (UPS) (Lighting system of the New NH3 will be handed over and managed by local authority, while ITS facilities will be managed by DRVN. Accordingly, power supply system for lighting system and ITS facilities should be separately installed to clarify its demarcation.)	**(1) Power Supply to ITS Facilities** Not specified	Acceptable

Source: ITS Integration Project (SAPI) Study Team

13.3 Traffic Information/Control System of New NH3 Road Management Office

1) Necessity of Phased Development Plan on Traffic Information/Control System

According to the JICA draft ITS Standard, the traffic control and management of expressway in Vietnam will be carried out by following three (3) organization and/or system.

(1) Regional Main Centers (Ha Noi, Da Nang, Ho Chi Minh)

(2) Road Management Offices

(3) Roadside Equipment and Toll Office

The Regional Main Centers, which will be constructed at Ha Noi, Danang and Ho Chi Minh, should be in charge of traffic monitoring, traffic control and traffic information dissemination, and the management office are to be integrated by the Regional Main Center. On the other hand, Road Management Offices such as New NH3 Road Management Office should be in charge of patrol for surveying current conditions on the expressway, and the toll offices and the communication nodes on the section are to be controlled by the Road Management Office. In the JICA draft ITS Standard, the Road Management Office is to have only monitoring function for traffic control and management of their own roads necessary for the cases in emergency conditions, and operation and maintenance of their own roads. However, it is currently not sure when the Northern Regional Main Center, in charge of traffic monitoring, traffic control and traffic information dissemination on the New NH3, will be constructed. Accordingly, the New NH3 Road Management Office should have not only monitoring function but also temporarily traffic monitoring, traffic control and traffic information dissemination functions until the commencement of the services of the Northern Regional Main Center.

Thus, the phased system operation plan of traffic information/control system, which realizes the traffic control and management functions mentioned above, must be considered as:

Phase-1: Operation with full required functions for the traffic control and management on the New NH3

Phase-2: Operation with handed over/shared functions with the Northern Main Center

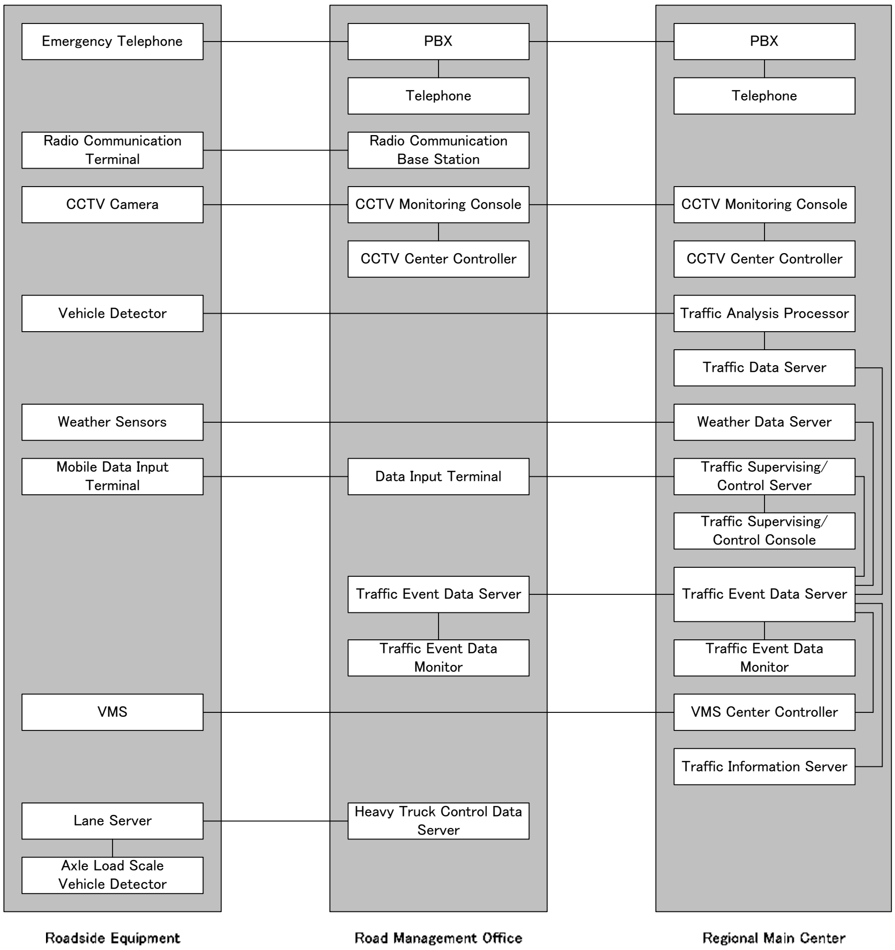
2) Operation Framework, ITS Implementation Package and Required System Components

The JICA draft ITS Standard sets up five (5) expressway operational frameworks for the traffic control and management using ITS, that is, “Incident Notification”, “Road/Traffic Monitoring”, “Traffic Event Data Management”, “Traffic Information Dissemination” and “Heavy Truck Control”, and defines the ITS implementation packages to realize those operational frameworks.

Table 13.4 summarizes relationships among the operational frameworks, ITS implementation packages and required system components to be installed at roadside, the Road Management Office and the Regional Main Center.

Theoretical configuration of required system components is illustrated as figure below.

Figure 13.5 Theoretical System Configuration Specified in JICA Draft ITS Standard



Source: ITS Integration Project (SAPI) Study Team

Table 13.4 ITS Packages and Required System Components

Operation Framework	ITS Package		Required Component		
			Roadside	Road Management Office	Regional Main Center
Incident Notification	Telephone Exchange	This functional package allows to send an emergency call and a request for help to the Main Centers and road management offices at an incident occurrence by telephones installed at roadsides and administrative telephones installed at the toll offices, and allows to send directives to the units concerned at an instant for clearing incidents and enforcing traffic regulations.	Emergency Telephone	PBX Telephone	PBX Telephone
	Mobile Radio Communication	This functional package allows the road operators to exchange information between road operation vehicles/workers on the expressway and the road management office by using radio communication.	Radio Communication Terminal (In-Vehicle, Mobile)	Radio Communication Base Station	-
Road/Traffic Monitoring	CCTV Monitoring	This functional package allows the road operators to capture current situation and traffic conditions on the expressways and to monitor the captured video image at the Main Centers and road management offices by using cameras.	CCTV Camera	CCTV Monitoring Console CCTV Center Controller	CCTV Monitoring Console CCTV Center Controller
	Vehicle Detection	This functional package allows the road operators to measure actual traffic volume, heavy vehicle ratio and vehicle velocity on the expressways for developing road operation/improvement plans by using vehicle detectors.	Vehicle Detector	-	-
	Traffic Analysis	This functional package allows the road operators to keep track of traffic conditions on the expressways, such as crowdedness and vehicle velocity, by processing and analyzing the data captured by vehicle detectors.	-	-	Traffic Analysis Processor Traffic Data Server
	Weather Monitoring	This functional package allows the road operators to estimate dangerous conditions for road traffic on the expressways by using data acquired by the sensors.	Weather Sensors	-	Weather Data Server
	Traffic Supervision	This functional package allows the road operators at the Main Center and road management office to supervise totally and visually the current traffic conditions on the expressways and the information organized as traffic events.	Mobile Data Input Terminal	Data Input Terminal	Traffic Supervising/ Control Console Traffic Supervising/ Control Server

Source: ITS Integration Project (SAPI) Study Team

Operation Framework	ITS Package		Required Component		
			Roadside	Road Management Office	Regional Main Center
Traffic Event Data Management	Event Detection	This functional package allows the road operators to automatically recognize occurrence of traffic accidents, broken-down vehicles and left obstacles on the expressways and to send notification to the Main Centers and road management offices by analyzing video images from cameras.	CCTV Camera Image Detection	-	-
	Traffic Event Data Management	This functional package allows the road operators to conduct traffic control, regulation and information dissemination on the expressway, in the unified/integrated form, by categorizing the results acquired through emergency telephones, mobile radio communication, event detection, traffic analysis and weather monitoring and by organizing them as the data of traffic events corresponding to the place/time of occurrence and the priority.	-	Traffic Event Data Server Traffic Event Data Monitor	Traffic Event Data Server Traffic Event Data Monitor
Traffic Information Dissemination	VMS Indication	This functional package allows the road operators to provide road users on the expressways with the information organized as traffic events by using VMS (Variable Message Sign) installed at the place short of entrances and exits.	VMS	-	VMS Center Controller
	Traffic Information	This functional package allows the road operators to provide other organizations with the information organized as traffic events on the expressways by using the Internet.	-	-	Traffic Information Server
Heavy Truck Control	Axle Load Measurement	This functional package allows the road operators to detect/regulate overloaded heavy trucks on the expressways by using axle load scale installed in the exit tollgate lane exclusive for large-size vehicles.	Lane Server Axle Load Scale Vehicle Detector	-	-
	Overloading Management	This functional package allows the road operators to store/retrieve data of the heavy trucks overloaded on the expressways by using computers and software installed in the road management office.	-	Heavy Truck Control Data Server	-

Source: ITS Integration Project (SAPI) Study Team

3) Coverage and Introduction Policy of Traffic Information/Control System in Each Phase

Though the New NH3 Road Management Office will be equipped with traffic monitoring, traffic control and traffic information dissemination functions until the establishment of the Northern Regional Main Center, traffic information/control system introduced in the New NH3 need not have full-scale system components, since 1) total length of targeted road is less than 62km and 2) almost all traffic control and management functions are transferred to the Northern Regional Main Center.

Aiming at reducing the implementation cost and efficient functional transition to the Northern Regional Main Center, the traffic information/control system will be introduced with following implementation coverage and policy.

(1) Phase-1: Initial Stage without Regional Main Center

Coverage of the system

The traffic information/control system shall have following traffic control and management functions on the New NH3.

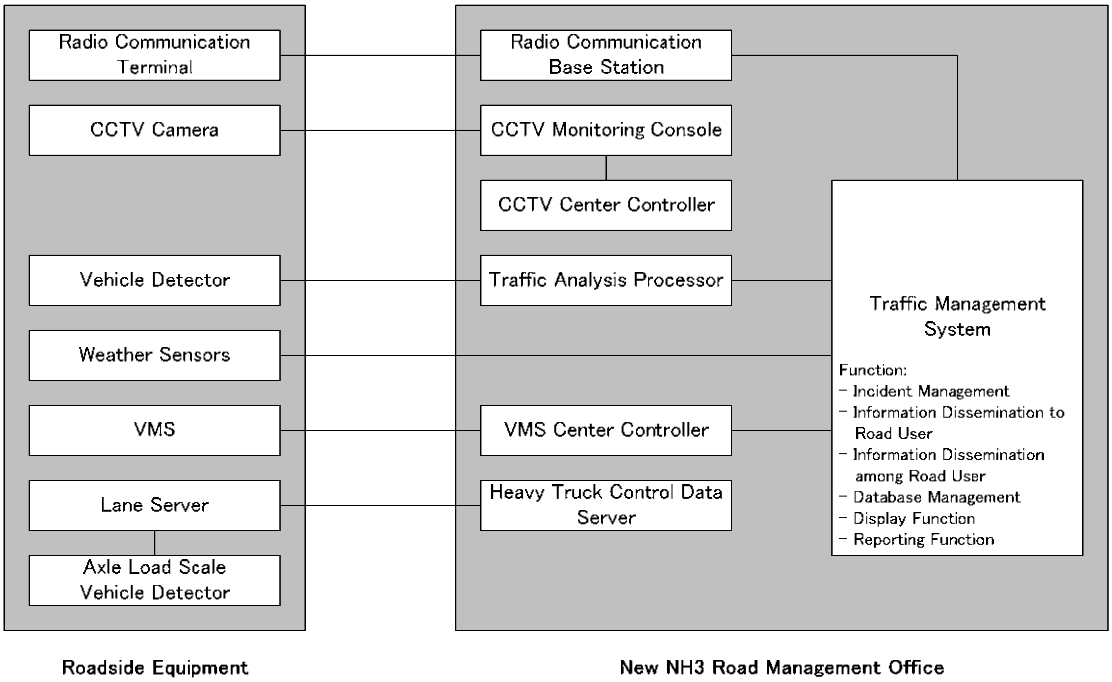
- Incident Notification
- Road/Traffic Monitoring
- Traffic Event Data Management
- Traffic Information Dissemination
- Heavy Truck Control

The system covers the traffic control and management functions of the New NH3 and does not include the functions of other connecting expressways such as NH1A and NH18.

Implementation Policy

a) The traffic information/control system in the New NH3 Road Management Office and roadside equipment is configured as figure below.

