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:

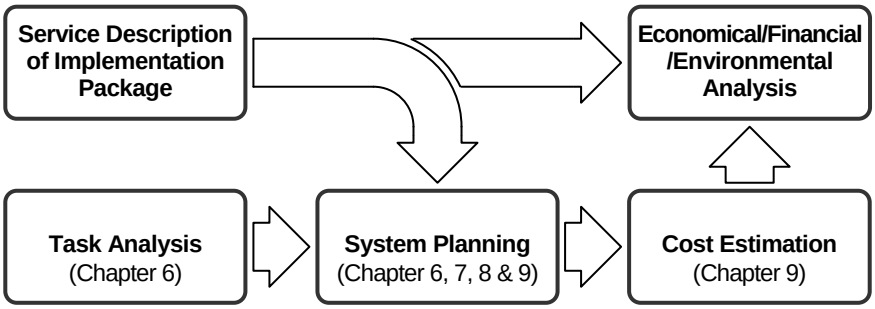
- ITS implementation effects
- Cost reduction effects by system integration compared to without integration

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.

Base Case

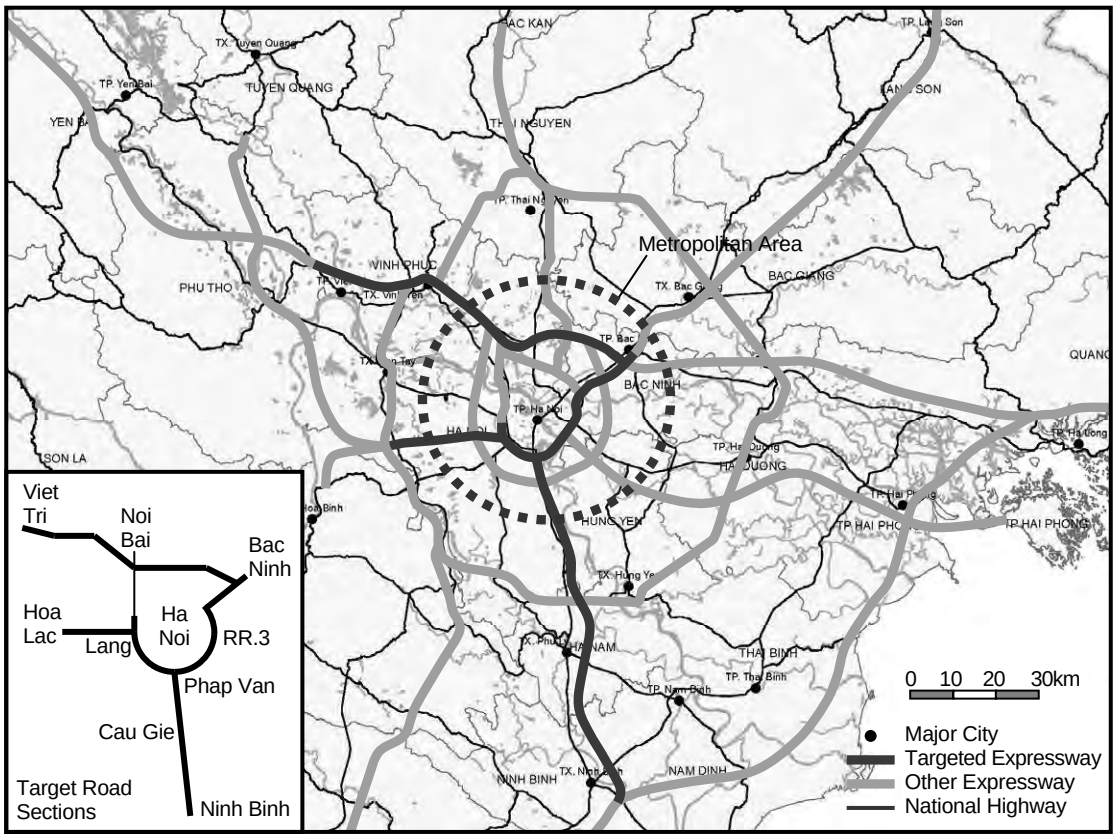
Ha Noi Metropolitan Area is to be defined as the study area. The target road network of the Project is to be formed by selections of the road sections below, which are shown in the official letter 2584/VEC-DA from VEC to MOT, evaluating effects of the project implementation.

(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 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

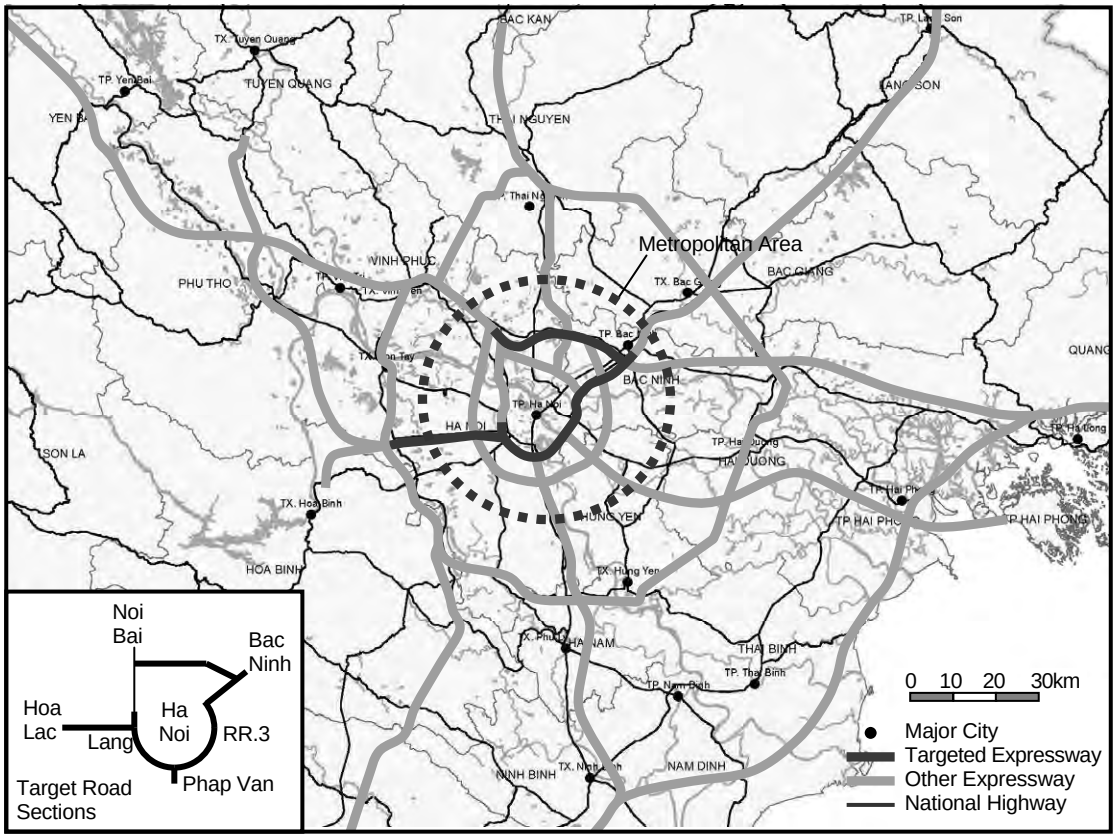
The road network of the comparison case 1 is to be formed consisting of the road sections selected from the followings:

(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

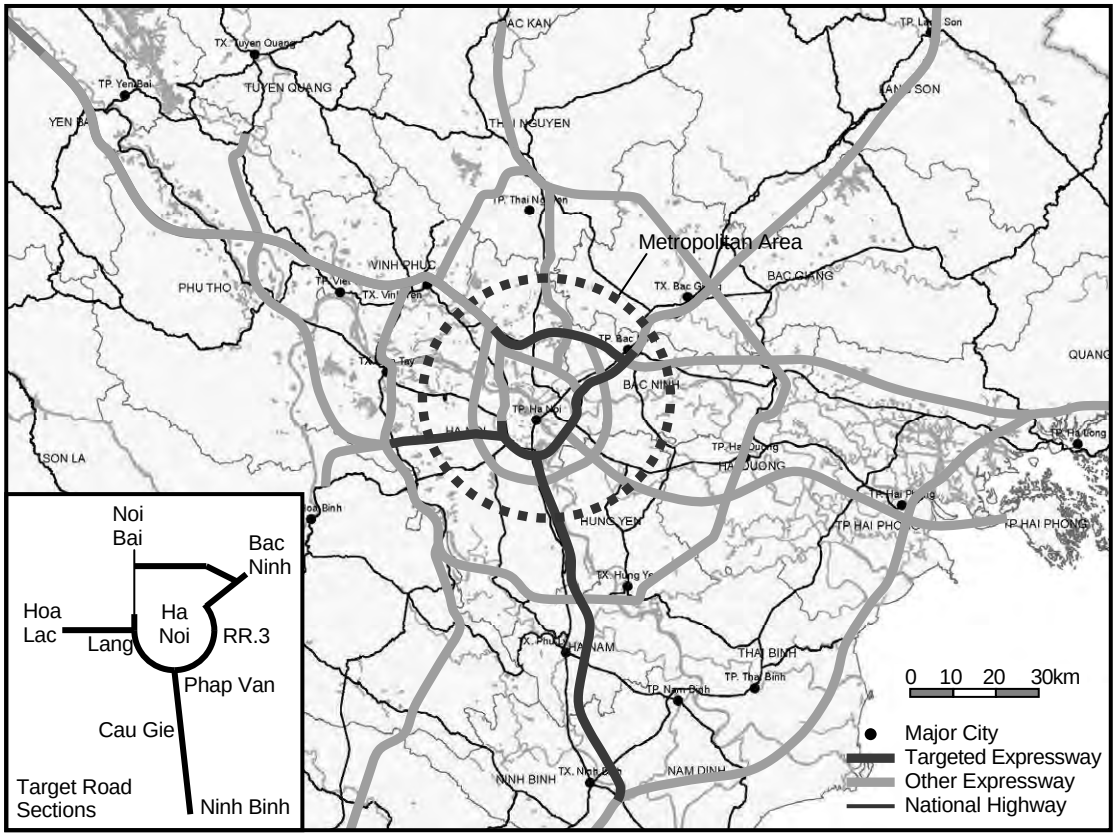
The road network of the comparison case 2 is to be formed consisting of the road sections selected from the followings:

(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

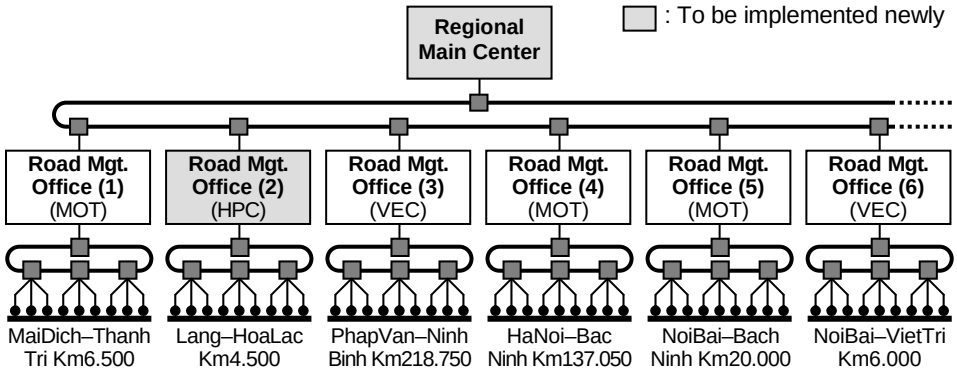
Source: ITS Integration Project (SAPI) Study Team

8.3 Outline of Project

1) Center Equipment

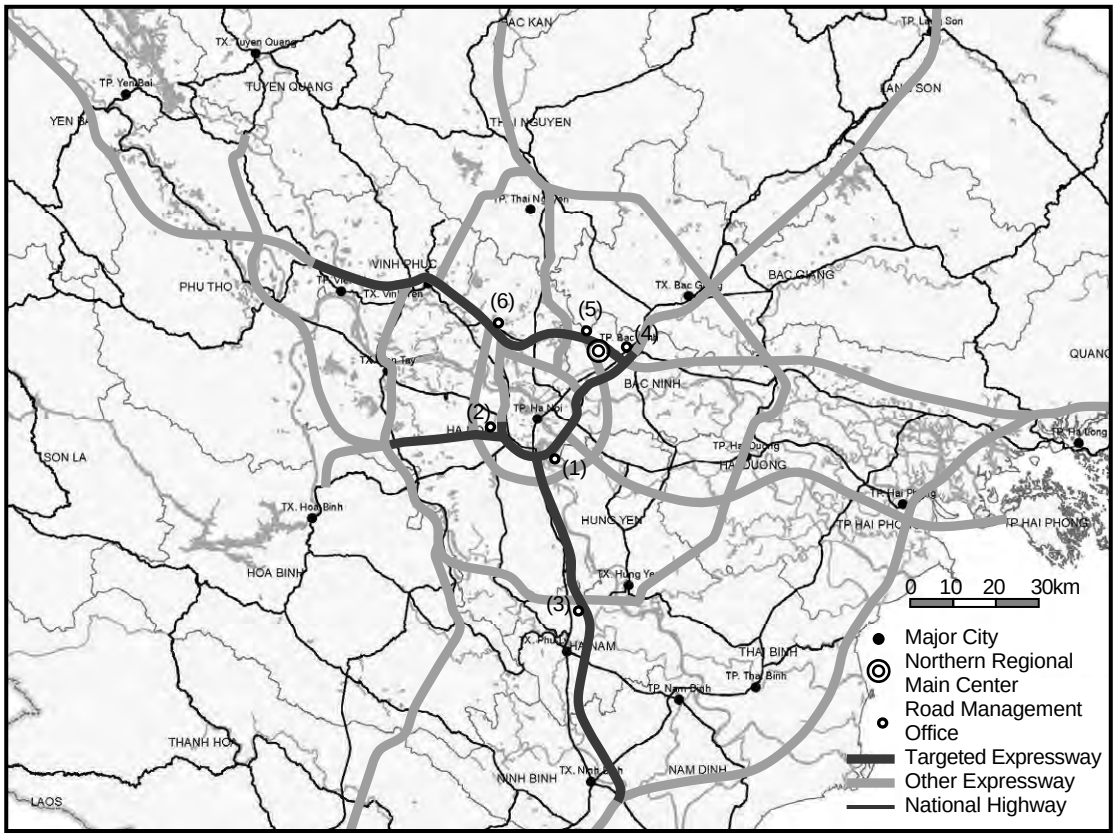
The structure and location of the Northern Regional Main Center and the road management offices are shown in the figures below. The center equipment for all of the Northern Regional Main Center and the road management offices needs to be implemented in the Project. The building construction only for 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

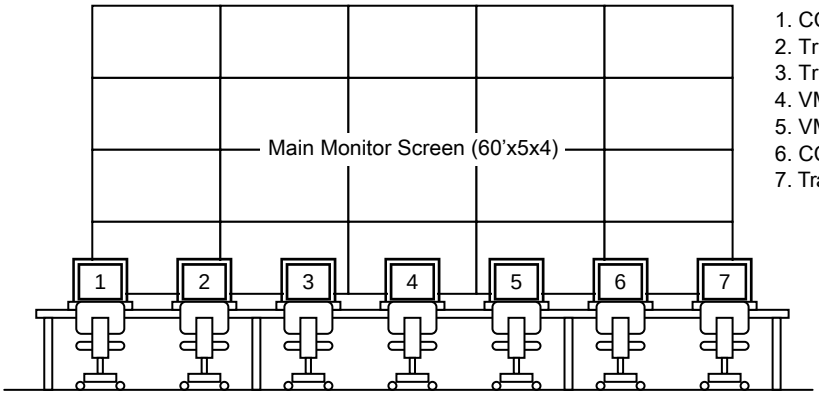
(1) Northern Regional Main Center

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



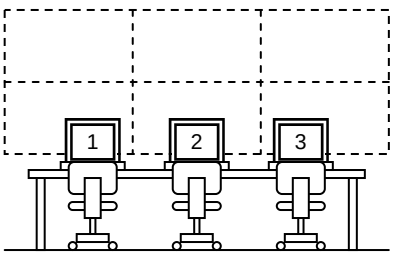
1. CCTV Center Controller Console
2. Traffic Event Data Input Device
3. Traffic Event Data Input Device
4. VMS Center Controller Console
5. VMS Center Controller Console
6. CCTV Center Controller Console
7. Traffic Supervising/Control Console

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.

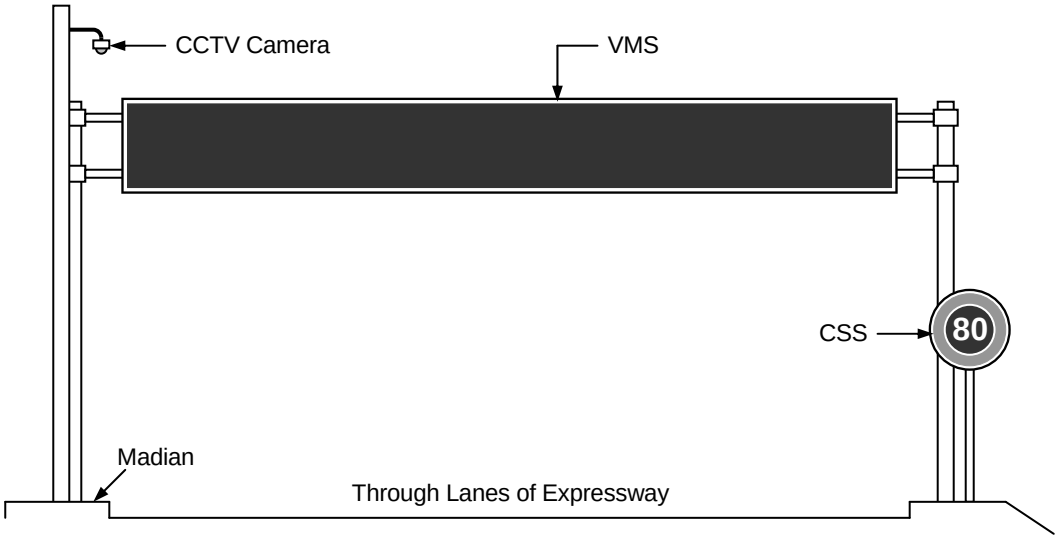
Source: ITS Integration Project (SAPI) Study Team

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.

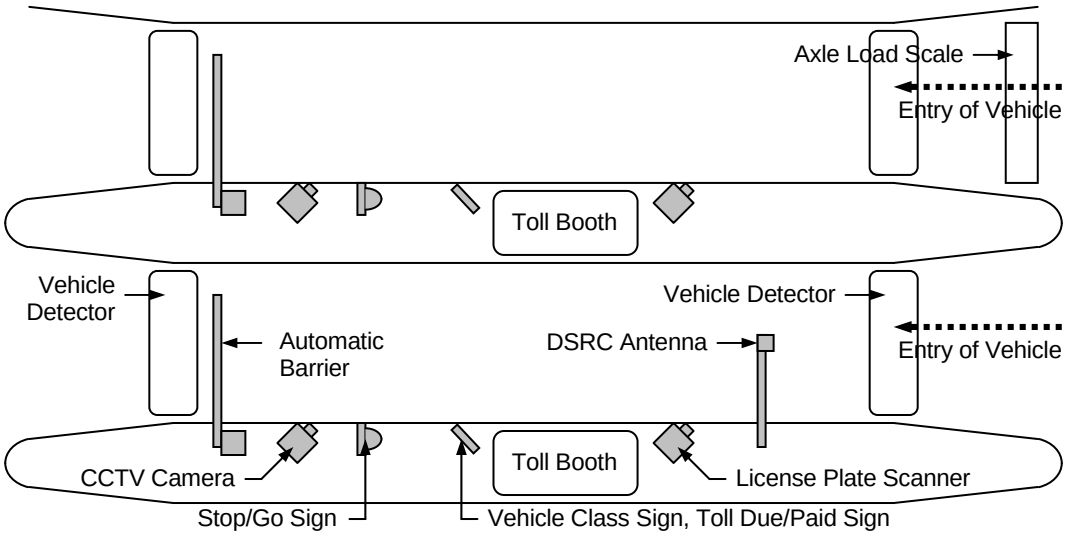
- CCTV camera (for monitoring and for event detection)
- Vehicle detector
- VMS (Variable Message Sign)
- CSS (Changeable Speed Limit Sign)
- ETC (Electronic Toll Collection)
- Touch&Go/manual
- Axle load scale

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

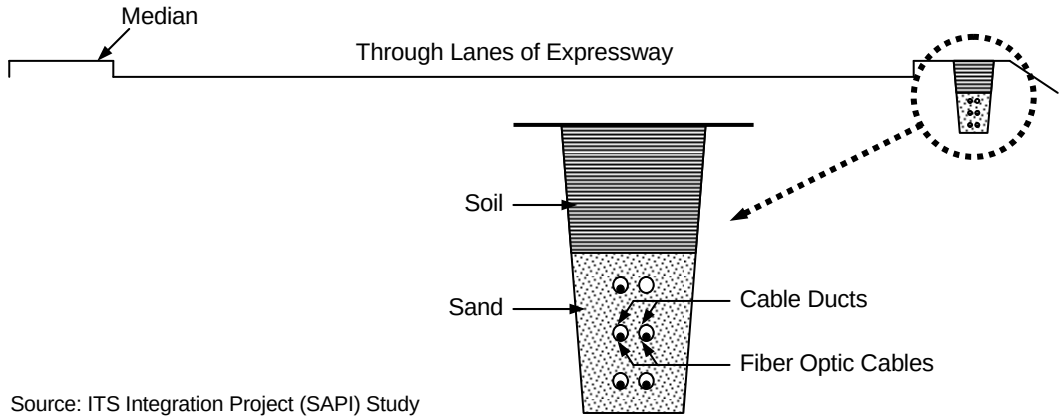
Note, * : Fully equipped with image recognition, ** : Excluding items to be installed by Grant and 1st Stage ITS (designed by Cadpro).

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 Management Server	set	16
	Toll Management Center		
	Toll Management 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 Management Server	set	3
	Toll Management Center		
	Toll Management 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 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. 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, 26, 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

Required costs for the comparison cases are of estimated as shown in the following tables.

Table 8.6 Estimated Cost of Comparison Case 1

Table 8.7 Estimated Cost of Comparison Case 2

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

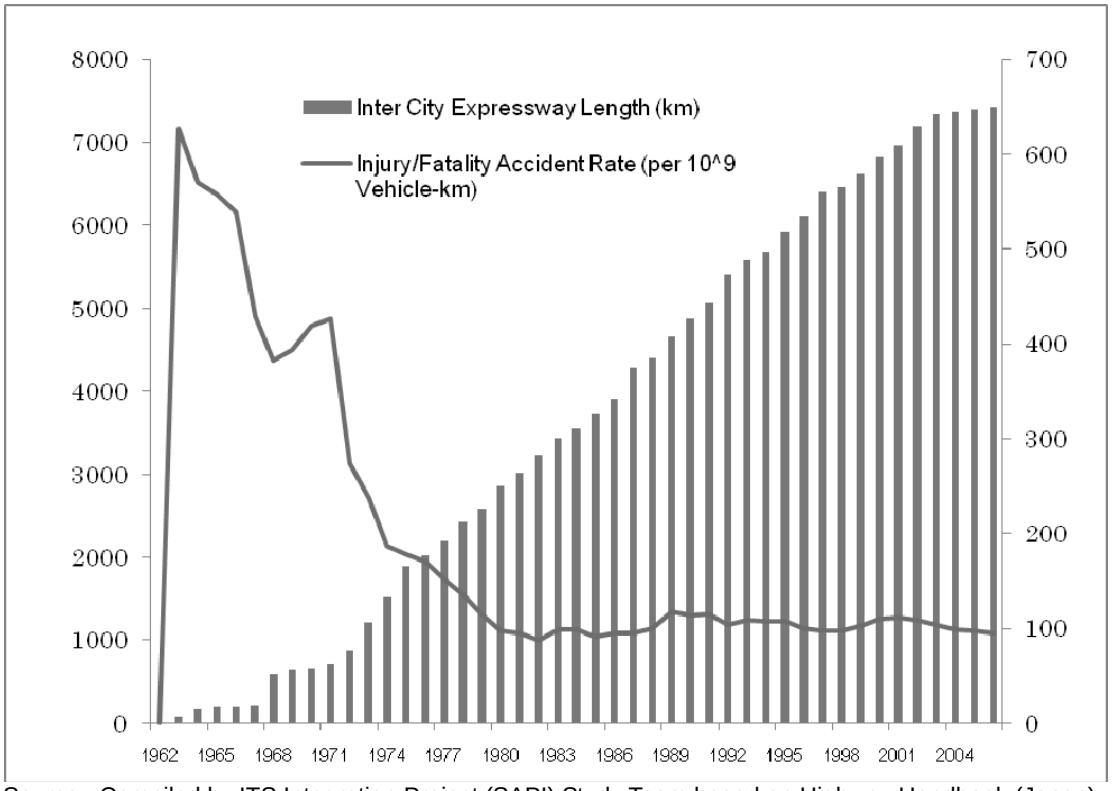
Year	Number of Accidents (Injury/Fatality Accident)	Total Length on Operation (km) of Expressway	Estimated Rate of Accident per km of Expressway Operation Length
1965	301	189.7	1.59
1970	2,671	649.3	4.11
1975	2,271	1,888.3	1.20
1980	2,152	2,859.8	0.75
1985	2,802	3,720.9	0.75
1990	5,541	4,869.4	1.14
1995	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:

in Hanoi

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.

in Japan

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.)