Figure 13.6 Traffic Information/Control System Component Phase-1 (Without Regional Main Center)



Source: ITS Integration Project (SAPI) Study Team

b) Traffic Management System, which is vital components of the traffic information/ control system, will be provided in the New NH3 Road Management Office to manage, monitor, control and integrate the data collected directly from roadside equipment or through each system processing server and have traffic event data management and traffic supervision functions.

c) Incident notification function from road users by using mobile phone will be introduced in the New NH3. Apart from this, mobile radio communication system will be provided to communicate with road operation vehicles/workers on the expressway, and radio communication base station will be constructed in the New NH3 Road Management Office.

d) Following system components in the New NH3 will be provided for realizing the road/traffic monitoring function:

- CCTV monitoring system
- Vehicle detector system
- Weather monitoring system

In the Road Management Office, separate processing server or console/controller for each system except weather monitoring system will be introduced to collect and process the data from roadside equipment. Weather data processing will be made by traffic management system because the weather monitoring system consists of only one set of roadside sensors and provision of exclusive processing is to be not required.

e) Traffic information dissemination function to road users by using VMS will be introduced in the New NH-3. VMS center controller to control VMS at roadside will be provided in the road management office. Traffic information system which is defined as one of traffic information dissemination package will not be introduced in the New NH3 Project since the system aims to provide traffic event data with other organizations and such function will be realized by oral communication through public telephone in this phase.

f) As for heavy truck control function, axle load scale and related equipment at roadside and heavy truck control data server in the Road Management Office will be provided in Phase-1. The system is to be only utilized by the traffic inspector at roadside or the office for enforcement of overloaded vehicle and no system transfer is needed even after the Northern Regional Main Center is established.

g) Each system component shall have future expandability and compatibility with the Northern Regional Main Center after-mentioned.

(2) Phase-2

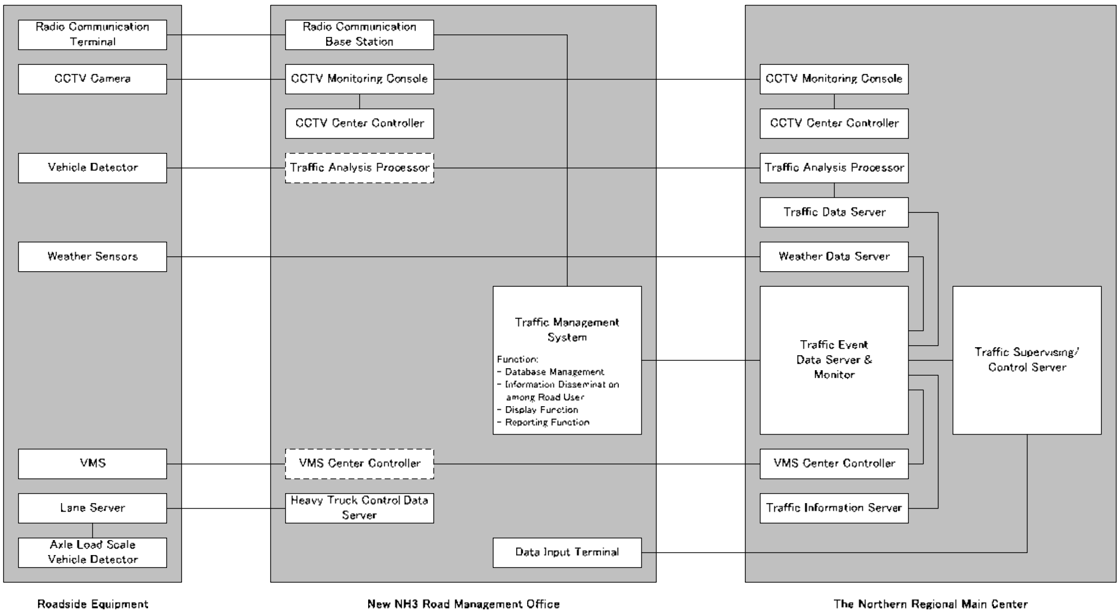
Coverage of the system

The traffic information/control system in the New NH3 Road Management Office shall keep necessary monitoring functions and major traffic monitoring/control/information dissemination functions will be transferred to the Northern Regional Main Center.

Implementation and transition policy

a) The traffic information/control system in both of the New NH3 Road Management Office and the Northern Regional Main Center is configured as figure below.

Figure 13.7 Traffic Information/Control System Component Phase-2



Source: ITS Integration Project (SAPI) Study Team

b) The Northern Regional Main Center will be equipped with traffic event data server consolidating the data collected from or processed at roadside equipment and/or the road management office. The traffic management system in the New NH3 Office will be functioning as a counterpart equipment of traffic data server.

c) Mobile radio communication system is a system to be utilized in the operational coverage of the Road Management Office. Therefore, the radio communication base station will continue to be used in Phase-2 without any functional changes from Phase-1.

d) CCTV monitoring system will be extended to connect to the Northern Regional Main Center through CCTV monitoring console with keeping camera control function in the New NH3 Management Office. By using Network Video Recorder (NVR) as CCTV center controller, the system expansion to the Northern Regional Main Center may be possible without modification of CCTV monitoring system in the New NH3 Road Management Office.

e) The vehicle detector and weather sensor will be directly connected with traffic analysis processor and weather data server installed in the Northern Regional Main Center in Phase-2. Though the diversion of traffic analysis processor hardware itself installed in the New NH3 Road Management Office in Phase-1 is difficult, it may be possible to transfer both traffic analysis processor software and weather processing software to the servers in the Northern Regional Main Center.

f) The truck control system in the Road Management Office will remain unchanged even after the Northern Regional Main Center is established.

g) Data input terminal and other required equipment will be additionally provided in the New NH3 Road Management Office in this phase.

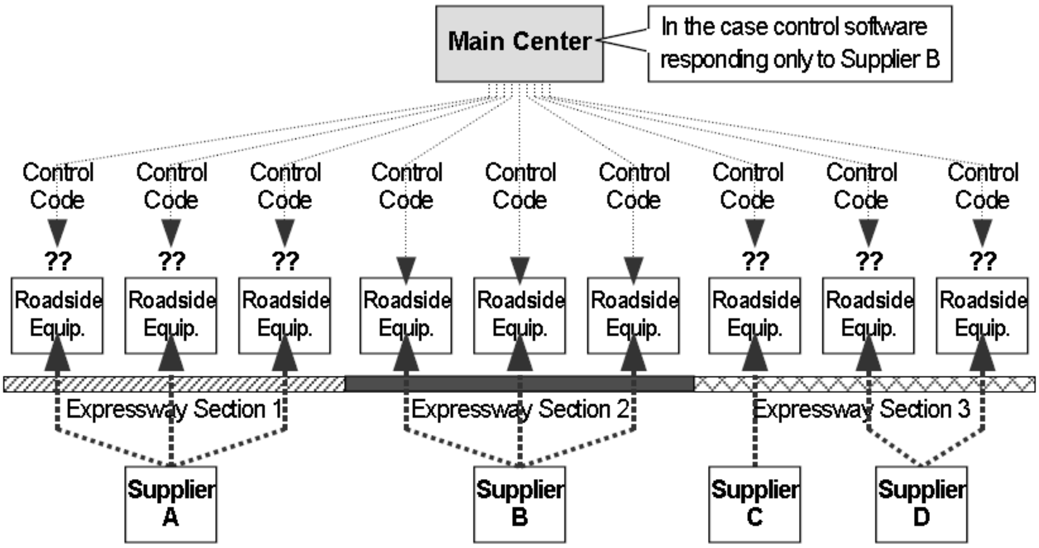
4) Considerations on Future Expandability and Compatibility with the Northern Regional Main Center

As mentioned above, the traffic information/control system of the New NH3 to be introduced in Phase-1 will be expanded to connect to the Northern Regional Main Center in Phase-2, accordingly the system must have following future expandability and compatibility with the Northern Regional Main Center.

(1) Integration of Roadside Equipment Control

ITS consists of various system components including roadside equipment, road management office system and regional main center system. The traffic control and monitoring is to be conducted by controlling the roadside equipment and actual equipment control will be made through control codes transmitted from the road management office and the Regional Main Center. On the other hand, implementation of roadside equipment including the New NH3 is conducted in construction projects of individual road sections, thus, unification of the control code must be considered.

Figure 13.8 Control Codes Incompatible among Different Suppliers



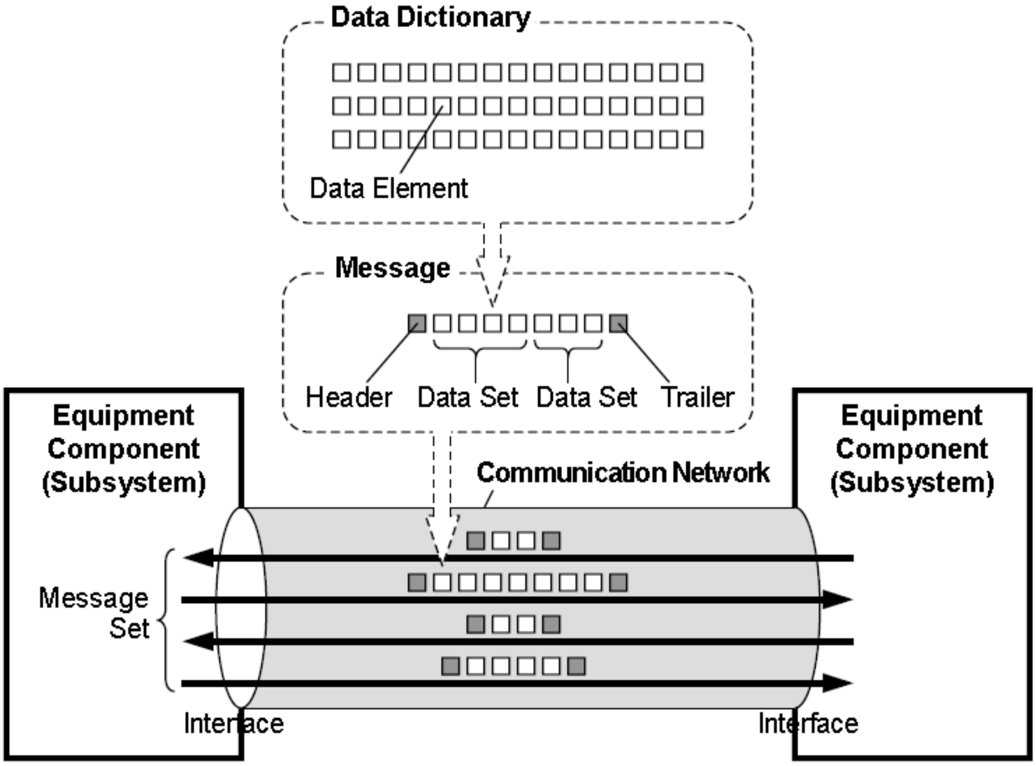
Source: ITS Standards & Operation Plan Study Team

The ITS packages to be unified such control codes among whole packages are CCTV monitoring and VMS system. As for the CCTV monitoring system, NVR (Network Video Recorder) is one of useful integration tools for controlling CCTV cameras procured by different suppliers. Since detailed specifications of NVR are currently being studied by the JICA SAPI project, NVR and CCTV camera to be introduced in the New NH3 must meet the system requirements specified in the SAPI project. On the other hand, there is no effective integration tool and standard for controlling VMSs at this moment. Thus, for VMS implementation in the New NH3 Project, the supplier will be requested to disclose the control code in order to incorporate the VMS control function on the New NH3 into VMS control software in the Northern Regional Main Center.

(2) Message/ Data Interoperability

Although other ITS roadside equipment except CCTV monitoring and VMS system need not particular control codes, the message and data of all roadside equipment to be exchanged with the centralized equipment installed in road management office and the Regional Main Center must be unified in accordance with ISO/IEC 11179.

Figure 13.9 Conceptual Illustration of Message List/ Data Dictionary



Source: ITS Standards & Operation Plan Study Team

For securing interoperability of ITS message/data exchange, the draft message/data standards which specify the message list and data dictionary have been developed in the JICA previous study and further details are being studied in the JICA SAPI project. The ITS facilities in the New NH3 must have conformity with the message/data standards.

(3) Expandability of Communication Network

A network structure of the communication on the New NH3 will be separately configured with three (3) hierarchy, trunk network, local network and access network. The trunk network connecting with the Northern Regional Main Center will be introduced in later stage when the Northern Regional Main Center is constructed. Therefore, the network equipment in the New NH3 shall be only equipped with the network interface between the Northern Regional Main Center such as LAN port, etc. at initial stage.

However, the fiber optic cable shall have enough capacity for future connection even the location plan of the Northern Regional Main Center is not yet fixed, in order to avoid double constructions of the cable. Required fiber optic cable core for connecting with the Regional Main Center is estimated 8 cores or more.

13.4 Proposed Modifications to ITS Implementation Plan on New NH3

1) CCTV Monitoring System

(1) Outline of Modification on CCTV Monitoring System Plan

In the previous ITS basic plan for the New NH3, CCTV camera is proposed to be installed at diverting and merging points near interchange only since;

a) The New NH3 doesn't have continuous lighting system. Therefore, it may be possible that CCTV monitoring system could not be effectively working due to lack of required illuminance, even if the CCTV camera is installed at the interval of 2km.

b) Power supply system are planned only to cover surrounding areas of interchanges and intersections where ITS facilities will be placed. In case the CCTV camera is installed at the interval of 2km, additional power supply system will be required. It may results in high construction costs.

However, CCTV cameras must be arranged throughout the highway with 2 km interval as specified in previous chapter with following reasons.

- According to the MOT decision No.2503/BGTVT-KHCN dated 4 May 2011, it is clearly mentioned that utilization of IP digital camera with high resolution is more and more popular due to reasonable price and its remarkable advantages in image centralization recording and traffic management.
- Incident notifications on entire highway are possible.
- Even under the conditions in heavy rain, darkness or the night, CCTV camera is still effective at identifying severities of incidents by monitoring of vehicle light or tail-lamp.
- Power supply system can be provided with low construction costs by feeding commercial power to CCTV cameras located at midway between interchanges without backup power supply.

(2) Arrangement Plan of CCTV Camera

Proposed arrangement plan of CCTV Camera becomes as **Table 13.5** and **Figure 13.10**. Proposed location of CCTV camera is set up by considering the following actual road conditions on the New NH3.

a) Location of toll barrier, interchanges and merging/diversion sections where most attentions for road operation must be paid on the highway,

b) Horizontal and vertical alignment of the highway,

c) Location of flyover or others which will be visual obstacle for CCTV monitoring,

d) Manhole position to connecting fibre optic cable with CCTV Camera for transmitting CCTV image to Road Management Office.

As a result, total of 44 PTZ cameras including 4 cameras for exclusively monitoring toll barrier and michi-no-eki will be provided in the New NH3 Project.

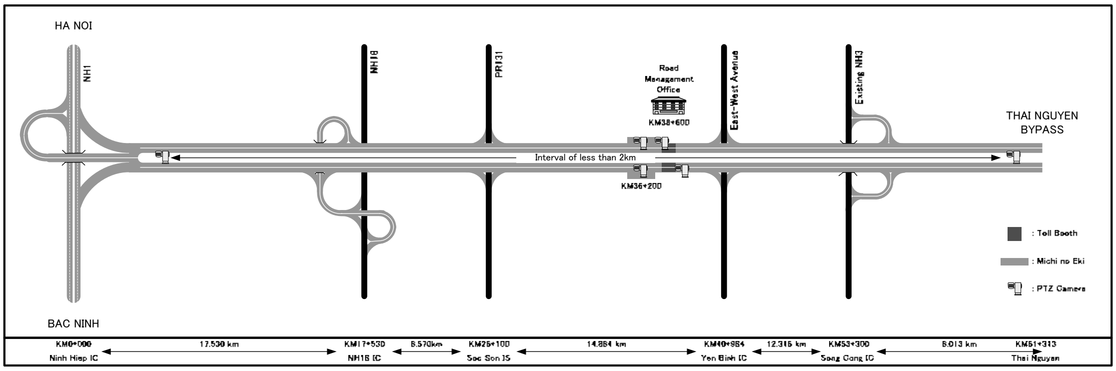
Table 13.5 Proposed CCTV Camera Location

No.	Location	Distance (km)	Type	Remarks	No.	Location	Distance (km)	Type	Remarks	No.	Location	Distance (km)	Type	Remarks
1	KM 0+785.0	0.79	PTZ		16	KM 23+350.0	2.00	PTZ		31	KM 40+400.0	1.35	PTZ	Yen Binh IC Monitoring, Yen Binh IC Ramp(km 40+984)
2	KM 2+355.0	1.57	PTZ		17	KM 25+350.0	2.00	PTZ	Soc Son IC Monitoring, Soc Son IC Ramp (km 26+100)	32	KM 41+400.0	1.00	PTZ	Yen Binh IC Monitoring, Pho Yen Flyover (km 41+812)
3	KM 3+925.0	1.57	PTZ	Flyover 01 (km 4+710)	18	KM 26+500.0	1.15	PTZ	Soc Son IC Monitoring, Flyover 07 (km 26+740)	33	KM 42+692.4	1.29	PTZ	
4	KM 5+225.0	1.30	PTZ	Flyover 02 (km 5+740)	19	KM 27+735.6	1.24	PTZ		34	KM 44+453.1	1.76	PTZ	
5	KM 6+410.0	1.19	PTZ		20	KM 29+726.7	1.99	PTZ		35	KM 46+213.9	1.76	PTZ	
6	KM 7+750.0	1.34	PTZ	Flyover 03 (km 8+420)	21	KM 31+717.8	1.99	PTZ		36	KM 47+974.6	1.76	PTZ	Fedder Road 17 Flyover (km 48+885)
7	KM 9+298.5	1.55	PTZ	Flyover 04 (km 10+177)	22	KM 33+708.9	1.99	PTZ		37	KM 49+708.0	1.73	PTZ	
8	KM 10+700.3	1.40	PTZ		23	KM 35+700.0	1.99	PTZ	Service Area Diversion Section	38	KM 51+354.0	1.65	PTZ	
9	KM 11+746.8	1.05	PTZ	Flyover 05 (km 12+270)	24	KM 36+200.0	-	PTZ	Service Area (Northband)	39	KM 53+000.0	1.65	PTZ	Song Cong IC Ramp (km 53+122)
10	KM 12+945.0	1.20	PTZ	Flyover 06 (km 13+620)	25	KM 36+200.0	-	PTZ	Service Area (Southband)	40	KM 53+700.0	0.70	PTZ	
11	KM 14+580.0	1.64	PTZ		26	KM 36+600.0	0.90	PTZ	Service Area Diversion Section, Flyover 08 (km 37+200)	41	KM 55+671.4	1.97	PTZ	
12	KM 16+500.0	1.92	PTZ	NH18 IC Monitoring, NH18 IC Ramp (km 16+850)	27	KM 37+850.0	1.25	PTZ		42	KM 57+642.9	1.97	PTZ	
13	KM 17+350.0	0.85	PTZ	NH18 IC Monitoring	28	KM 38+500.0	-	PTZ	Toll Plaza (km 38+600)	43	KM 59+614.3	1.97	PTZ	Flyover 10 (km 60+600.0)
14	KM 19+350.0	2.00	PTZ		29	KM 38+700.0	-	PTZ	Toll Plaza (km 38+600)	44	KM 61+100.0	1.49	PTZ	Ending Point (km 61+313.2)
15	KM 21+350.0	2.00	PTZ		30	KM 39+052.5	1.20	PTZ	Flyover 09 (km 39+405)					

Note PTZ: Camera with Pan-Tilit-Zoom functions

Source: ITS Integration Project (SAPI) Study Team

Figure 13.10 Location Map of CCTV Camera



Source: ITS Integration Project (SAPI) Study Team

(3) Other Modifications on CCTV Monitoring System

Power supply system in the New NH3 Project is currently proposed only to cover surrounding areas of interchanges where lighting system and ITS facilities will be located. Therefore, additional power supply system must be provided to feed commercial power to CCTV camera placed at midway between interchanges.

Following three (3) alternatives for supplying power to CCTV camera placed at midway are considerable;

- Alternative-1: Feeding from power supply system at interchange,
- Alternative-2: Feeding from newly constructed power supply system for each CCTV camera with backup power supply system, and
- Alternative-3: Feeding from newly constructed power supply system for each CCTV camera without backup power supply system.

Comparison of alternatives for power supply system is summarized as table below. Considering the cost effectiveness, alternative-3 is proposed as power supply system to CCTV camera placed at midway between interchanges.

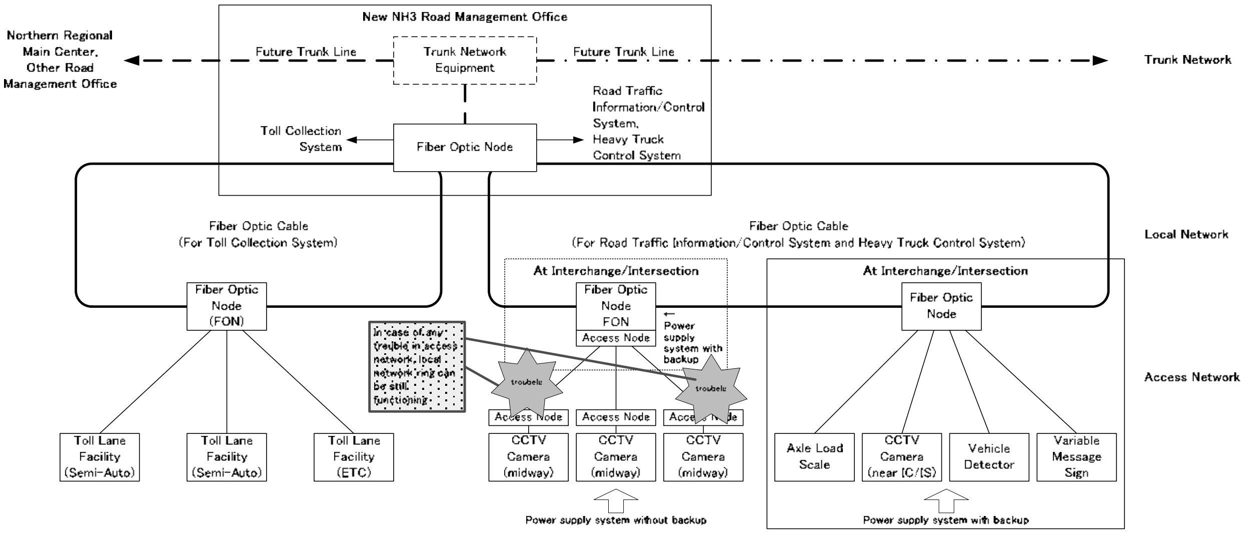
Table 13.6 Comparison of Power Supply System to CCTV Camera

Alternatives / Items	Alternative-1 Power supply from interchange	Alternative-2 Additional power supply system with backup	Alternative-3 Additional power supply system without backup
1. Outline	Electricity is fed from power supply system with backup (UPS and DEG) installed at interchange.	Electricity is fed from newly constructed power supply system with backup (UPS and DEG) at each CCTV camera location.	Electricity is fed from newly constructed power supply system without backup at each CCTV camera location.
2. Required Equipment	- Power cable and PVC cable from nearest interchange - UPS and DEG at interchanges (increased capacity is required)	- Down step transformer at each camera location - UPS and DEG at each camera location	- Down step transformer at each camera location
3. Advantage	- CCTV monitoring is available even during commercial power interruption	- CCTV monitoring is available even during commercial power interruption	- Construction cost is cheaper than other alternatives
4. Disadvantage	- Voltage drop must be considered due to long distance feeder. - Additional conduit system is necessary along the expressway - Large capacity UPSs and DEGs are required at interchanges	- UPS and DEG is additionally required at each camera location - Construction costs will be quite high	- In case of power failure, CCTV image at midway between interchanges cannot be monitored in Road Management Office.
5. Cost	High	High	Low
Recommendation	Average	Average	Recommended

Source: ITS Integration Project (SAPI) Study Team

As well as power supply system, structure and hierarchy of communication system for connecting CCTV camera must be reviewed to secure the total network reliability. The roadside equipment on the New NH3 such as CCTV camera, VMS, vehicle detector is connected by firer optic cable of which network configuration is applied to flattened ring topology. Though Gigabit/10Gigabit Ethernet with Resilient Packet Ring (RPR) having fail-over function, which can guarantee connectivity even if one communication node or fibre optic cable is down, will be employed as communication system of the New NH3, the communication system will not be functioning in case two or more communication node be in failure caused by wide area blackout. Avoiding whole network failure and securing the data transmission reliability, CCTV camera network must be separately configured with other ITS facilities by using access node 1:1 connection with Fibre Optic Node (FON). Following figure illustrates proposed network configuration of the New NH3.

Figure 13.11 Proposed Network Configuration of the New NH3



Source: ITS Integration Project (SAPI) Study Team

2) Vehicle Detection System

An ultrasonic type sensor was tentatively selected as the vehicle detector sensor in the previous ITS basic plan of the New NH3, while three (3) alternatives for traffic detector sensor, i.e. i) Loop-coil type, ii) Ultrasonic type, and iii) Image recognition type, has been proposed in the JICA draft ITS Standard and finally the image recognition type is recommended as mentioned in previous chapter. Also, in MOT decision No.2503/BGTVT-KHCN, it is clearly mentioned that it is priority to choose digital IP camera in design of surveillance camera system in expressway combining with traffic detection, traffic volume and traffic flow speed function (VDS).

Considering the following major advantages, the image recognition type sensor is recommended to be applied to vehicle detector sensor for the New NH3.

- Multiple lane/zone detection is applicable,
- Image recognition camera can be located on any places of expressway including bridge section,
- Applicable to identify traffic swerved from lanes,
- Secondary usage for visual judgment is capable, and
- Maintenance work on the pavement can be avoided.

However, it is possibility that image recognition type detector may not be well functioning under the bad weather conditions such as dense fog and heavy rain. Therefore, the detailed specifications of vehicle detector sensor must be further studied in the detailed design stage.

3) Axle Load Measurement

(1) Outline of Modification on Axle Load Measurement Plan

Following three (3) alternatives for axle load scale locations were studied in the JICA draft ITS Standard.

- Alternative-1: Closely back from entrance tollgates
- Alternative-2: Closely behind from entrance tollgates
- Alternative-3: Closely back from exit tollgates

As a result, the location closely back from exit tollgates is proposed for axle load scale due to its advantages such as avoiding large land acquisition for overloaded vehicle rejection.