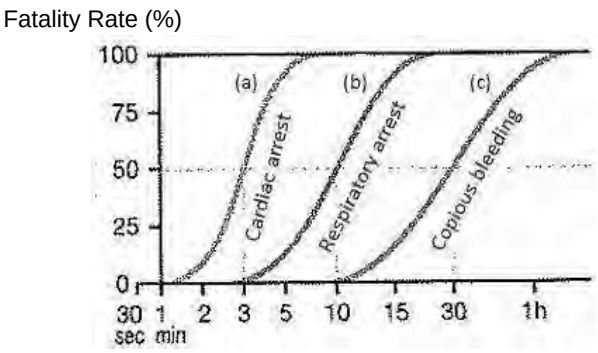
(b) That is, this enable to shorten the required time taken for emergency vehicles (ambulance, police car, tow truck, etc.) to arrive at scene of incidents.
(The reduction of required time for emergency services can be also obtained through mitigation of traffic congestion by detour selection of some 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 Checking Severity of Accident by CCTV Camera	Yes	No
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	2015	235	165	82	0.31	1,409	986	493	1.84
(268 km)	2020	359	251	126	0.47	2.154	1,508	754	2.81
Case 1	2015	109	76	43	0.31	653	457	229	2.11
(108 km)	2020	138	97	48	0.45	830	581	291	2.69
Case 2	2015	214	150	75	0.40	1,285	900	450	2.39
(188 km)	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

Observation on Quantified Indicators:

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.

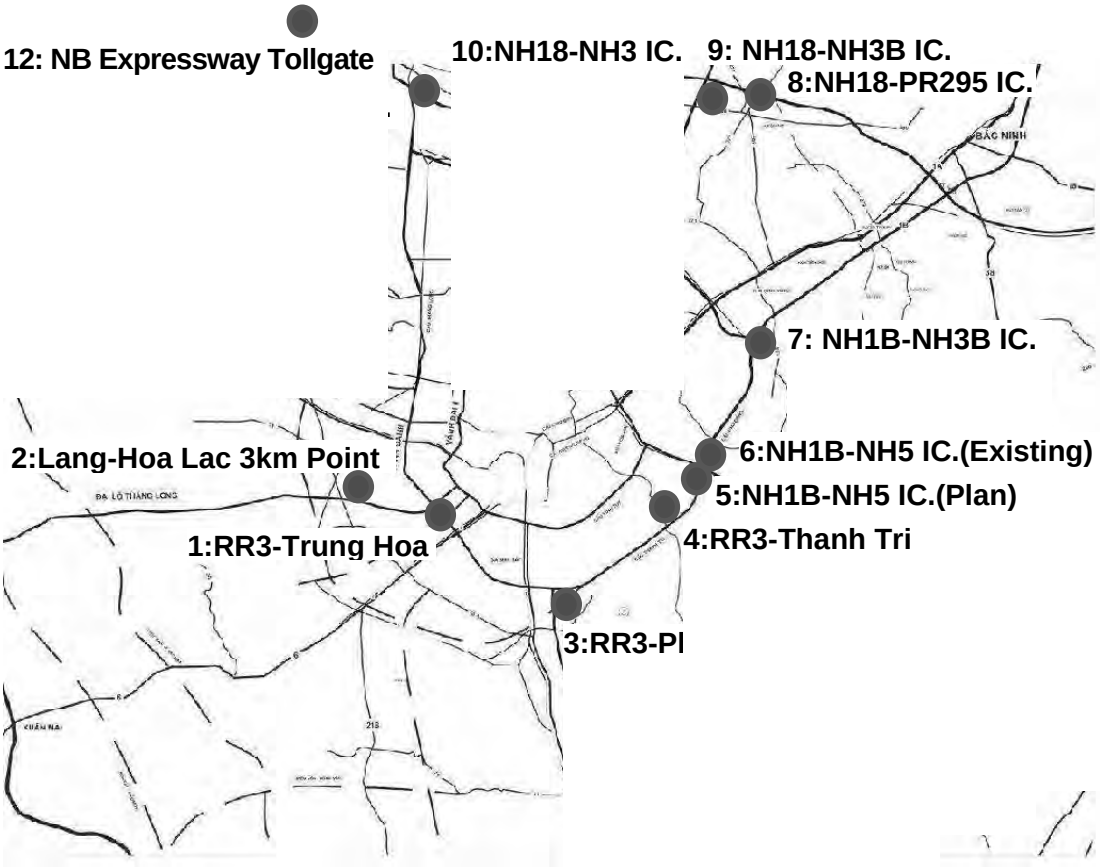
Basically all of twelve (12) candidate sites have consistency with broader plans and programs or already constructed/under way of road construction projects.

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

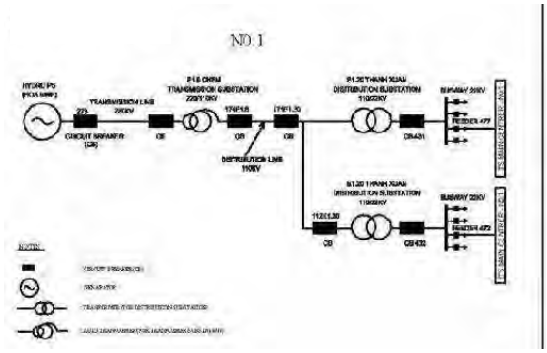
Source: ITS Integration Project (SAPI) Study Team

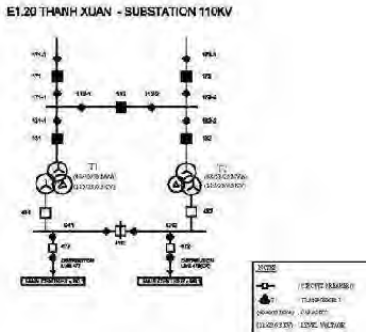
3) Power Supply Distribution to Candidate Sites

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.

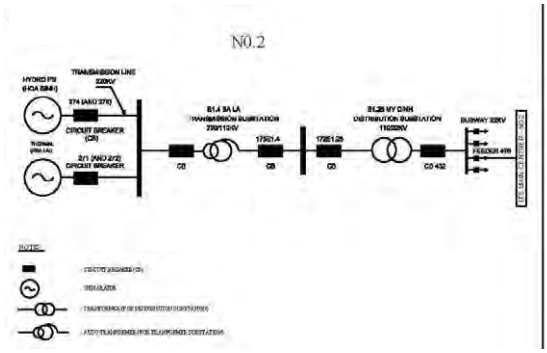
Table 9.1 Candidate Sites and Power Distribution System

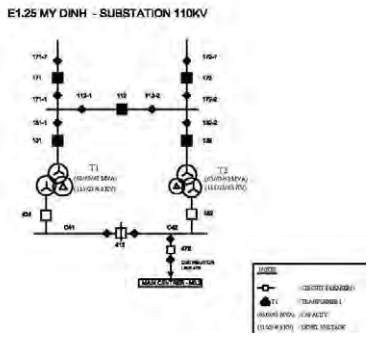
Candidate site 1: RR3–Trung Hoa



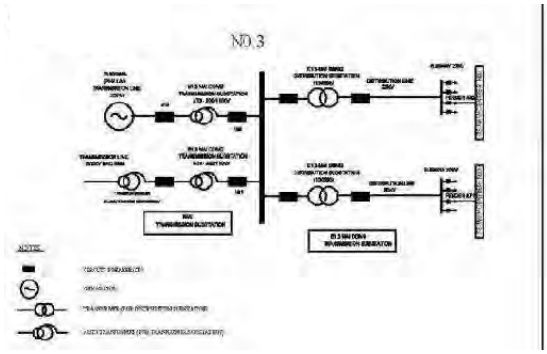


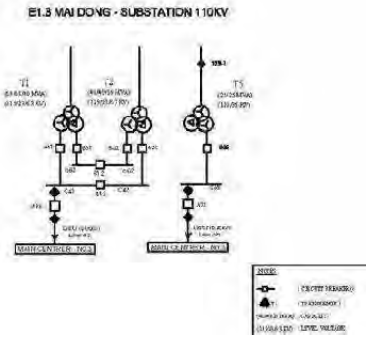
Candidate site 2: Lang–Hoa Lac 3km Point



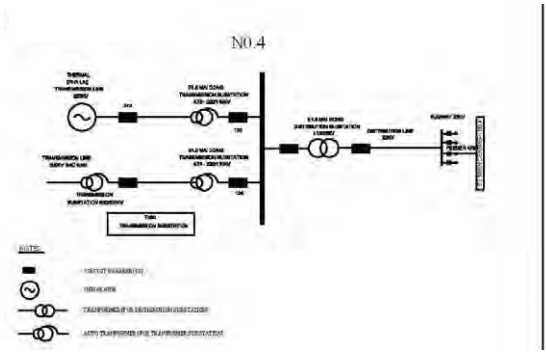


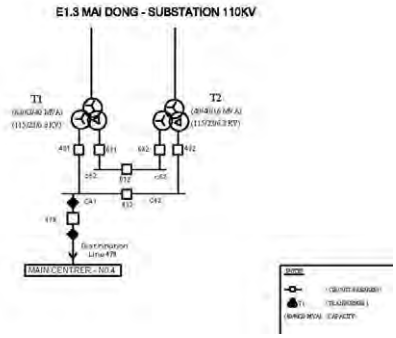
Candidate site 3: RR3–Phap Van IC



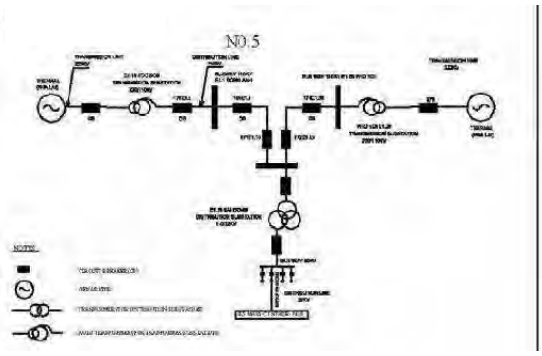


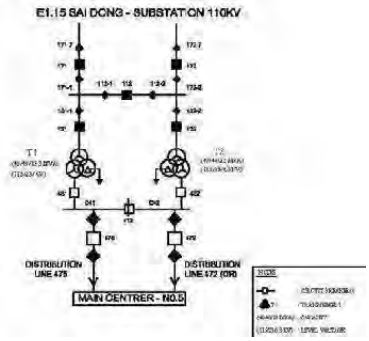
Candidate site 4: RR3 – Thanh Tri



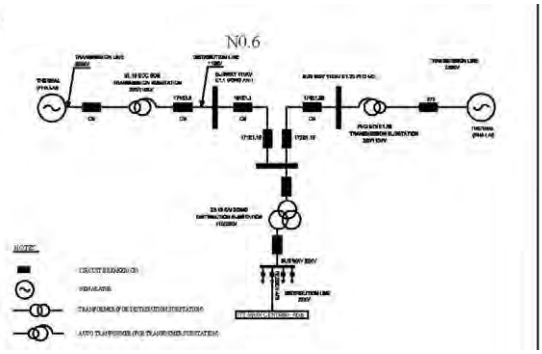


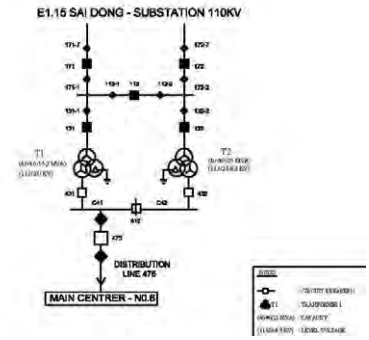
Candidate site 5: NH1B–NH5 IC. (Plan)



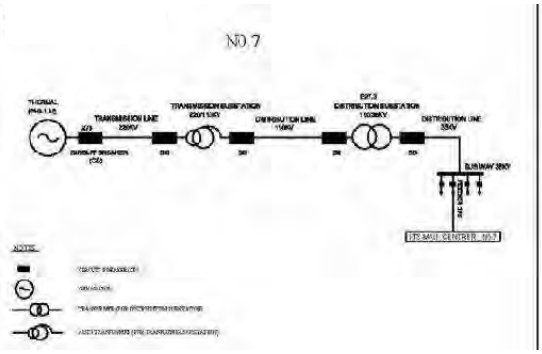


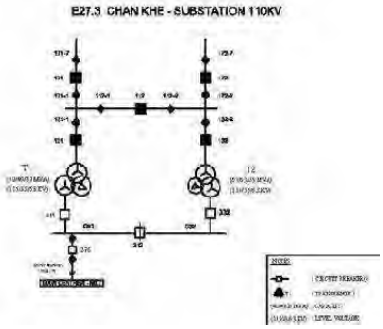
Candidate site 6: NH1B–NH5 IC. (Existing)