On the other hand, in the previous ITS basic plan for the New NH3, the axle load scale is proposed to be installed at each entering point on the expressway to immediately find out overweight vehicle.

The discrepancy between the proposed locations of axle load scale in the JICA draft ITS Standard and the previous ITS basic plan for the New NH3 is caused by differences of assumed access control, that is, the JICA draft standard has been prepared on assumption that targeted expressway is closed system while the New NH3 applies to open system which doesn’t have any exit tollgate on interchange. Therefore, the location plan suitable for open system is proposed in this report.

Following four (4) alternatives are setting up as axle load scale location applied to open system.

- Alternative-1: All deceleration lanes of interchanges
- Alternative-2: Closely back from toll barrier
- Alternative-3: All acceleration lanes of interchanges
- Alternative-4: Deceleration lanes of interchanges excepting NH1 and NH18

The comparison of alternatives is summarized as **Table 13.7** with following considerable factors;

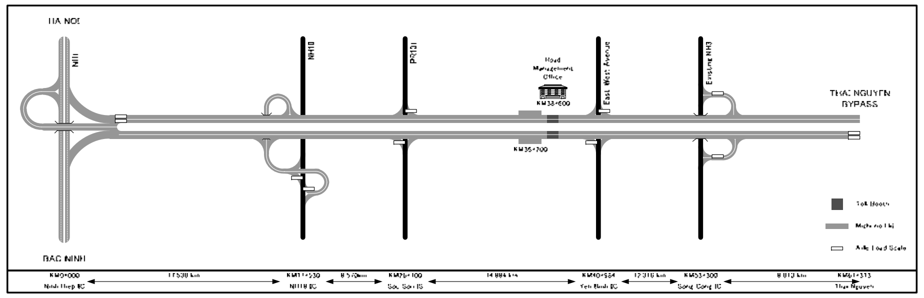
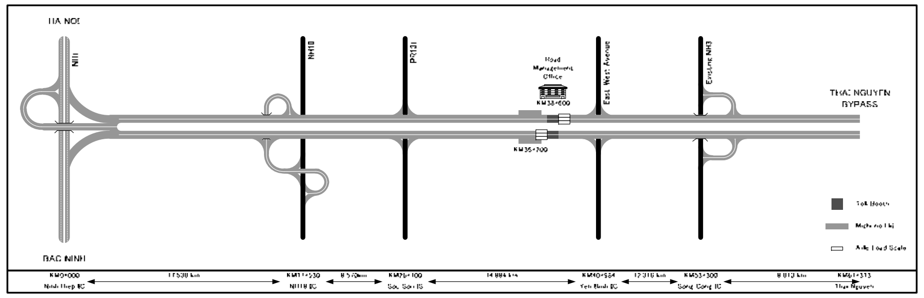
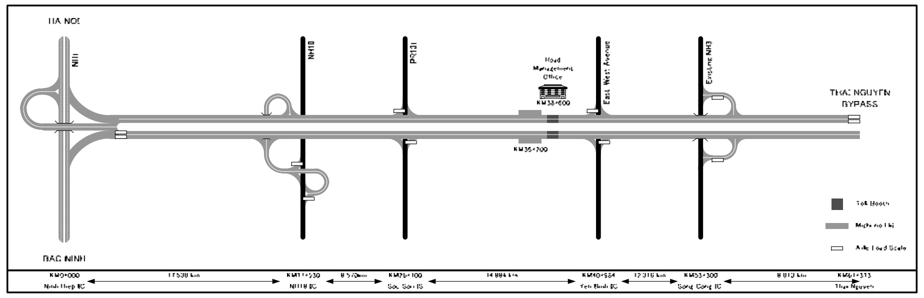
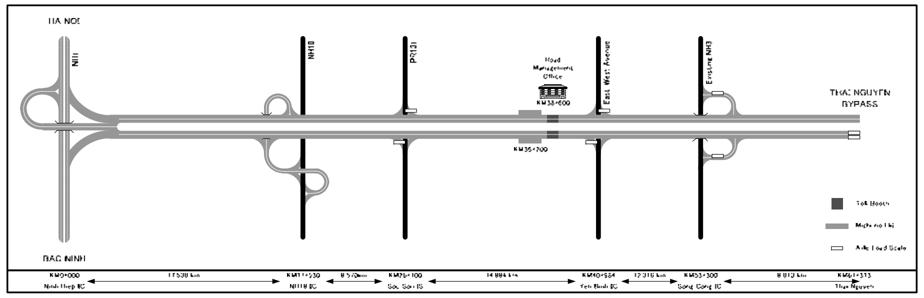
- Keeping measuring accuracy, such as
  - ➢ Tire passing track: all tires must be passing within the lane during vehicle photo taking time
  - ➢ Driving speed of vehicle: Maximum 40 km
  - ➢ Angle between lane direction and vehicle driving direction: within 5 degree
  - ➢ Angles of license-plate number fixing to the vehicle:
    horizontal angle: within 5 degree

vertical angle: within 10 degree

- Necessity of large land acquisition for rejecting overloaded vehicle
- Enforcement of overloaded vehicle on all expressway sections
- Effects of rejecting overloaded vehicles from the expressway
- Cost effectiveness

As a result, the location closely back from toll barrier (Alternative-2) is most recommendable arrangement for axle load scale applied to open system considering its advantages such as keeping measuring accuracy, easiness to secure the land for rejecting overloaded vehicle and cost effectiveness.

Table 13.7 Comparison on Axle Load Scale Location

Items Alternatives	Arrangement Plan	Measuring accuracy				Necessity of large land acquisition	Enforcement of overloaded vehicle on all expressway sections	Effects of rejecting overloaded vehicles from the expressway	Cost effectiveness		Recommendation
		Tire passing track	Driving speed of vehicle	Angle between lane direction and vehicle driving direction	Angles of license-plate number fixing to the vehicle				Number of Axle Load Scale	Cost	
Alternative-1 All deceleration lanes of interchanges		Difficult (No lane barrier on deceleration lanes)	Over measuring range (Max. 50km/h)	Difficult to keep measuring range (No lane barrier on deceleration lanes)	Difficult to keep measuring range, especially vertical angle	Necessary	Possible	Average	12	High	Not Suitable
Alternative-2 Closely back from toll barrier		Capable	Less than 40km/h	Within 5 degree	Within measuring range	Not Necessary	Possible	High	6	Low	Recommended
Alternative-3 All acceleration lanes of interchanges		Difficult (No lane barrier on acceleration lanes)	Over measuring range (Max. 50km/h)	Difficult to keep measuring range (No lane barrier on acceleration lanes)	Difficult to keep measuring range, especially vertical angle	Necessary	Possible in case axle road scales are installed on all connecting expressways and arterial roads	Average	12	High	Not Suitable
Alternative-4 Deceleration lanes of interchanges excepting NH1 and NH18		Difficult (No lane barrier on deceleration lanes)	Over measuring range (Max. 50km/h)	Difficult to keep measuring range (No lane barrier on deceleration lanes)	Difficult to keep measuring range, especially vertical angle	Necessary	Possible in case axle road scales are installed on NH1 and NH3	Average	8	Average	Not Suitable

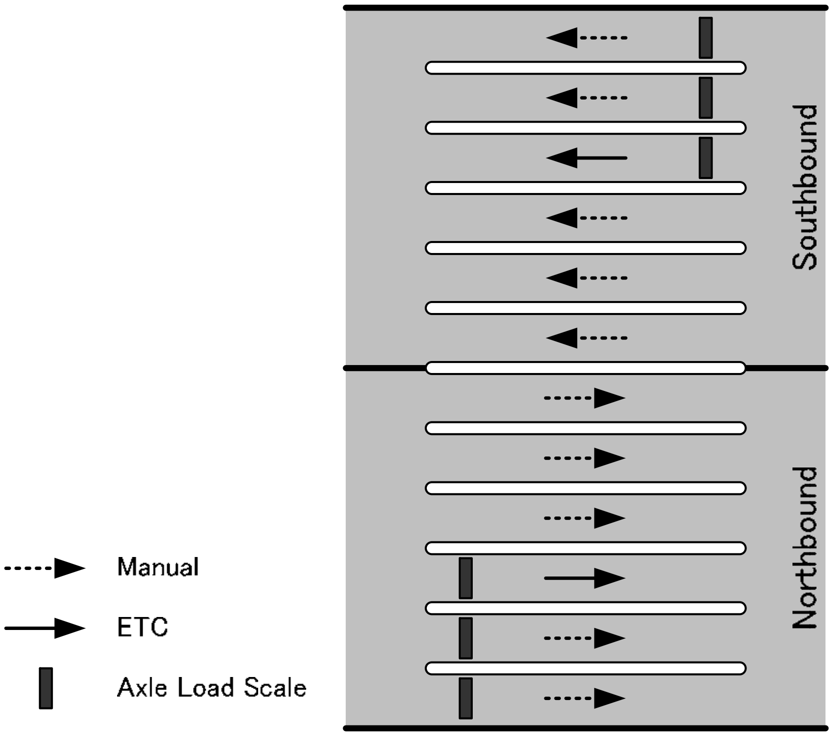
Source: ITS Integration Project (SAPI) Study Team

(2) Proposed Arrangement of Axle Load Scale on Toll Barrier

An arrangement plan of axle load scale on toll barrier for the New NH3 is set up in accordance with JICA draft ITS Standard.

- Axle load scales are installed on three (3) lanes near the roadside of the toll barrier in each direction.
- Vehicles equipped for ETC can be processed at the third lane from the roadside.
- Vehicles not equipped for ETC can be processed at the first or second lanes from the roadside.

Figure 13.12 Arrangement Plan of Axle Load Scale on Toll Barrier



Source: ITS Integration Project (SAPI) Study Team

13.5 ITS Implementation Plan for New NH3

1) ITS Implementation Package

No.	ITS Package		Unit	Quantity	Remarks
1	Traffic Surveillance System				
1.1	Vehicle Detection System	Roadside Equipment	set	10	
		Center Equipment	set	1	
1.2	Weather Monitoring System	Roadside Equipment	set	1	
1.3	CCTV Monitoring System	Roadside Equipment	set	44	
		Center Equipment	set	1	
1.4	Heavy Truck Control System	Roadside Equipment	set	6	
		Center Equipment	set	1	
1.5	Mobile Radio Communication System	Radio Base Station	set	1	
		Mobile Unit	set	40	In-vehicle:20, Mobile:20
1.6	Variable Message Sign System	Roadside Equipment	set	20	Entering:12, Exit: 8
		Center Equipment	set	1	
1.7	Traffic Management System	Center Equipment	set	1	
2	Toll Collection System				
2.1	Semi-Automatic Toll Collection System	Lane Equipment	lane	10	Barcode Ticket
		Toll Office Equipment	set	1	
2.2	Electronic Toll Collection (ETC) System	Lane Equipment	lane	2	Active DSRC
		Toll Office Equipment	set	1	
3	Communication System				
3.1	Fiber Optic System	Fiber Optic Node	set	8	
		Fibre Optic Cable	km	124	
3.2	Telephone Exchange	Telephone Exchange	lot	1	
4	Electrical Facility				
4.1	Electrical Facility		lot	1	

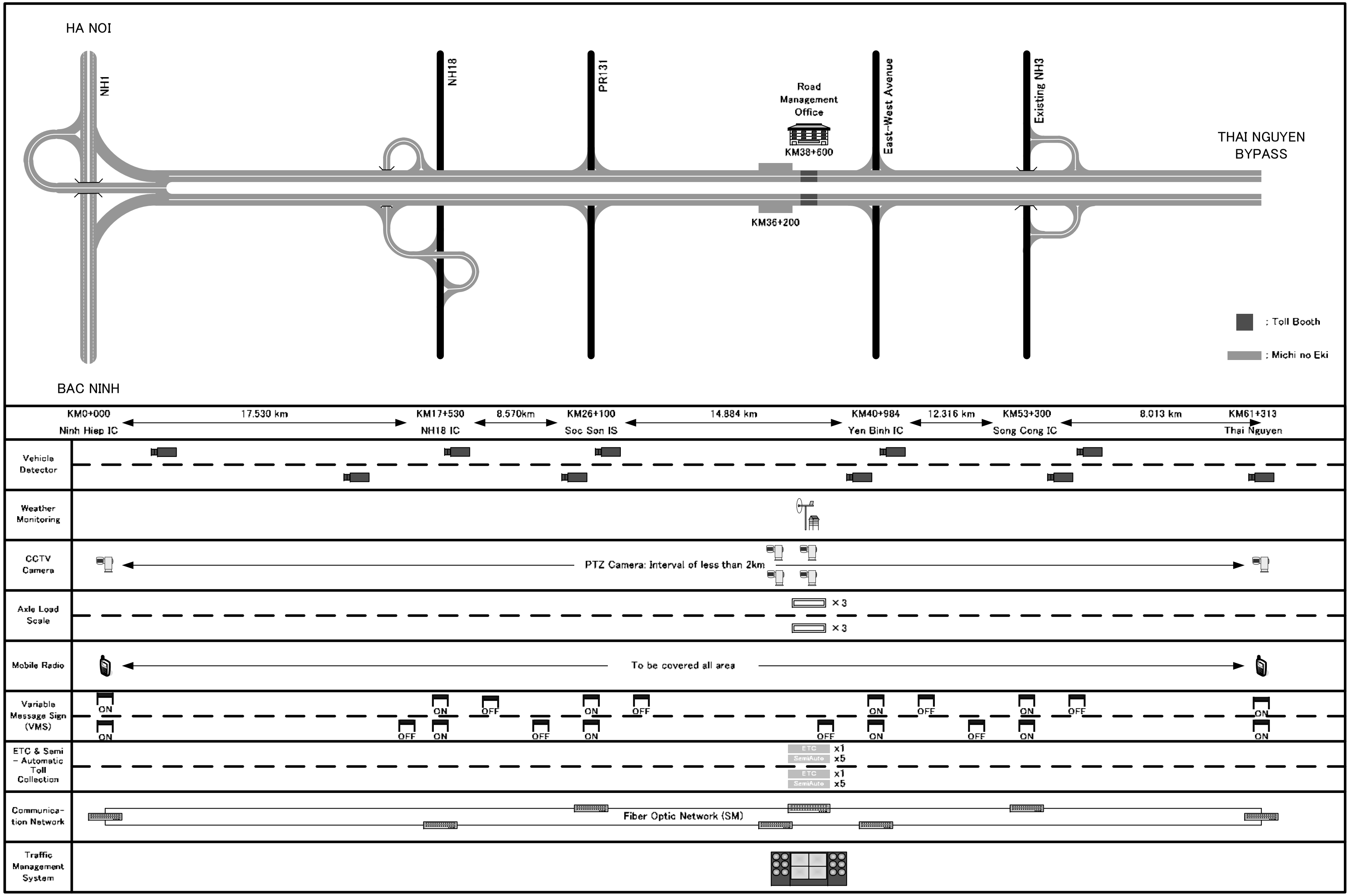
Source: Consultant of the New NH3 Project

2) Outline of Proposed ITS Implementation Plan for the New NH3

No	ITS Package/Facilities	Location Plan	Major Technical Specifications
1	Vehicle Detector System	One each between Interchanges	Image recognition type detector
2	Weather Monitoring System	Road Management Office	Anemometer, Thermometer, Rainfall gage and Visibility meter
3	CCTV Monitoring System	2km interval on main carriageway, tollgate and Michi-no-eki	Digital IP Camera with pan-tilt and zoom functions (PTZ Camera)
4	Vehicle Weighing System	Toll barrier	WIM (Weigh-in-motion) type sensor
5	Mobile Radio Communication System	Base Station: Road Management Office Vehicle Mounted Unit: 20, Mobile Unit: 20	VHF or UHF exclusive mobile communications
6	Variable Message Sign System	Upstream of each entering points, Upstream of each exit points (except beginning and ending points)	High Intensity LED Type
7	Traffic Management System	Located at km 38+600 (Road Management Office)	- CCTV Center Controller, NVR, Monitor Screen - Traffic Analysis Processor - VMS Center Controller - Heavy Truck Control Data Server - Traffic Management Server, Facility Management Server - Display Panel with Controller, etc.
8	Toll Collection System	Toll Barrier: Located at km 38+600	-
		Semi-Automatic Toll Collection System	Barcode Ticket
		Electronic Toll Collection (ETC) System	5.8GHz Active type DSRC
9	Communication System (Fiber Optic System, Telephone Exchange)	Fiber Optic Node: each interchange, RMO, Michi-no-eki	Gigabit/10Gigabit Ethernet
		Fibre Optic Cable: median of main carriageway	Fiber optic cable: SM (single mode) fibre cable
		Telephone Exchange: Road Management Office	IP-PBX
10	Electrical Facility	Each interchange, Road Management Office, Michi-no-eki	Commercial power with backup power supply (generator, UPS, etc.)

Source: ITS Integration Project (SAPI) Study Team

3) ITS Location Map



Source: Consultant of the New NH3 Project

13.6 Implementation Schedule for New NH3

Table 13.8 shows the revised ITS implementation schedule including detailed design, bidding and construction stage. The ITS implementation plan was reviewed on the basis of the following conditions.

[Detailed Design Stage]

1) Detailed design work will be immediately commenced from the begging of December 2011 after the authorization of revised ITS basic plan on the New NH3 by MOT.

2) A total of five (5) months will be needed for detailed design including preparation of drawings, P/Q document, bidding document and cost estimates.

3) In the early phase of detailed design stage, P/Q document will be prepared to minimize the total time period of bidding process.

[Bidding Stage]

1) P/Q announcement will be made in the beginning of March 2012 and prequalification period requires 45 days.

2) After prequalification, P/Q evaluation and the approval of P/Q evaluation report by PMU2, bidding announcement will be made in the beginning of July 2012. The bidding period needs 60 days.

3) After bid open, processes for bid evaluation and clarification, price negotiation and concurrence from MOT and JICA are required.

[Construction Stage]

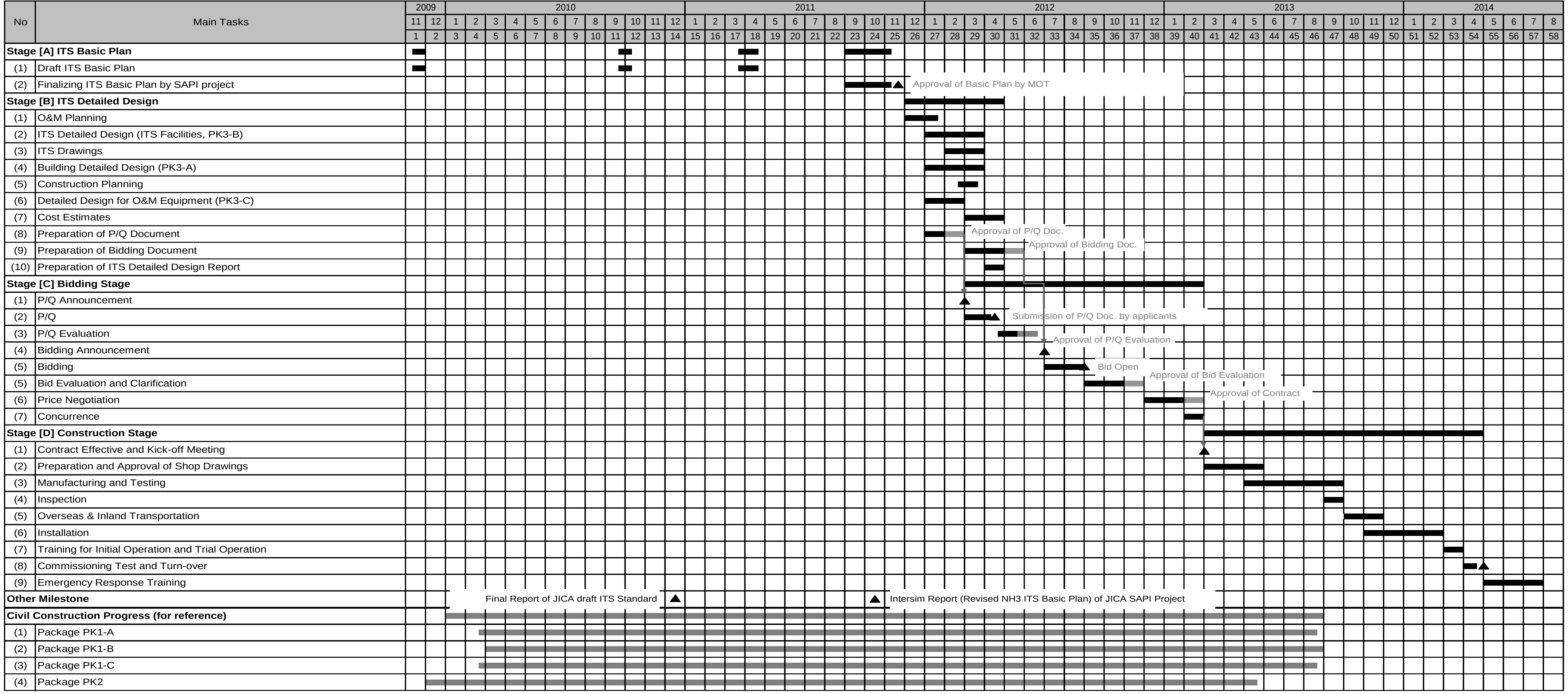
1) The construction work will be commenced from March of 2013 after bidding process.

2) A period of construction stage will be total of 14.5 months including the works for preparation of shop drawing (3months), manufacturing and testing (5months), factory inspection (1month), overseas and inland transportation (2months), equipment installation (4months), and training and trial operation (1month).

Finally, the turn over of ITS facilities will be expected in the middle of April 2014.

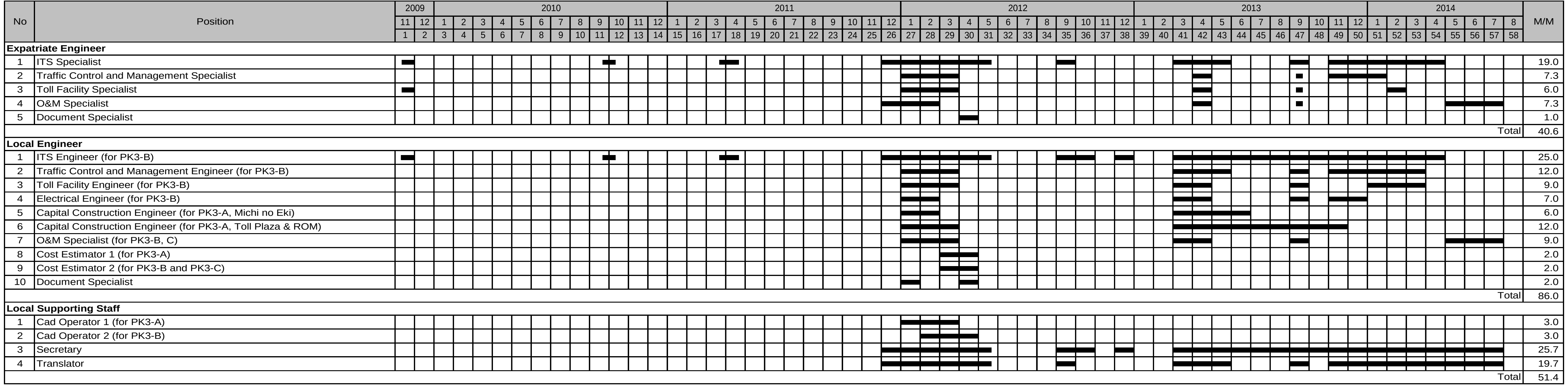
Table 13.8 ITS Implementation Schedule

A. ITS Implementation Schedule



No	Main Tasks
Stage [A] ITS Basic Plan	
(1)	Draft ITS Basic Plan
(2)	Finalizing ITS Basic Plan by SAPI project
Stage [B] ITS Detailed Design	
(1)	O&M Planning
(2)	ITS Detailed Design (ITS Facilities, PK3-B)
(3)	ITS Drawings
(4)	Building Detailed Design (PK3-A)
(5)	Construction Planning
(6)	Detailed Design for O&M Equipment (PK3-C)
(7)	Cost Estimates
(8)	Preparation of P/Q Document
(9)	Preparation of Bidding Document
(10)	Preparation of ITS Detailed Design Report
Stage [C] Bidding Stage	
(1)	P/Q Announcement
(2)	P/Q
(3)	P/Q Evaluation
(4)	Bidding Announcement
(5)	Bidding
(5)	Bid Evaluation and Clarification
(6)	Price Negotiation
(7)	Concurrence
Stage [D] Construction Stage	
(1)	Contract Effective and Kick-off Meeting
(2)	Preparation and Approval of Shop Drawings
(3)	Manufacturing and Testing
(4)	Inspection
(5)	Overseas & Inland Transportation
(6)	Installation
(7)	Training for Initial Operation and Trial Operation
(8)	Commissioning Test and Turn-over
(9)	Emergency Response Training
Other Milestone	
Civil Construction Progress (for reference)	
(1)	Package PK1-A
(2)	Package PK1-B
(3)	Package PK1-C
(4)	Package PK2

B. Consultant Manning Schedule (ITS)



No	Position	M/M
Expatriate Engineer		
1	ITS Specialist	19.0
2	Traffic Control and Management Specialist	7.3
3	Toll Facility Specialist	6.0
4	O&M Specialist	7.3
5	Document Specialist	1.0
	Total	40.6
Local Engineer		
1	ITS Engineer (for PK3-B)	25.0
2	Traffic Control and Management Engineer (for PK3-B)	12.0
3	Toll Facility Engineer (for PK3-B)	9.0
4	Electrical Engineer (for PK3-B)	7.0
5	Capital Construction Engineer (for PK3-A, Michi no Eki)	6.0
6	Capital Construction Engineer (for PK3-A, Toll Plaza & ROM)	12.0
7	O&M Specialist (for PK3-B, C)	9.0
8	Cost Estimator 1 (for PK3-A)	2.0
9	Cost Estimator 2 (for PK3-B and PK3-C)	2.0
10	Document Specialist	2.0
	Total	86.0
Local Supporting Staff		
1	Cad Operator 1 (for PK3-A)	3.0
2	Cad Operator 2 (for PK3-B)	3.0
3	Secretary	25.7
4	Translator	19.7
	Total	51.4

Source: ITS Integration Project (SAPI) Study Team

13.7 Project Cost for New NH3

The cost for the ITS package of the New NH3 is estimated as rough order basis with following conditions:

- Cost is on 2011 basis,
    - ROM (Rough Order Magnitude) cost information from major international manufacturers
    - Past projects contract price information
- Consultant’s internal cost estimation data,
- Not including contingencies and government tax, and
- Not including costs for creation of new organization and site preparation (building), etc.