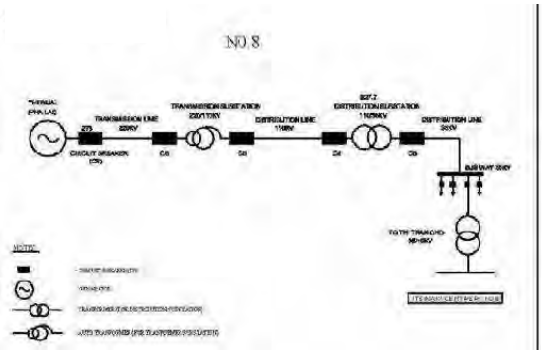


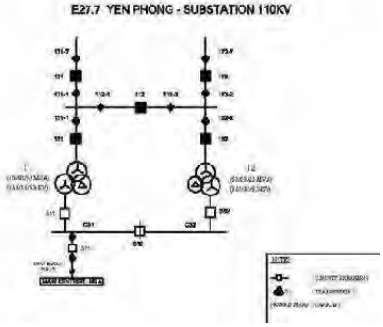
Candidate site 7: NH1B–NH3B IC



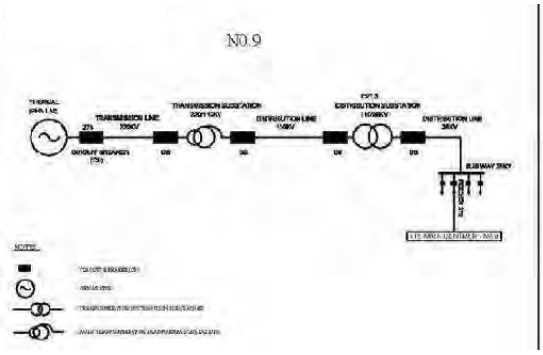


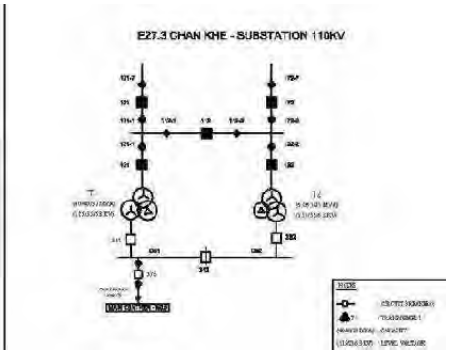
Candidate site 8: NH18–PR295 IC



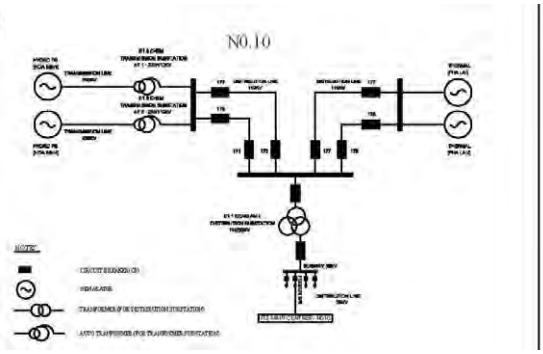


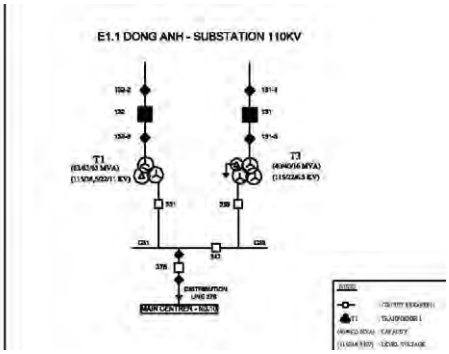
Candidate site 9: NH18–NH3B IC



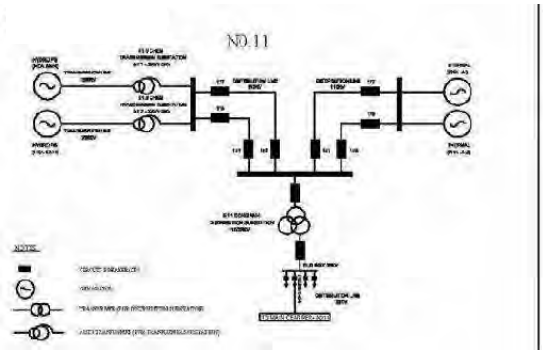


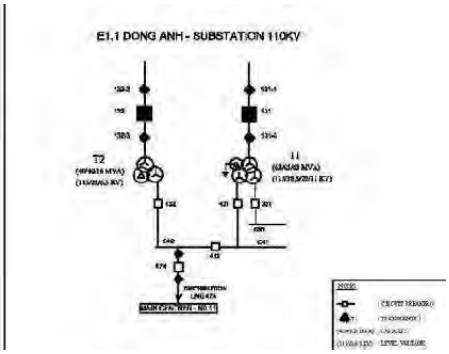
Candidate site 10: NH18–NH3 IC



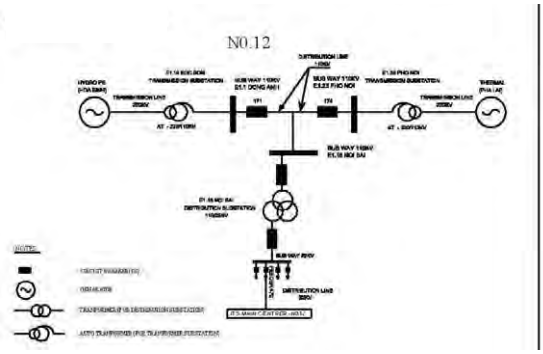


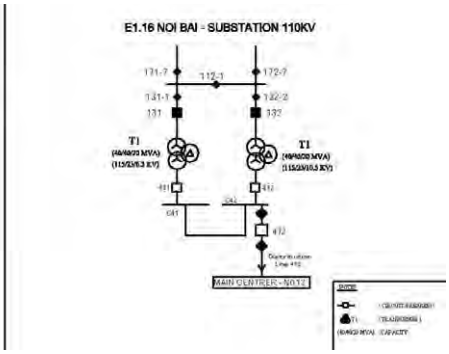
Candidate site 11: Thang Long–NH18 IC





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.

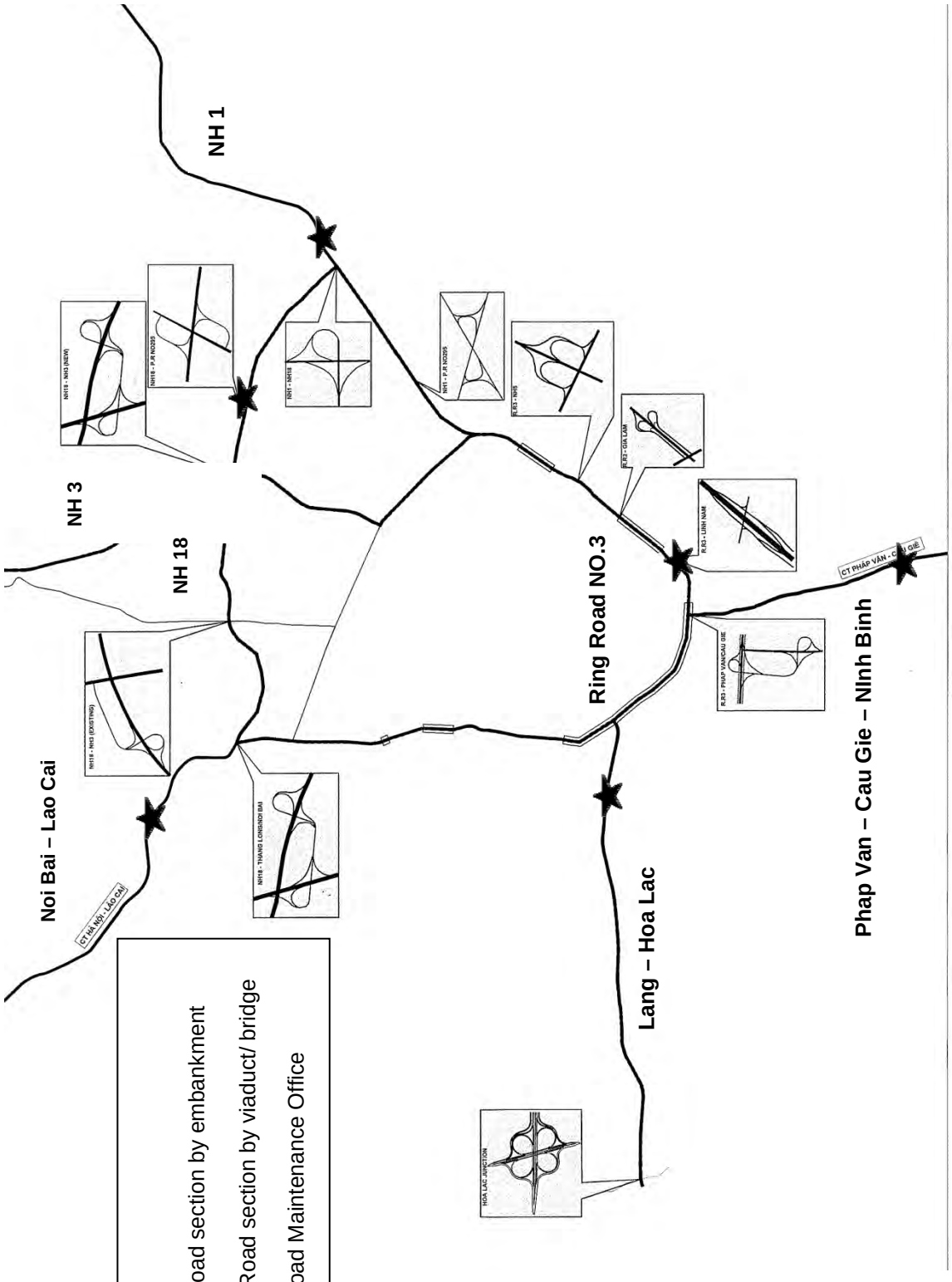
VPN operated by local network provider can be supported for the network linkage by the contract basis. The cost for VPN service per month is depended on Network data traffic capacity and numbers of station as the Northern Regional main Center and six (6) road management offices in showing the following 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.

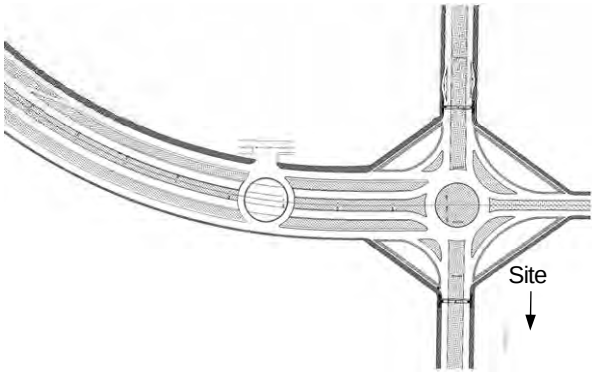
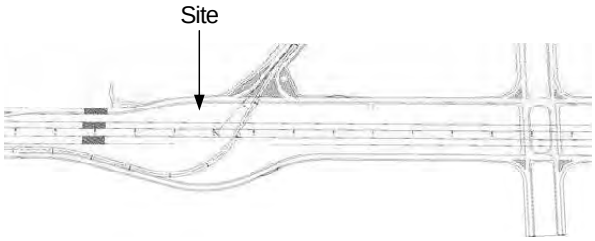
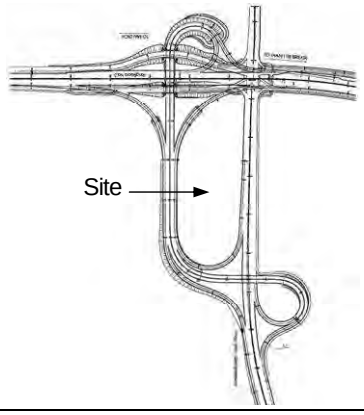
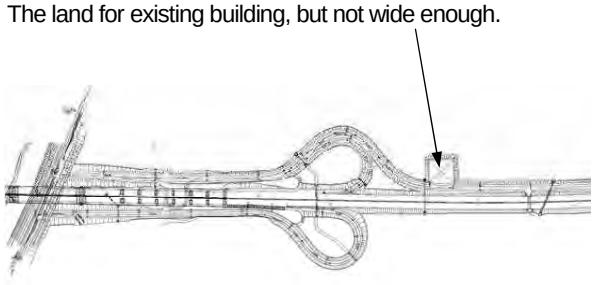
Candidate site 4: RR3 – Thanh Tri 	**Land use and land property:** Surrounding area of the proposed site is agricultural land use. The proposed site is in the vicinity of the Thanh Tri Bridge across the Red River and is the land for a building with narrow parking space managemend by PMU-TL. **Socioeconomic 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.

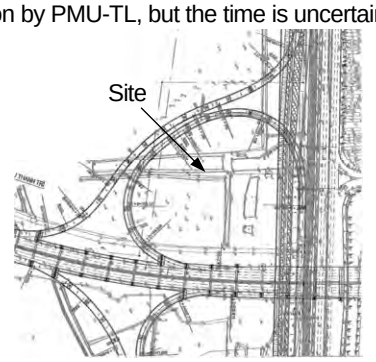
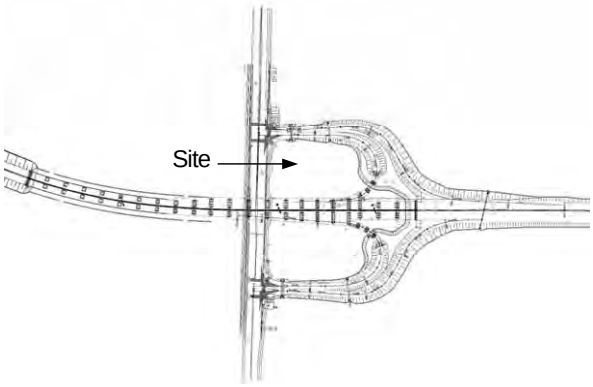
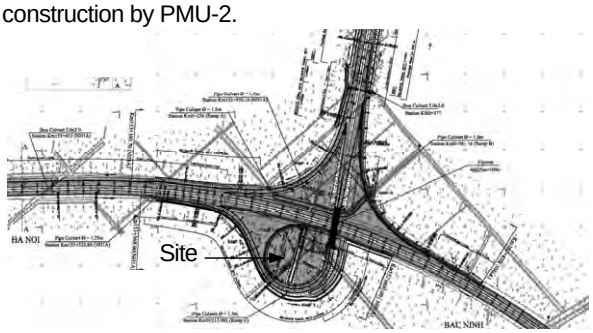
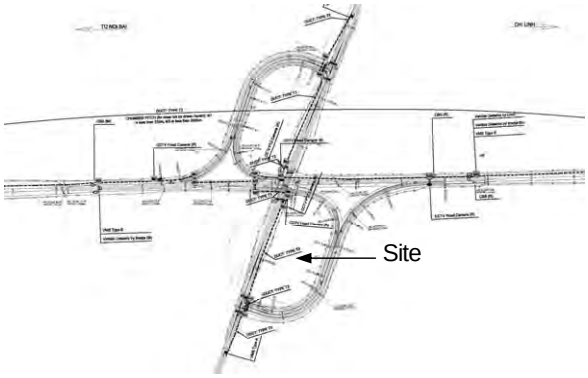
Candidate site 7: NH1B–NH3B IC. 	**Land use and land property:** The proposed area is agricultural use and ponds. Almost there is no residential area existed in surrounding. The proposed site will be within round shaped interchange access circuit. The proposed site will be owned by PNU-2 temporarily 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.

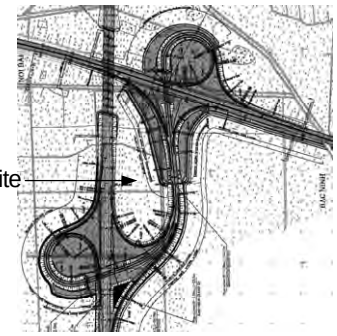
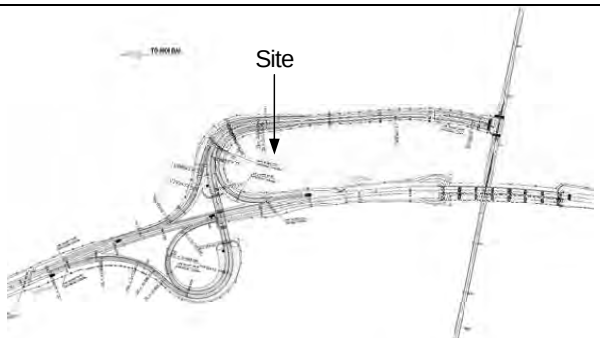
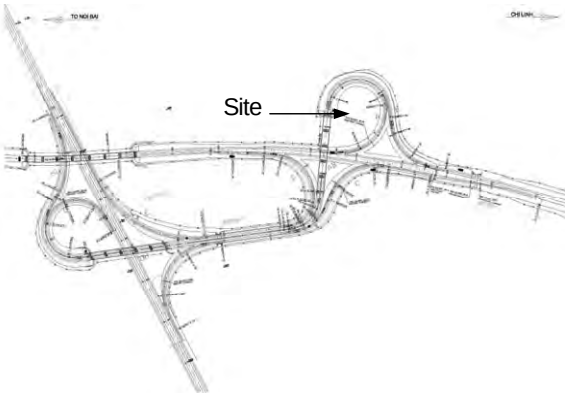
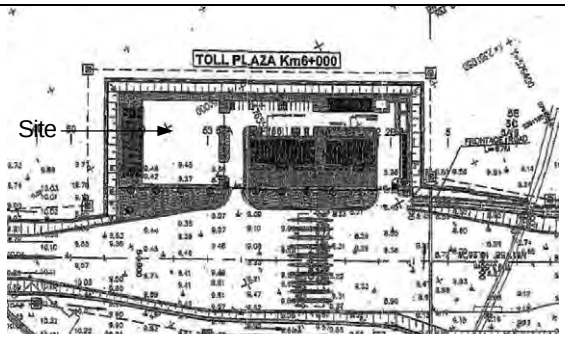
Candidate site 10: NH18–NH3 IC. 	**Land use and land property:** The proposed site and surrounding area is agricultural land use, ponds and a few residential area. The proposed site is within round shaped interchange access circuit. This area is many plots of agriculture and these landowner/stake holders 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

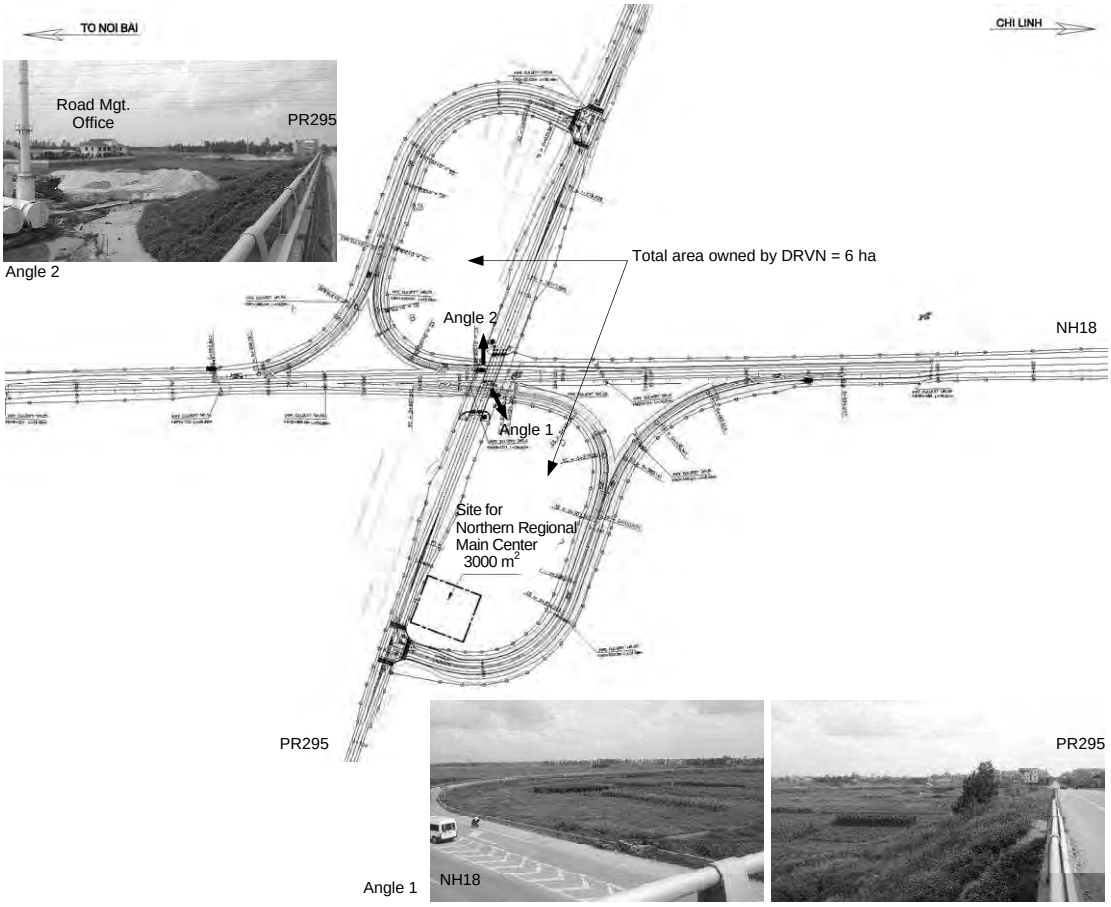
Source: ITS Standards & Operation Plan Study Team

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.

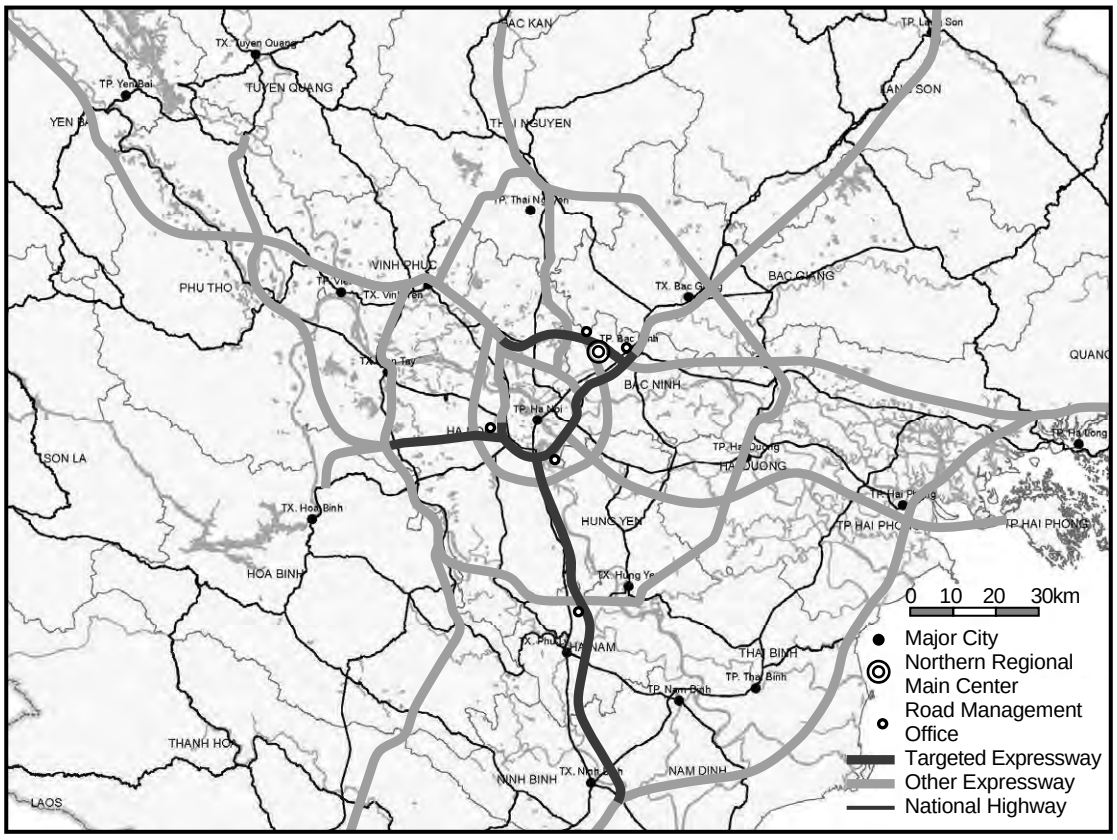
10.2 Project Regulatory and Legal Framework

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

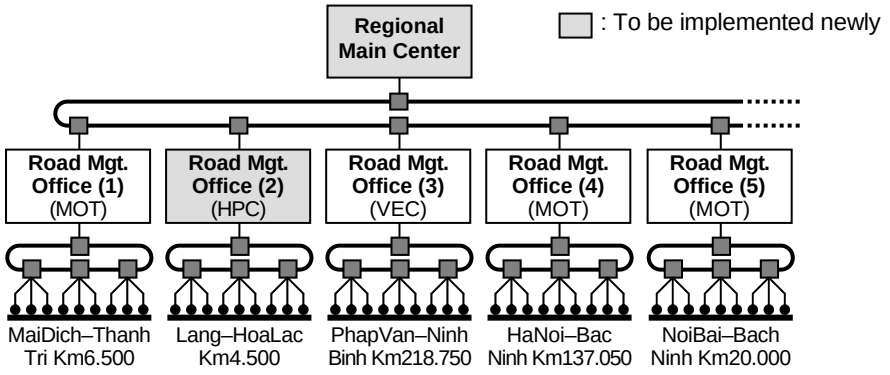
Target road section	Road length for cable installation (km)	Note
Mai Dich–Thanh Tri (Ring Road 3)	3.62 (Excluding via Duct =11.38km)	Earth work not required when cable installed via duct
Lang–Hoa Lac	28.0	
Phap Van–Cau Gie	-	Cable installed by others
Cau Gie–Ninh Binh	-	Cable installed by others
Ha Noi–Bac 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

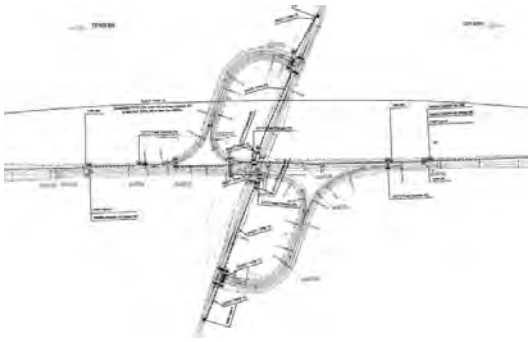
Disadvantages:

- Inconvenient for travelling
- New infrastructures need to be setup

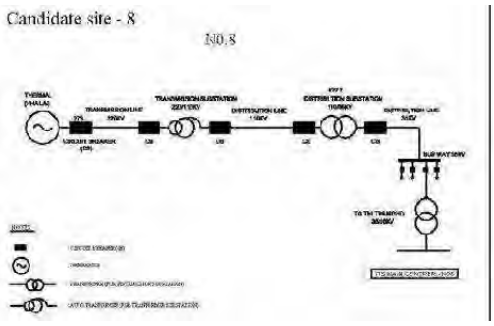
The selection of the best location was based on (i) Land use suitable on surroundings and avoiding land acquisition: total required area 3,000 m^2 includes 800 m^2 for building, 1,500 m^2 for car park and passage way and 700 m^2 for green area; (ii) Connectivity to optical fiber cable network installed 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.