The cost for the ITS package of the New NH3 is estimated around 607.9 billion VND which consists of 23.4 million USD as foreign currency portion and 120 billion VND as local currency portions as detailed in **Appendix-6**

The unit price information and cost estimate for the New NH3 will be further updated during detailed design stage to harmonize with ITS cost data for other expressways estimated by the JICA SAPI project.

14. Required Conditions for Project Implementation

14.1 General

Through the discussion in the Study, it became evident that the following conditions are required for the implementation of ITS Integration Project.

(1) The Project is to be implemented by VEC and the project budget is to be executed by MOT.

(2) Road management offices are to be integrated in a single hierarchical structure under the Northern Regional Main Center by decision of MOT.

(3) The Northern Regional Main Center is to be located at NH18 – PR295 Interchange.

(4) A team consists of the expressway police, the expressway ambulance and the road operator is to be assigned to each road management office.

(5) The road management office of Lang-Hoa Lac section is to be constructed on the north side at around KM4+500 of the section.

(6) The space for ITS operation is to be secured in all road management offices.

(7) The Banks for IC-card issuance/operation is to be selected by decision of the State Bank.

(8) The OBU Management Center for OBU Registration/Management is to be set up under Vietnam Register by decision of MOT.

(9) Axle load scale installation in the Project is to be defined as the 1st stage of stepwise implementation of the system for overloading regulation.

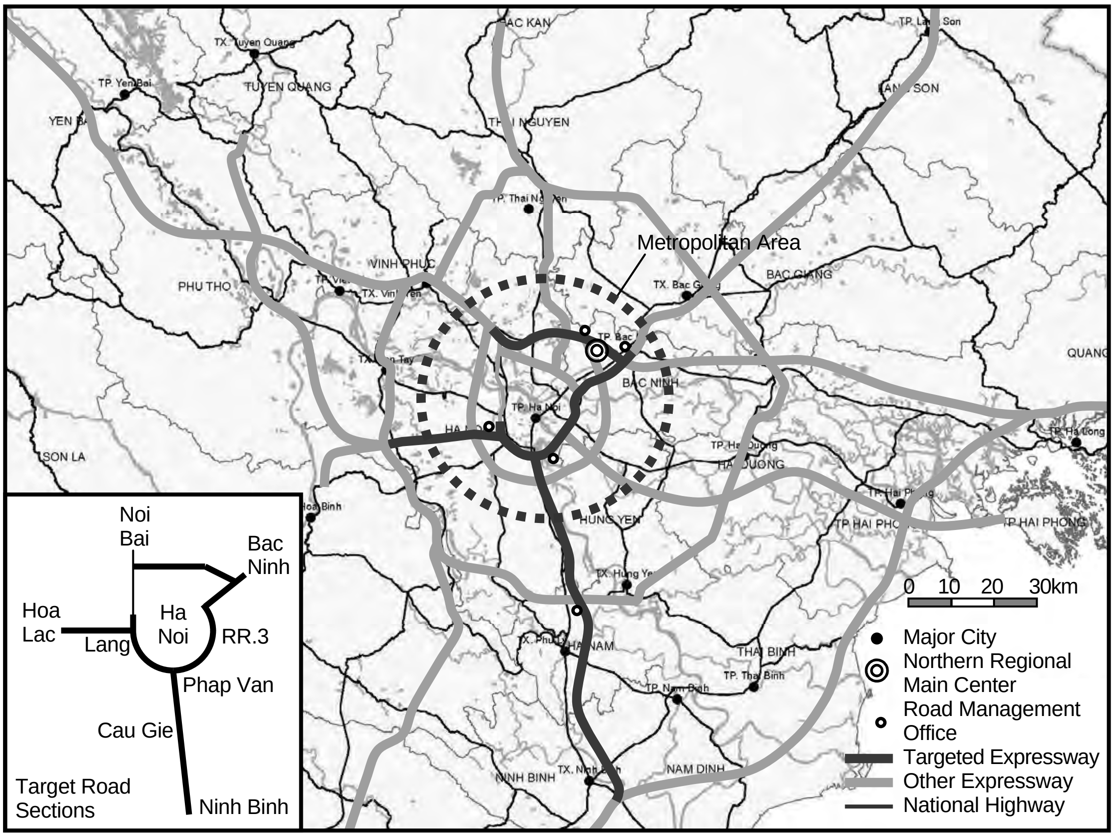
(10) The following legal systems are to be prepared:

- Setting up of the special telephone number without area code to call the Regional Main Center (by MOT and MIC)
- Definition of a specific organization responsible for enforcing traffic restriction on the expressway (by MOT and MOPC)
- Definition of specific banks responsible for IC-card issuance/operation for ETC and Touch&Go (by the State Bank)
- Definition of specific organization responsible for OBU registration/management for ETC (by MOT)
- Preparation of legal system to impose penalty against overloading by measuring axle load (by MOT)
- Preparation of legal system for unlawful drivers who ignore payment of penalty against overloading or toll (by MOPC).

14.2 Project Implementation Organization

The Implementation organization and Role sharing for the ITS integration project is based on the figure below.

Figure 14.1 Road Network for ITS Integration Project



	Standards	Owner	Center Operator	–	Implementation Org. for (b),(c),(d),(e)
Northern Regional Main Center	MOT	MOT	MOT/VEC	–	MOT/VEC

Road Sections	Length	Standards	Road Owner	Road Operator	Case**	Implementation Org. for (b),(c),(d),(e)
ITS Integration Project	268 km					
Mai Dich–Thanh Tri (RR3)	27 km	MOT	DRVN	RMU-2	A	MOT/VEC
Lang–Hoa Lac	28 km	MOT	HPC	HTD	A	MOT/VEC
Phap Van–Cau Gie	30 km	MOT	PPP	PPP	B	MOT/VEC
Cau Gie–Ninh Binh	50 km	MOT	VEC	VEC-O&M	A	MOT/VEC
Ha Noi–Bac Ninh	20 km	MOT	DRVN	RMU-2	A	MOT/VEC
Noi Bai–Bac Ninh	33 km	MOT	DRVN	RMU-2	A	MOT/VEC
Other Road Sections						
Ha Noi–Hai Phong	105km	MOT	VIDIFI	VIDIFI	B	VIDIFI
Ha Noi–Thai Nguyen	60km	MOT	DRVN	RMU-2	A	DRVN
Viet Tri–Lao Cai	185km	MOT	VEC	VEC-O&M	A	VEC

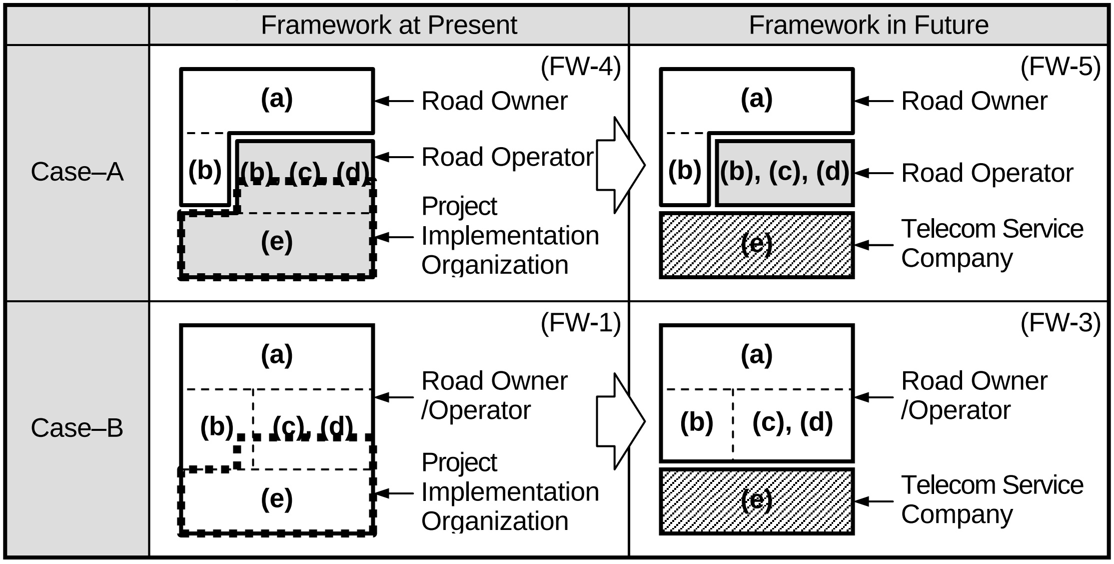
Note, ⬚ : Project implementation organization, which is necessary for implementing the Project covering the sections owned by the organization other than VEC, ** : See Figure 14.2
the

Source: ITS Integration Project (SAPI) Study Team

Required Condition:

The Project is to be implemented by VEC and the project budget is to be executed by MOT.

Figure 14.2 Total Framework of Expressway Operation



Note: (a) Road structure/facility management
(b) Toll collection/management
(c) Traffic information/control
(d) Overloading regulation
(e) Communication network management

Source: ITS Integration Project (SAPI) Study Team

Roles of each organization for expressway operation are to be shared as shown below.

Roles of Expressway Management Organization in MOT

- Regulation on hardware/software in compliance with the ITS Standards
- Issue of permission for enforcing serious traffic restrictions such as road closure
- Integrated management on the data from toll collection/management, traffic information/ control and heavy truck control (including overloading regulation)
- Check of the validity of toll revenue in comparison with the data of traffic
- Evaluation of road operator's achievement in the expressway operation.

Roles of Road Owner

- Ownership/maintenance of road structure/facilities of an expressway section other than ITS
- Ownership of facilities of ITS of an expressway section
- Toll collection/management of an expressway section.

Roles of Road Operator

- Operation/maintenance of hardware/software
- Assistance of toll collection of an expressway section
- Traffic information/control of an expressway section
- Overloading regulation of an expressway section.

Roles of Telecom Service Company (in the Future)

- Ownership/maintenance of facilities of communication system of ITS
- Operation of communication system of ITS.

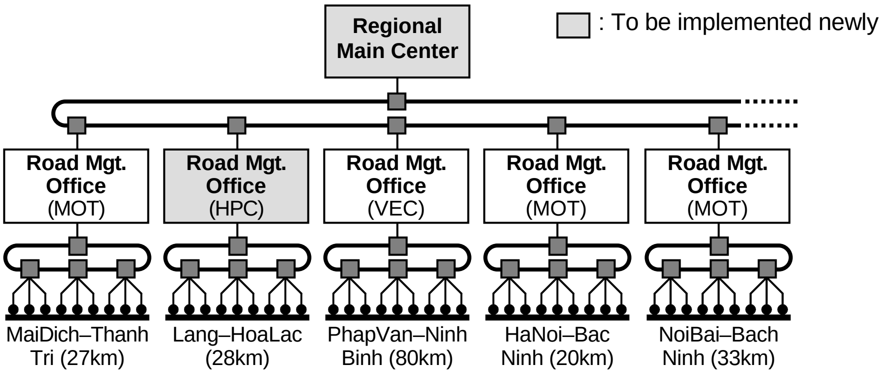
14.3 A Single Hierarchical Structure

Required Condition:

Road management offices are to be integrated in a single hierarchical structure under the Northern Regional Main Center by decision of MOT.

Road management offices are integrated in a single hierarchical structure under the Northern Regional Main Center. The center equipment of the Northern Regional Main Center and the road management offices and the buildings for the Northern Regional Main Center and the road management office of the Lang – Hoa Lac section is to be implemented in the Project.

Figure 14.3 Northern Regional Main Center and Road Management Offices



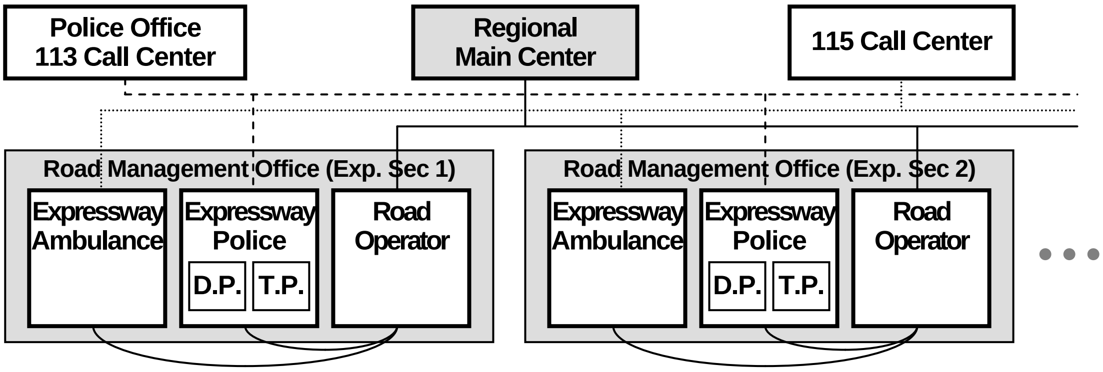
Source: ITS Integration Project (SAPI) Study Team

14.4 Cooperation Team in Road Management Office

Required Condition:

A team consists of the expressway police, the expressway ambulance and the road operator is to be assigned to each road management office.