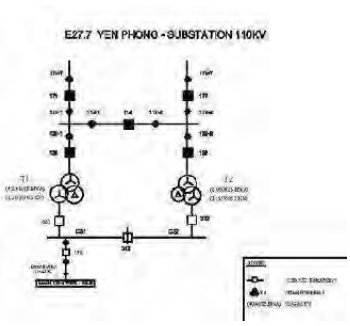
Location of Northern Regional Main Center at NH18–PR 295 Interchange (most recommended): has the most favorable conditions, convenient to connect fiber cable network, sufficient size, land acquisition not required, insignificant environmental impacts.

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

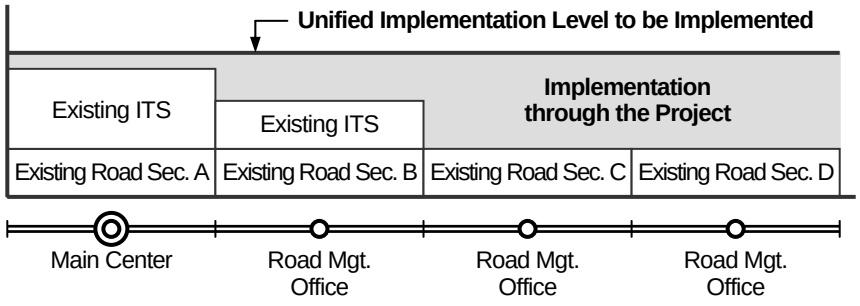
In this chapter, the items below are discussed. The objective and the Scope of the Project are to be mentioned at the outset, and outlines of the Project are to be clarified, Consequently, the discussion results of the cost, packages and schedule of the Project implementation are shown according to the 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.

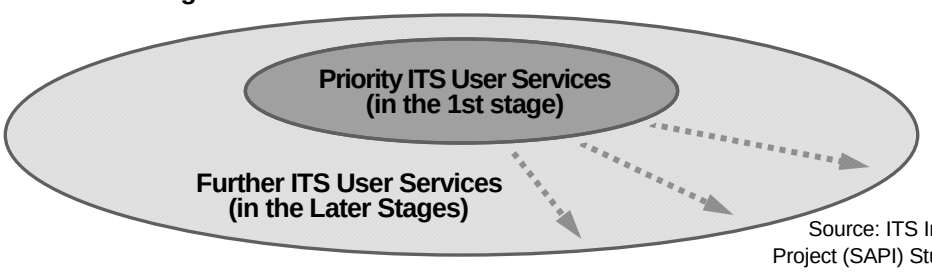
Figure 11.1 Unification of Implementation Levels through the ITS Integration Project



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

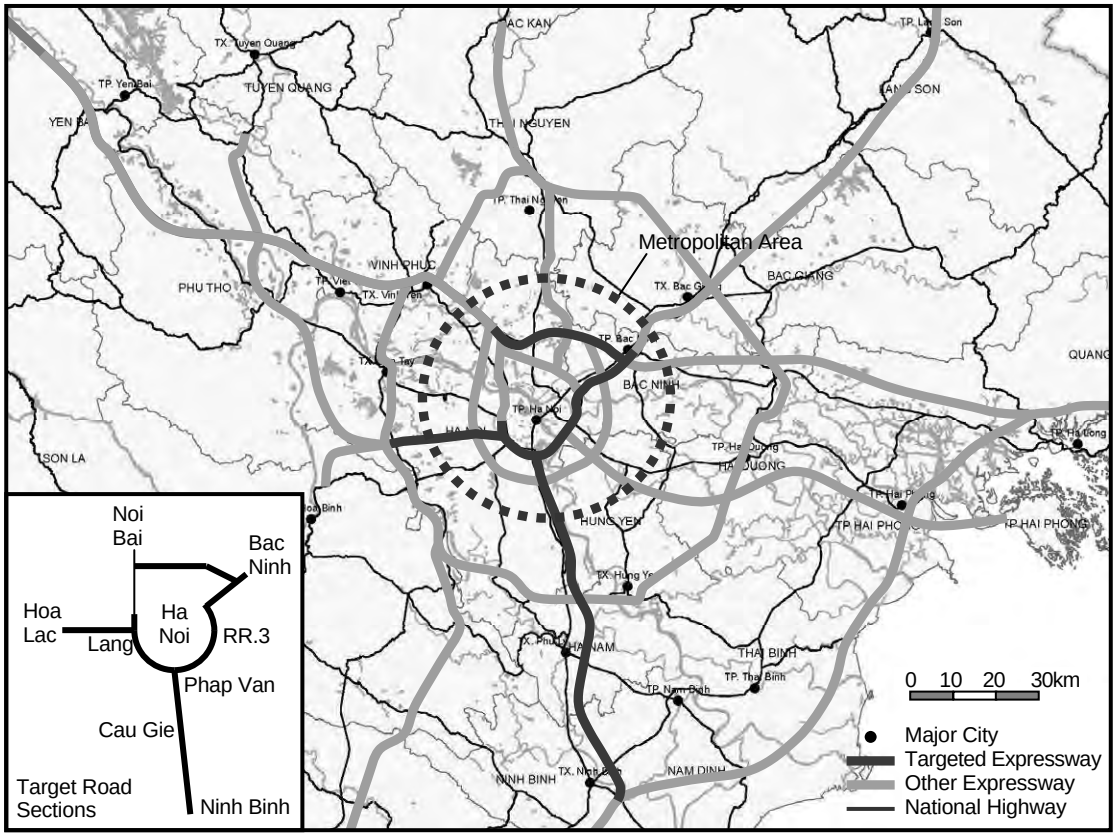
1) Project Area

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

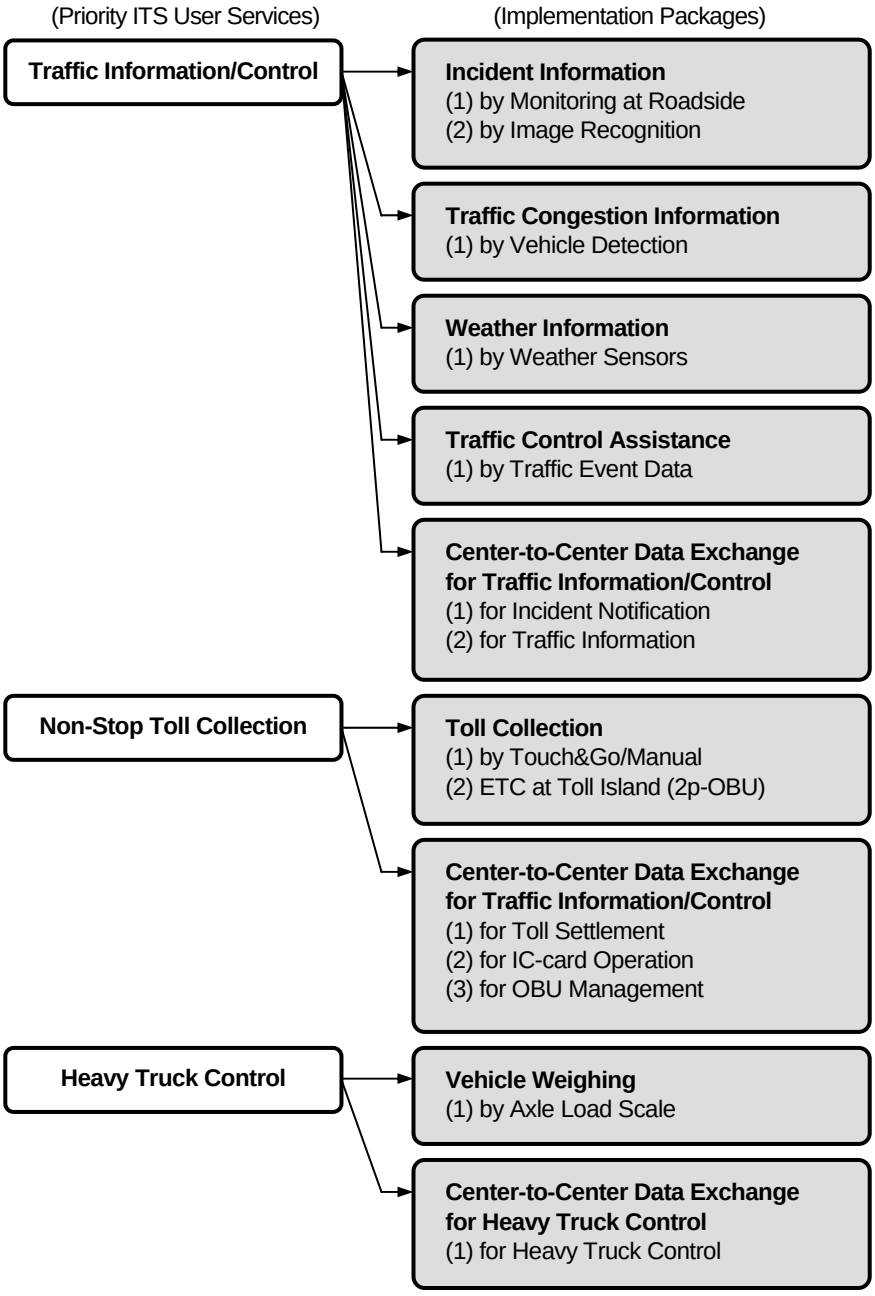
The following discussion results are to be shown for the design of the vehicle weighing system.

- 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.

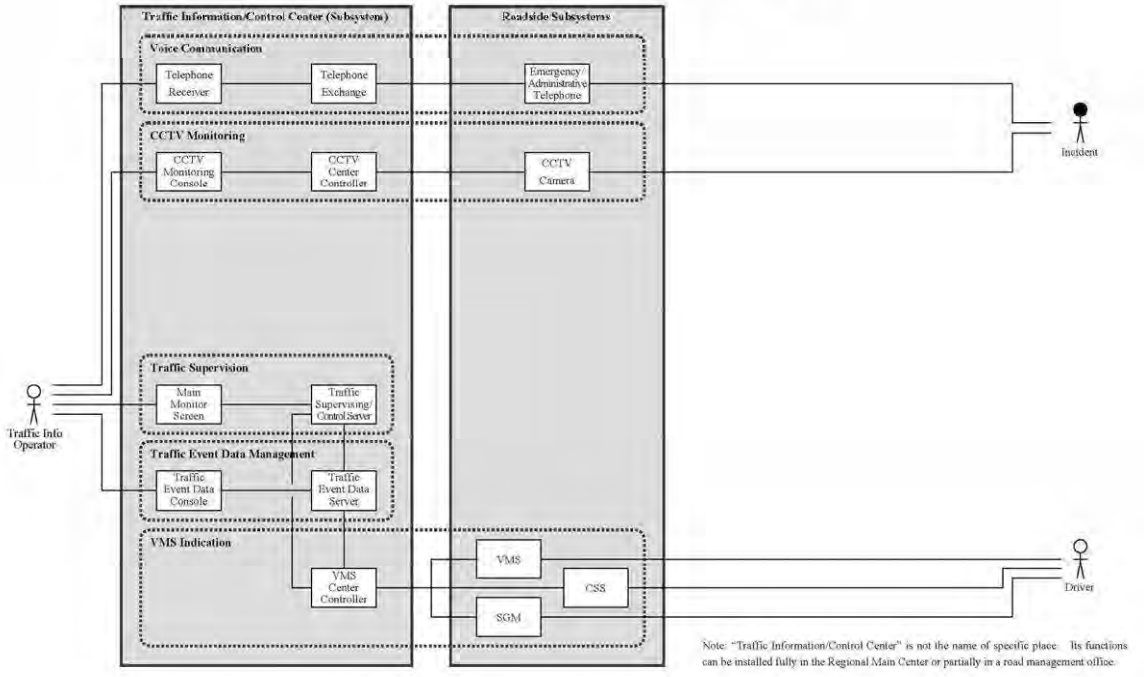
Figure11.4 Implementation Packages for Priority ITS User Services



Source: ITS Integration Project (SAPI) Study Team

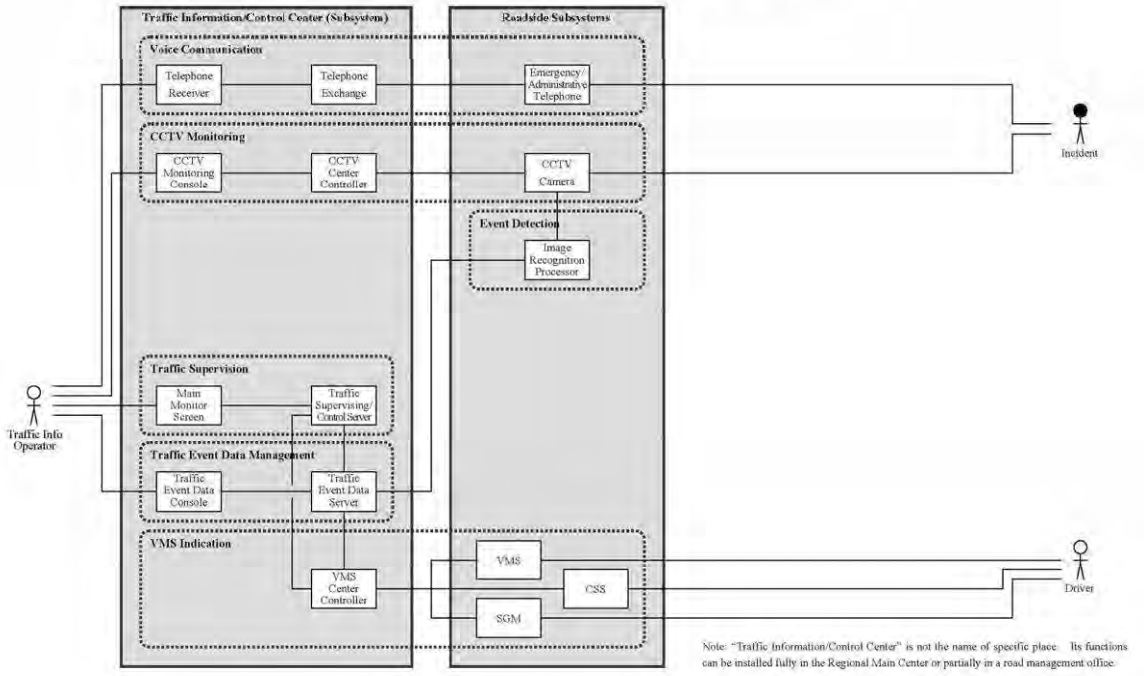
The system architecture is to be prepared for actualizing each implementation package being composed of subsystems as shown in the following pages.

Figure 11.5 Incident Information – (1) by Monitoring at Roadside



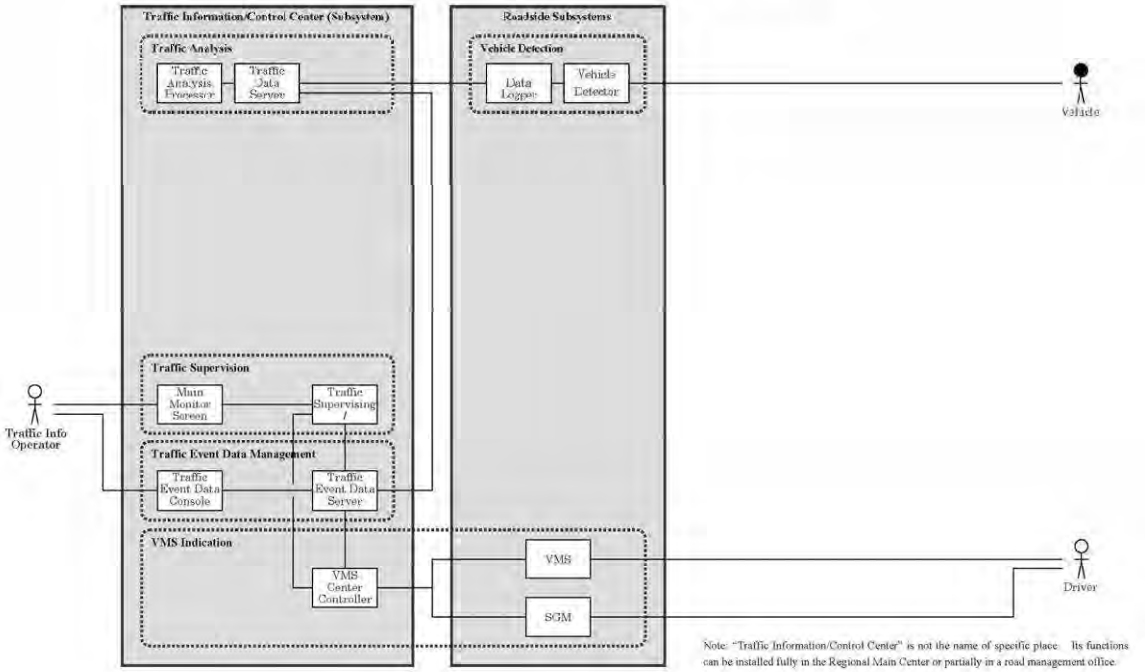
Source: ITS Integration Project (SAPI) Study Team

Figure 11.6 Incident Information – (2) by Image Recognition



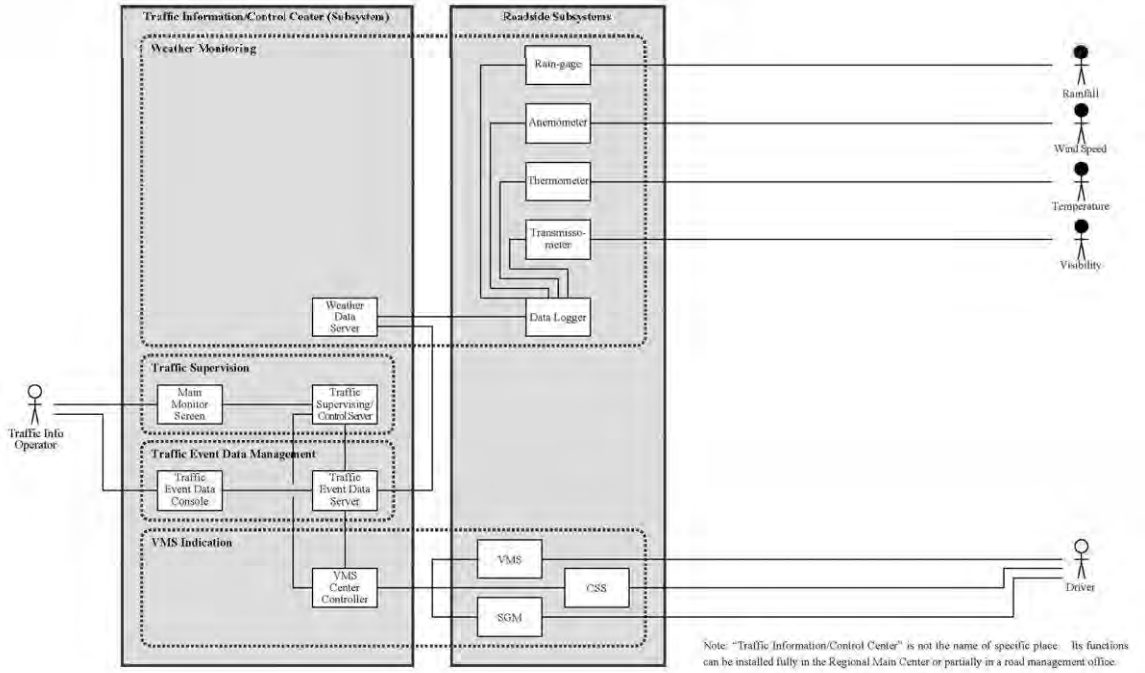
Source: ITS Integration Project (SAPI) Study Team

Figure 11.7 Traffic Congestion Information – (1) by Vehicle Detection



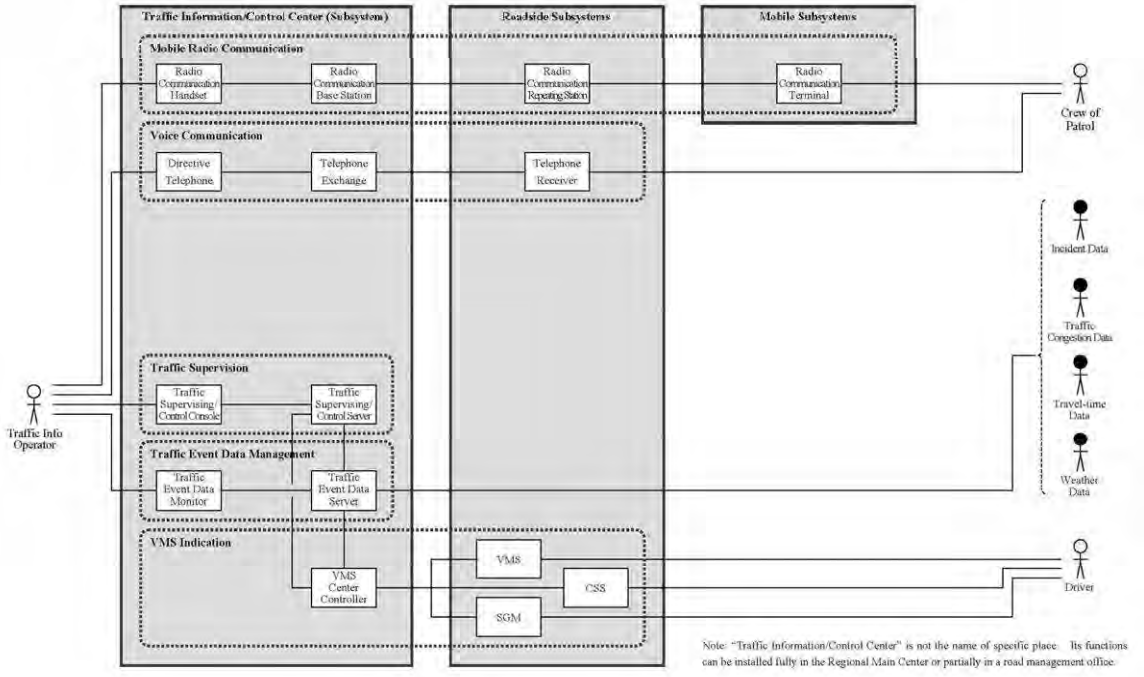
Source: ITS Integration Project (SAPI) Study Team

Figure 11.8 Weather Information by – (1) Weather Sensors



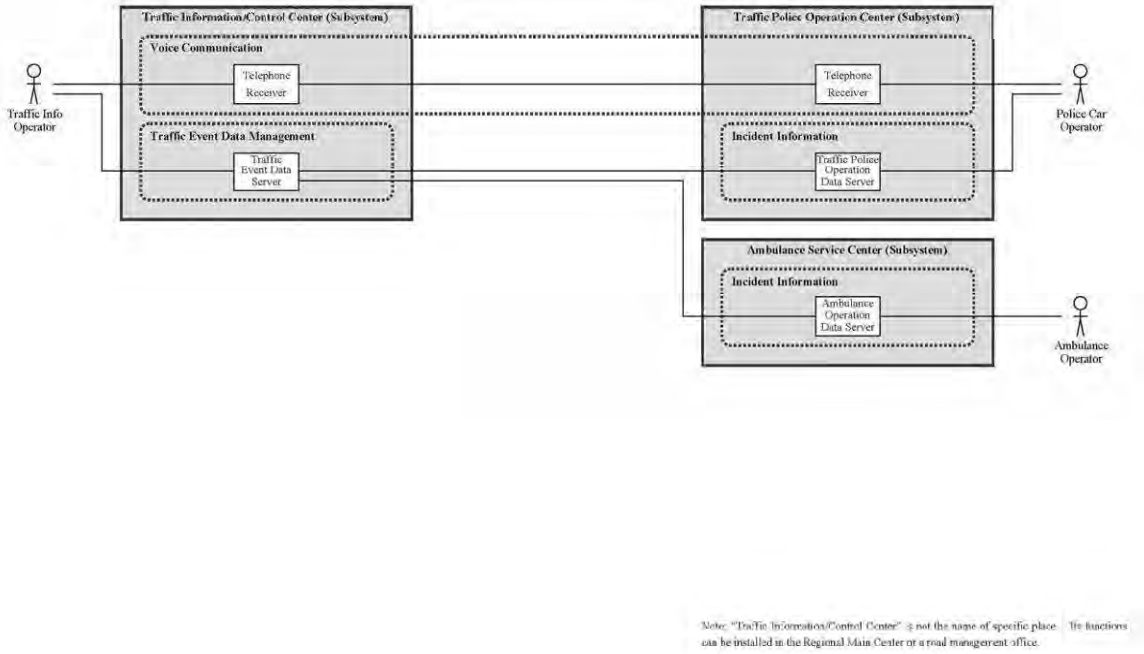
Source: ITS Integration Project (SAPI) Study Team