Figure 14.4 Cooperation Team in Road Management Office



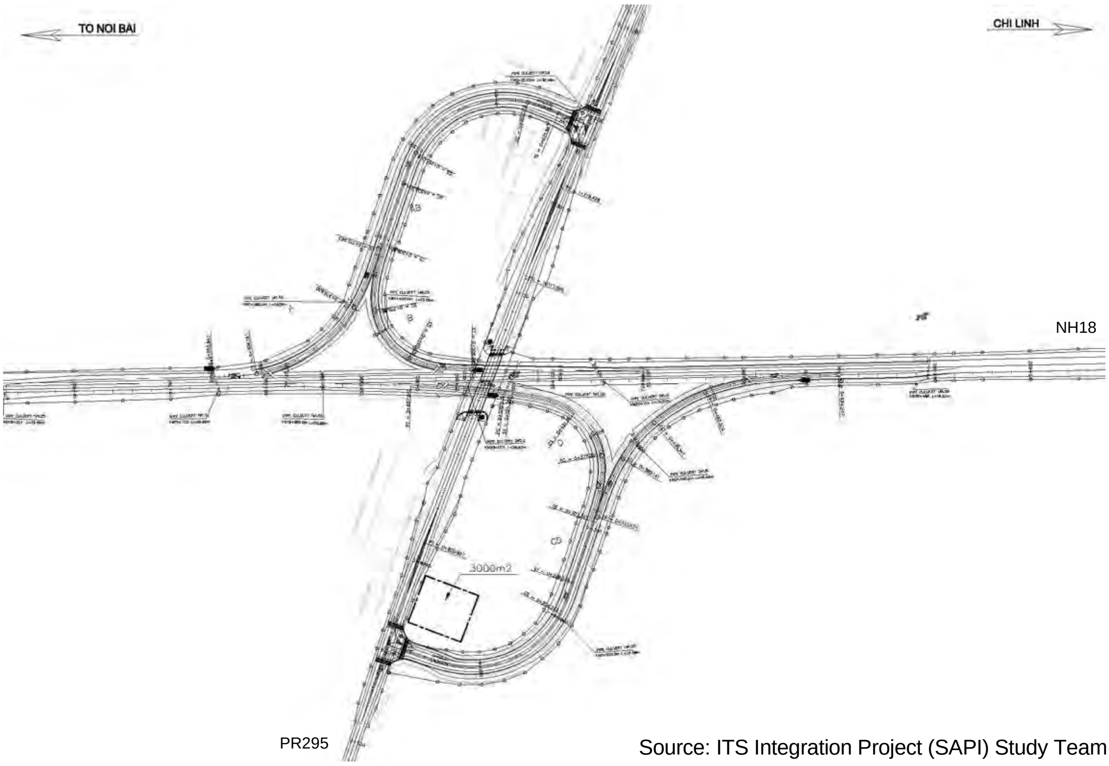
Source: ITS Integration Project (SAPI) Study Team

14.5 Location of Northern Regional Main Center

Required Condition:

The Northern Regional Main Center is to be located at NH18 – PR295 Interchange.

Figure 14.5 Location of Northern Regional Main Center



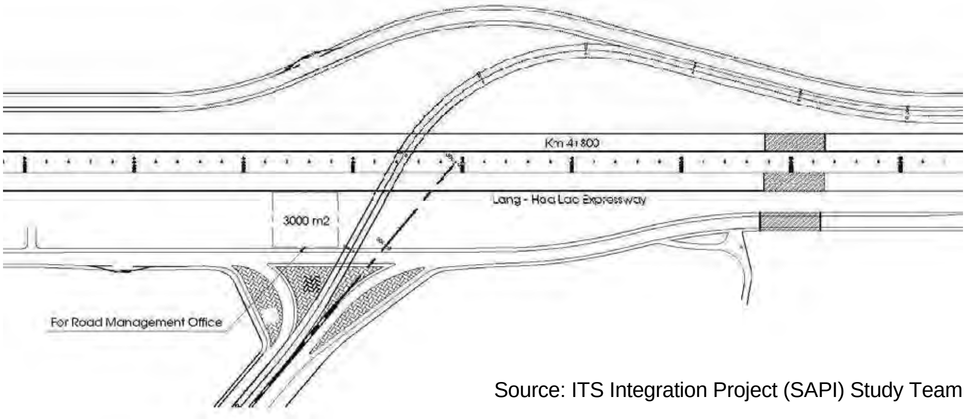
Source: ITS Integration Project (SAPI) Study Team

14.6 Location of Road Management Office of Lang – Hoa Lac

Required Condition:

The road management office of Lang – Hoa Lac section is to be constructed on the north side at around KM 4+500 of the section.

Figure 14.6 Location of Road Management Office of Lang – Hoa Lac



Source: ITS Integration Project (SAPI) Study Team

14.7 Space for ITS in Road Management Office

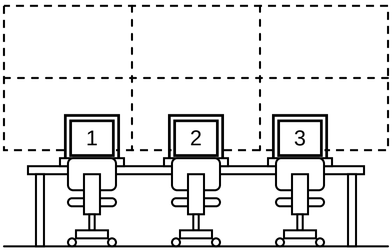
Required Condition:

The space for ITS operation is to be secured in all road management offices.

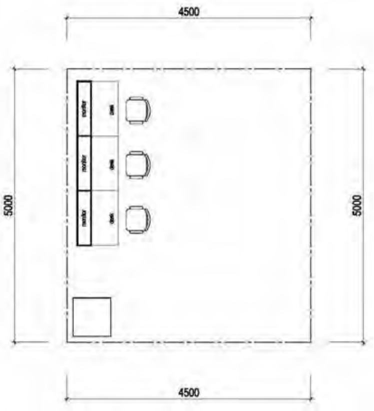
The space 22.5 m^2 for ITS operation is to be secured in all road management offices below.

- Road Mgt. Office of Mai Dich–Thanh Tri : existing
- Road Mgt. Office of Lang – Hoa Lac : to be constructed in the Project
- Road Mgt. Office of Phap Van – Cau Gie – Ninh Binh : to be constructed in other project
- Road Mgt. Office of Ha Noi–Bac Ninh : existing
- Road Mgt. Office of Noi Bai–Bach Ninh : existing
- Road Mgt. Office of Noi Bai–Viet Tri : to be constructed in other project.

Figure 14.7 Space for ITS in Road Management Office



1	Traffic Event Data Input Device
2	CCTV Monitoring Console
3	CCTV Monitoring Console



Source: ITS Integration Project (SAPI) Study Team

14.8 IC-card Issuance/Operation Organization

Required Condition:

The Banks for IC-card issuance/operation is to be selected by decision of the State Bank.

The framework below needs to be established for IC-card issuance/operation in both use of Touch&Go and ETC. Issue/recharge service is provided by a single bank in the 1st stage and by several banks in later stages.

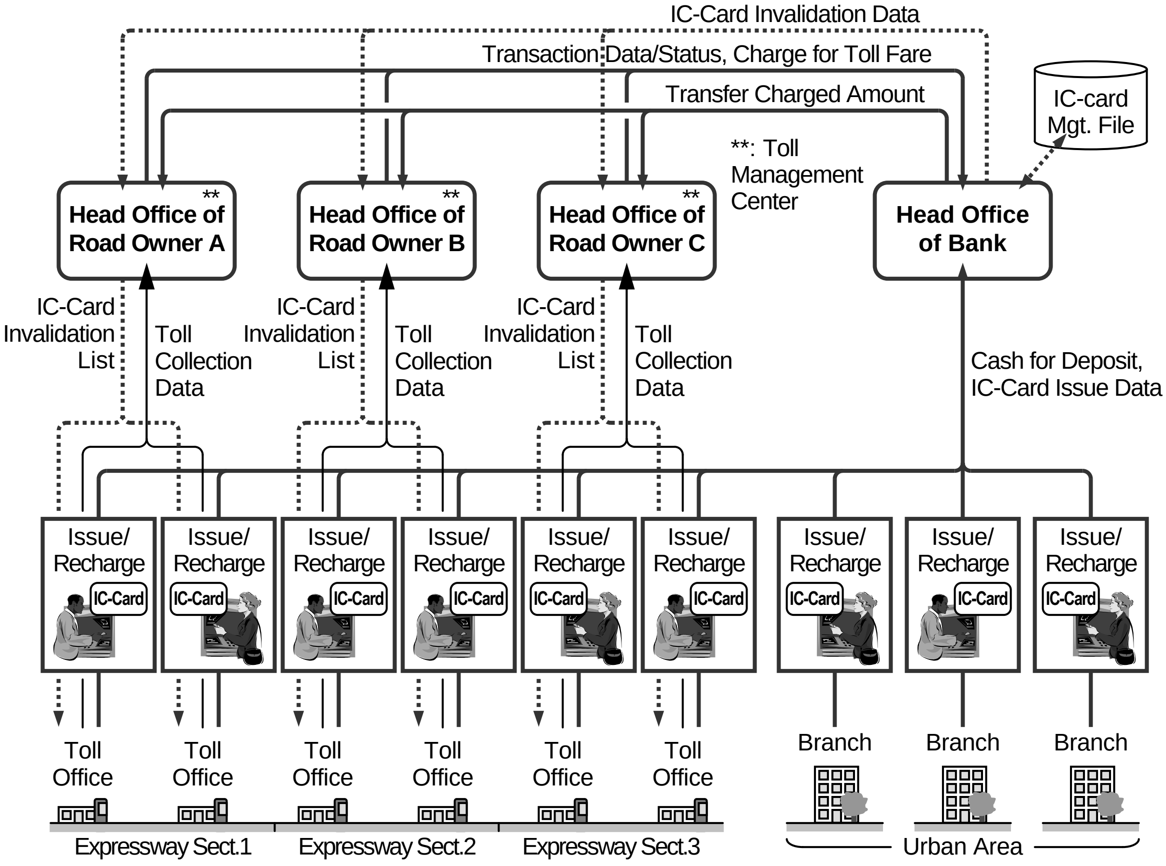
(1) Roles of Road Owner

- Toll collection/management of an expressway section
- Transfer of transaction data/status
- Charge for toll fare.

(2) Roles of Bank

- IC-card issue/recharge/management service
- Transfer of charge amount to the road owner
- Generation/distribution of IC-card validation list
- Assistance for toll enforcement.

Figure 14.8 Framework for IC-Card Issuance/Operation



Source: ITS Standards & Operation Plan Study Team

14.9 OBU Registration/Management Organization

Required Condition:

The OBU Management Center for OBU Registration/Management is to be set up under Vietnam Register by decision of MOT.

The framework below needs to be prepared for OBU registration/management, in which an OBU management center is operated by a unified organization for many different road owners and banks, because several banks will make a toll settlement by ETC in later stage.

(1) Roles of Expressway Management Organization in MOT

- Regulation on hardware/software in compliance with the ITS Standards.

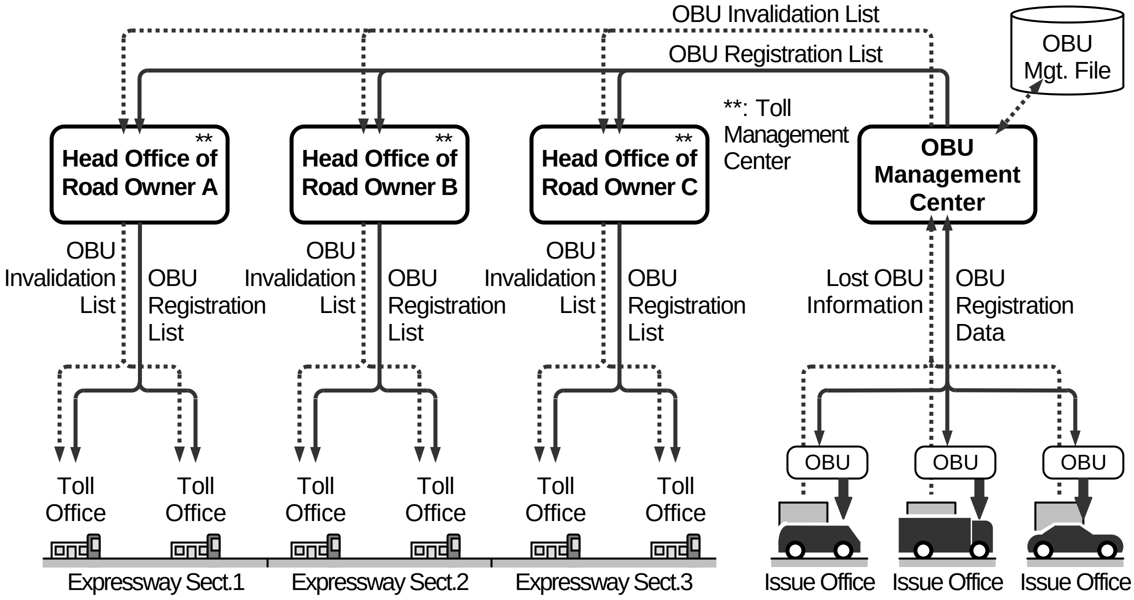
(2) Roles of Road Owner

- Toll collection/management of an expressway section.

(3) Roles of OBU Management Center

- OBU registration/management service
- Generation/distribution of OBU registration/invalidation list
- Assistance for toll enforcement.

Figure 14.9 Framework for OBU Registration/Management



Source: ITS Standards & Operation Plan Study Team

14.10 Axle Load Scale Arrangement

Required Condition:

Axle load scale installation in the Project is to be defined as the 1st stage of stepwise implementation of the system for overloading regulation.

The system for overloading regulation is to be implementation stepwise; however, additional measures are necessary as shown by underlines.

In the Project :1st Stage

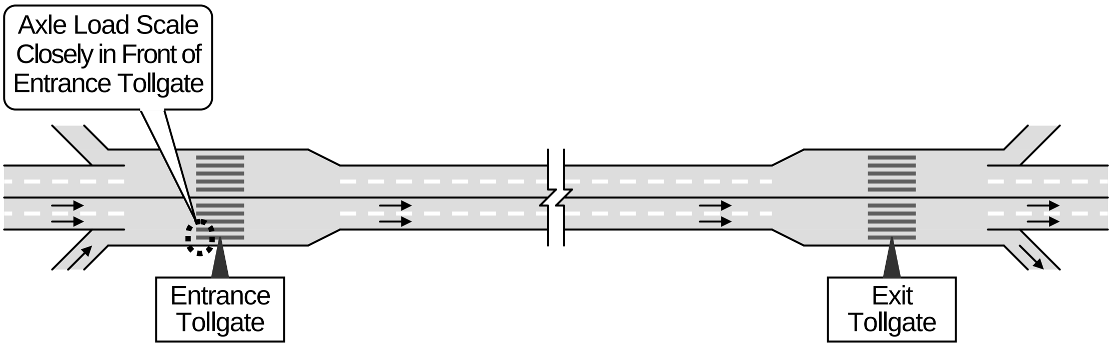
(1) Axle load scales are to be installed in front of the entrance tollgate.

(2) The total weight of a truck is to be estimated from the total value of measured axle loads and the license number is to be captured.

(3) A ticket for indicating measured weight is to be handed to the driver of the truck beyond the limit of measured weight, and the driver is required to pay penalty and to go out from the expressway at the next (or nearest) exit tollgate: <u>however, it is necessary for the Government to prepare a legal framework to impose penalty by measuring axle loads</u>.

(4) Road operators are never to permit the truck beyond the limit to enter any expressway by referring to the captured license number.

Figure 14.10 Axle Load Scale in Front of Entrance Tollgate (In the Project)



Source: ITS Integration Project (SAPI) Study Team

In the Future :Next Stage

(1) <u>A weighbridge is to be installed additionally at the place along expressways (or at the exit tollgate) with enough space based on the results of discussion on the data of axle load measurement accumulated from the 1st stage.</u>

(2) The total weight of a truck is to be estimated from the total value of measured axle loads and the license number is to be captured.

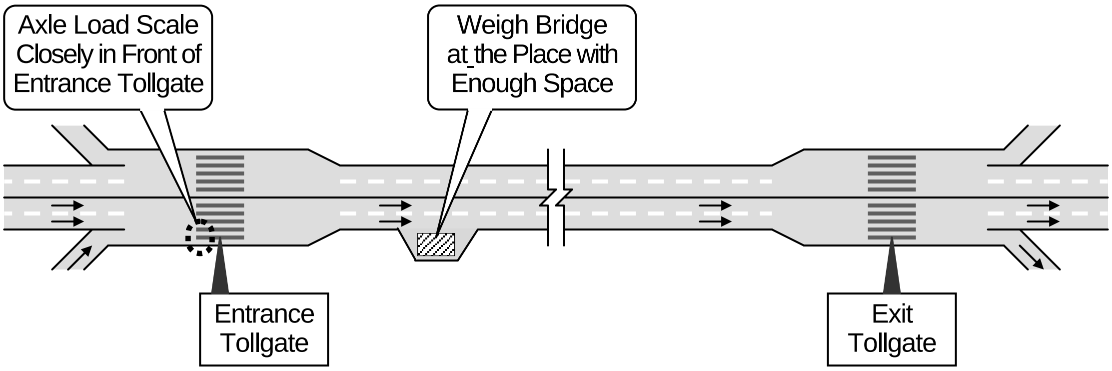
(3) A ticket for indicating measured weight is to be handed to the driver of the truck beyond the limit of measured weight, and the driver is required to go to the place of weighbridge

and to measure the total weight of the truck.

(4) In the case the total weight is beyond the limit value, the driver of the truck is required to pay a penalty and to reduce the total weight of truck by reshipment.

(5) Road operators are never to permit the truck enter any expressway unless otherwise the payment of the penalty and reducing of the total weight; <u>however, it is necessary for the Government to prepare a legal framework against unlawful drivers who ignore payment of penalty (or toll).</u>

Figure 14.11 Axle Load Scale in Front of Entrance Tollgate (In Future)



Source: ITS Integration Project (SAPI) Study Team

14.11 Preparation of Legal Systems

<u>**Required Condition:**</u>

Needed legal systems are to be prepared.

The needed legal systems below are to be prepared in advance of implementation of the Project.

- Setting up of the special telephone number without area code to call the Regional Main Center (by MOT and MIC)
- Definition of a specific organization responsible for enforcing traffic restriction on the expressway (by MOT and MOPC)
- Definition of specific banks responsible for IC-card issuance/operation for ETC and Touch &Go (by the State Bank)
- Definition of specific organization responsible for OBU registration/management for ETC (by MOT)
- Preparation of legal system to impose penalty against overloading by measuring axle load (by MOT)
- Preparation of legal system for unlawful drivers who ignore payment of penalty against overloading or toll (by MOPC).

15. Revision of Draft ITS Standards

15.1 General

The following documents are reviewed and revised in the Study:

- Summary of ITS Master Plan (see Appendix-7)
- Draft ITS Design Standards (3 volumes for the priority ITS user services, Appendix-7)
- Draft ITS General Specifications (24 volumes for the functional packages, Appendix-7)
- Draft ITS Message/Data Standards (see Appendix-7)
- Draft ITS Communication System Plan (see Appendix-8).

15.2 Summary of ITS Master Plan

The following discussion results in the Master Plan are reviewed, revised and summarized:

- Goals of ITS for inter-city road network
- ITS user services and road map
- Operation/maintenance service to be provided on expressway
- Implementation package
- System architecture
- Policy of stepwise ITS implementation by package

15.3 Draft ITS Design Standards

The revised version of the Draft Design Standards are organized in 3 volumes corresponding to the priority ITS user services as follows:

(1) Traffic Information/Control System
(2) Automated Toll Collection/Management System
(3) Vehicle Weighing System

1) Traffic Information/Control System

This volume of the Draft Design Standards defines basic concepts, general architecture and actualization methods as a unified form for designing the system of traffic information/control. The outline of the service to be provided by traffic information/control is described below.

This service provides accurate surveillance of traffic conditions on expressways and adjacent arterial roads. This service assists prompt action of the road operator and emergency vehicles by notifying occurrences of traffic accidents, broken-down vehicles and left obstacles. This service allows drivers en route and in advance to avoid the influence of the incidents by providing accurately updated information. This service also allows appropriate interchange/ route selection by providing drivers en route with information on crowdedness and estimated travel-time. This service makes it possible to measure actual traffic volume continuously for developing road improvement plans.

This volume of the Draft Design Standards includes the following functional packages:

(1) Voice Communication

(2) CCTV Monitoring
(3) Event Detection (by Image)
(4) Vehicle Detection
(5) Traffic Analysis
(6) Weather Monitoring
(7) Traffic Event Data Management
(8) Traffic Supervision
(9) VMS Indication
(10) Mobile Radio Communication
(11) Traffic Information.
(12) Integrated Data Management.

2) Automated Toll Collection/Management System

This volume of the Draft Design Standards defines basic concepts, general architecture and actualization methods as a unified form for designing the system of toll collection/management. The outline of the service to be provided by non-stop toll collection is described below.

This service enables toll collection without stopping vehicles: ETC (Electronic Toll Collection). This service relieves bottlenecks at the tollgates and allows smooth incoming and outgoing of vehicles at interchanges. This service reduces the number of tollbooths and solves the problem of land acquisition, especially for tollgates in suburban areas where traffic congestion will become an issue in the near future. This service allows simple vehicle inspection at border crossings, and provides the road/vehicle operators with the time of vehicle passage at tollgates. Computerized toll management can vastly reduce uncollected toll revenue due to the failure in counting/classifying vehicles, and can realize appropriate sharing of the toll revenue among the different road operators.

This volume of the Draft Design Standards includes the following functional packages:

(1) Tollgate Lane Monitoring
(2) Vehicle Identification
(3) Lane Control
(4) Road-to-Vehicle Communication
(5) IC-card Recording
(6) Toll Management
(7) OBU Management.

3) Vehicle Weighing System

This volume of the Draft Design Standards defines basic concepts, general architecture and actualization methods as a unified form for designing the system of vehicle weighing. The outline of the service to be provided by heavy truck control is described below.

This service eliminates overloading of heavy trucks by automatic execution of vehicle weighing at interchanges. It reduces damage to the road structure and extends its durable lifetime. This service reduces congestion caused by heavy trucks and allows freight transport to improve safety by eliminating overloading. This service allows prompt action of the road operator at the occurrence of serious accidents caused by heavy trucks and hazardous material trucks, and taking appropriate vehicle operation by keeping track of trucks on the expressway network.

This volume of the Draft Design Standards includes the following functional packages:

(1) Axle Load Measurement
(2) Measurement Lane Monitoring.

15.4 Draft ITS Data/Message Standards

ITS consists of many equipment components, which are illustrated in the diagrams of system architecture in the Draft Design Standards and the Draft General Specifications. Provisions for securing compatibility of the equipment components are defined in the Draft General Specifications.

The equipment components need to be connected with each other by communication network in order to exchange messages and data among them, to realize the system and to provide intended services. For this purpose, inter-operability of message/data and connectability of interfaces need to be secured by preparing the standards for ITS as follows:

- Draft General Specifications → Compatibility of equipment components
- Draft Message/Data Standards → Inter-operability of message/data
- Draft Communication System Plan → Connectability of interfaces.

The Draft Message/Data Standards are developed in the Study in order to define a message list and a data dictionary and establish inter-operability of message and data.

1) Message List

A multitude of messages need to be exchanged among equipment components for implementing services of ITS. Major messages are shown in the document by respectively specifying the items below.

- Name of message
- Equipment component on one side of interface
- Equipment component on the other side of interface
- Names of Included data sets
- Names of Major Included data elements.

2) Data Dictionary

Messages include a number of data sets consisting of data elements. Major data elements are shown in the document by respectively specifying the attributes below.

- Name of data element
- Definition
- Presentation category
- Form of representation
- Data type of data element values.

The attributes above are defined as mandatory in ISO/IEC 11179. In ISO/IEC 11179, three additional attributes listed below also are defined as mandatory; however, these are not included in the data dictionary because of insufficient discussion on them.

- Maximum size of data element values
- Minimum size of data element values
- Permissible data element Values

15.5 Draft ITS Communication Plan

The revised version of the Draft Communication System Plan includes the General Plan and the Draft Design Standards of communication system in order to establish connectability of communication network.

- General Plan of Communication System
- Draft Design Standards of Communication System.

The General Plan of Communication System shows the discussion results on the items below.

- Locations of Main Centers and network structure
- Communication network management
- Terminal layer for roadside equipment
- Basic procedure of expressway operation
- Integration of roadside equipment control
- Transmission method.

15.6 Draft ITS General Specifications

The revised version of the Draft General Specifications defines required processing functions, performance, interfaces and installation of equipment in order to establish compatibility of equipment components, which are organized in 24 volumes corresponding to the functional packages below.

(1) Voice Communication
(2) CCTV Monitoring
(3) Event Detection (by Image)
(4) Vehicle Detection
(5) Traffic Analysis
(6) Weather Monitoring
(7) Traffic Event Data Management
(8) Traffic Supervision
(9) VMS Indication
(10) Mobile Radio Communication
(11) Traffic Information
(12) Integrated Data Management
(13) Tollgate Lane Monitoring
(14) Vehicle Identification
(15) Lane Control
(16) Road-to-Vehicle Communication

(17) IC-Card Recording
(18) Toll Management
(19) OBU Management
(20) Axle Load Measurement
(21) Measurement Lane Monitoring
(22) Communication System
(23) Communication Ducts
(24) Base Structures