Figure 11.9 Traffic Control Assistance – (1) by Traffic Event Data



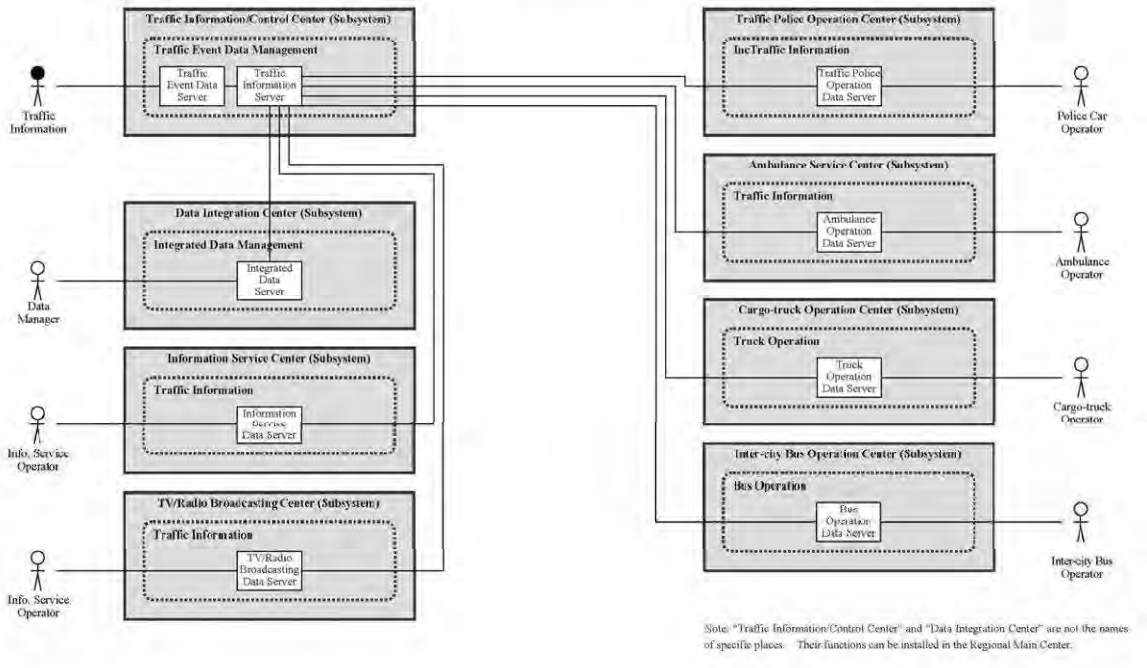
Source: ITS Integration Project (SAPI) Study Team

Figure 11.10 Center-to-Center Data Exchange – (1) for Incident Notification



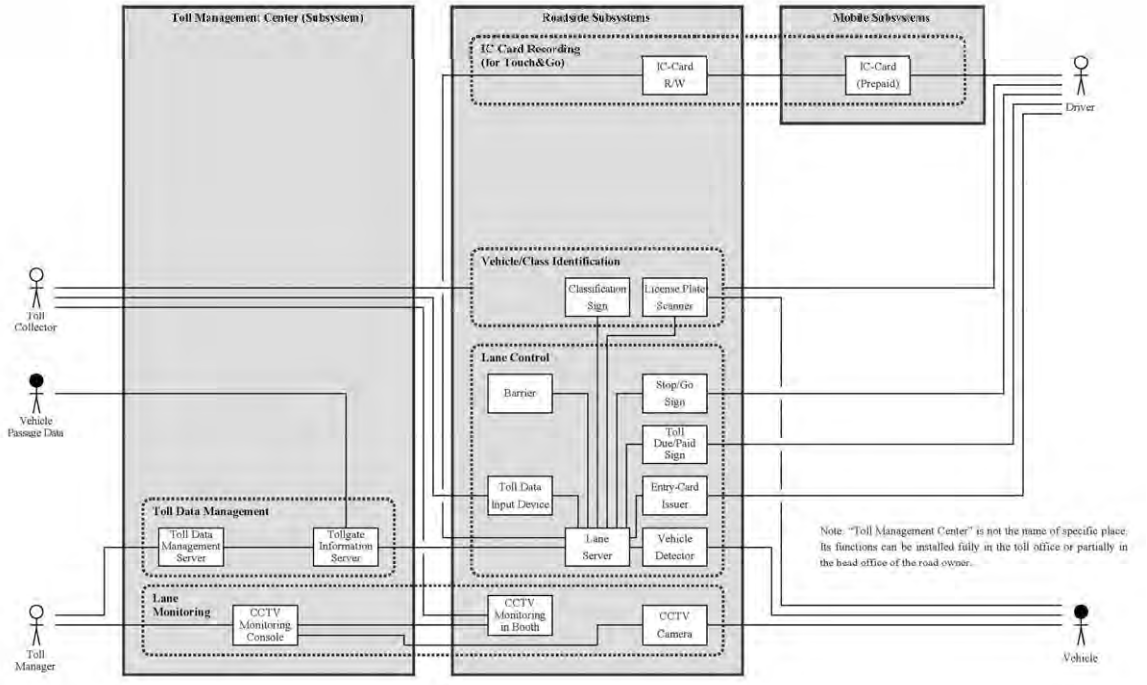
Source: ITS Integration Project (SAPI) Study Team

Figure 11.11 Center-to-Center Data Exchange – (2) for Traffic Information



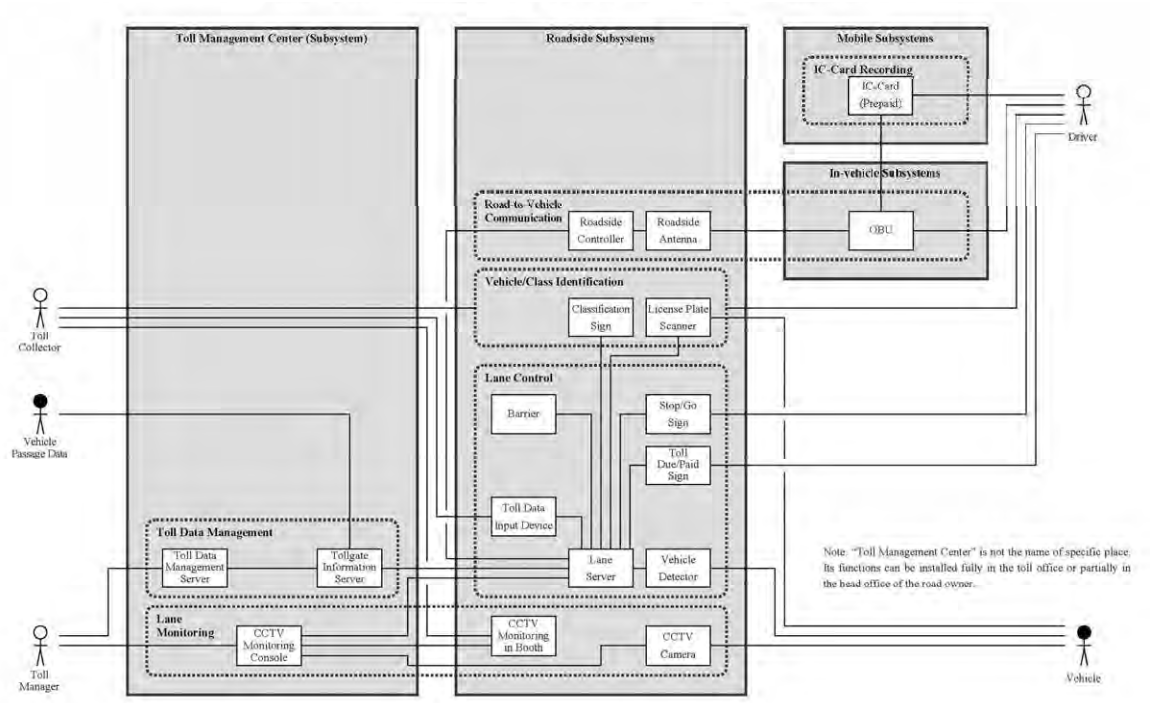
Source: ITS Integration Project (SAPI) Study Team

Figure 11.12 Toll Collection – (1) by Touch&Go/Manual



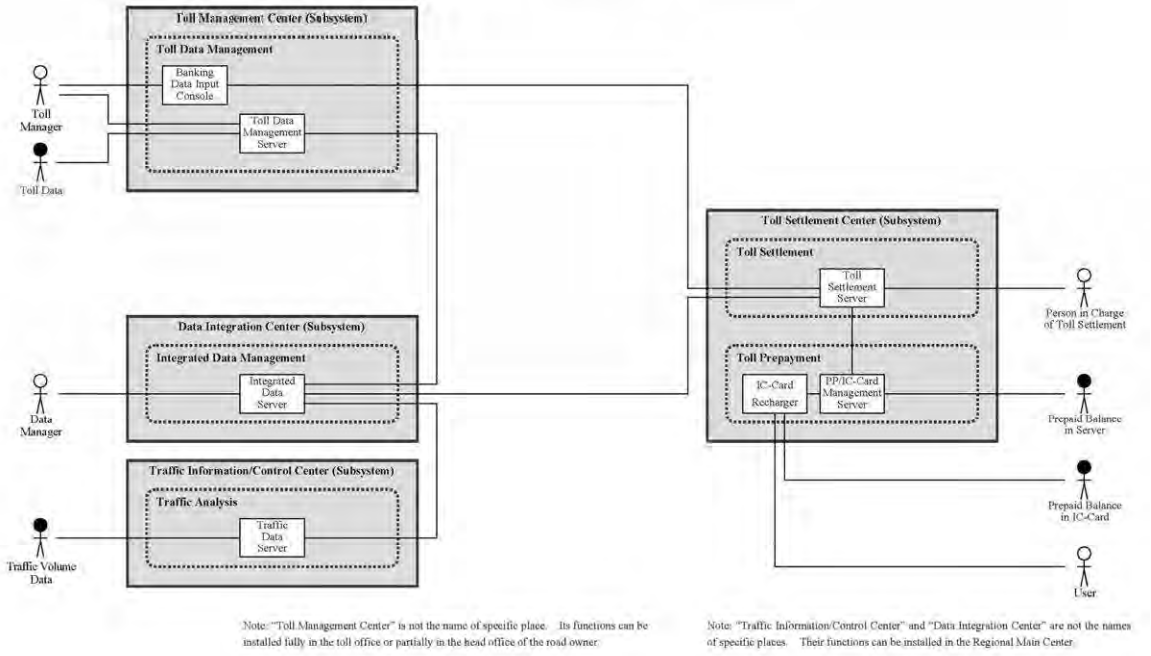
Source: ITS Integration Project (SAPI) Study Team

Figure 11.13 Toll Collection – (2) by ETC at Toll Island (2p-OBU)



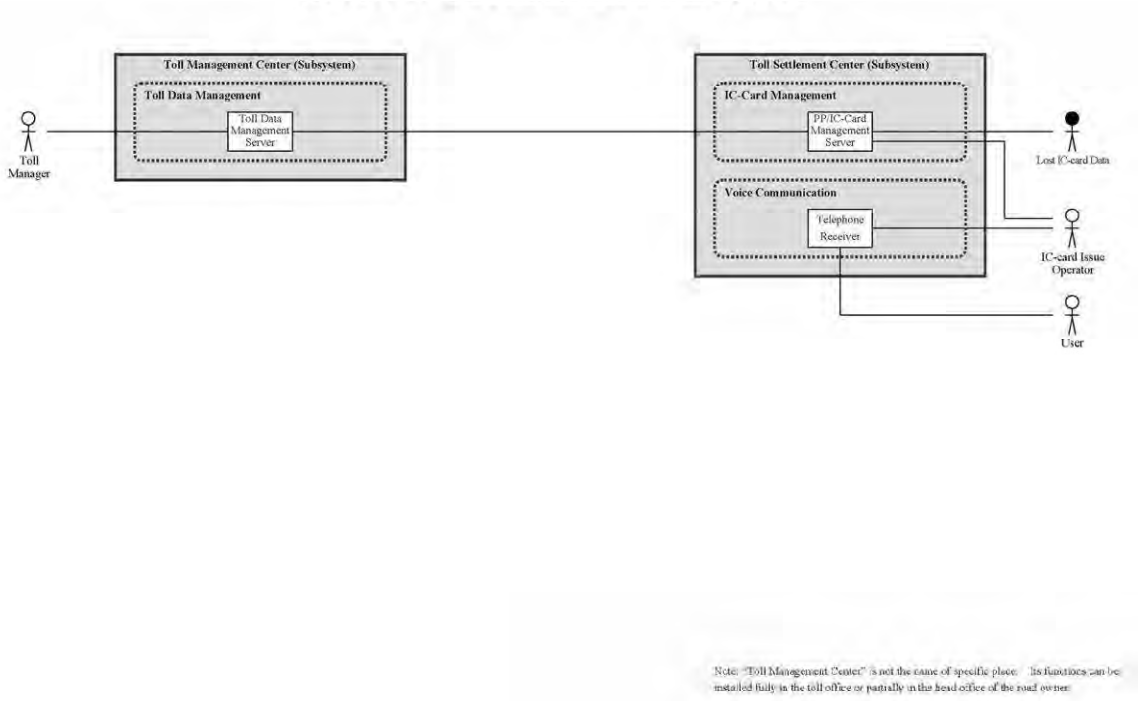
Source: ITS Integration Project (SAPI) Study Team

Figure 11.14 Center-to-Center Data Exchange – (1) for Toll Settlement



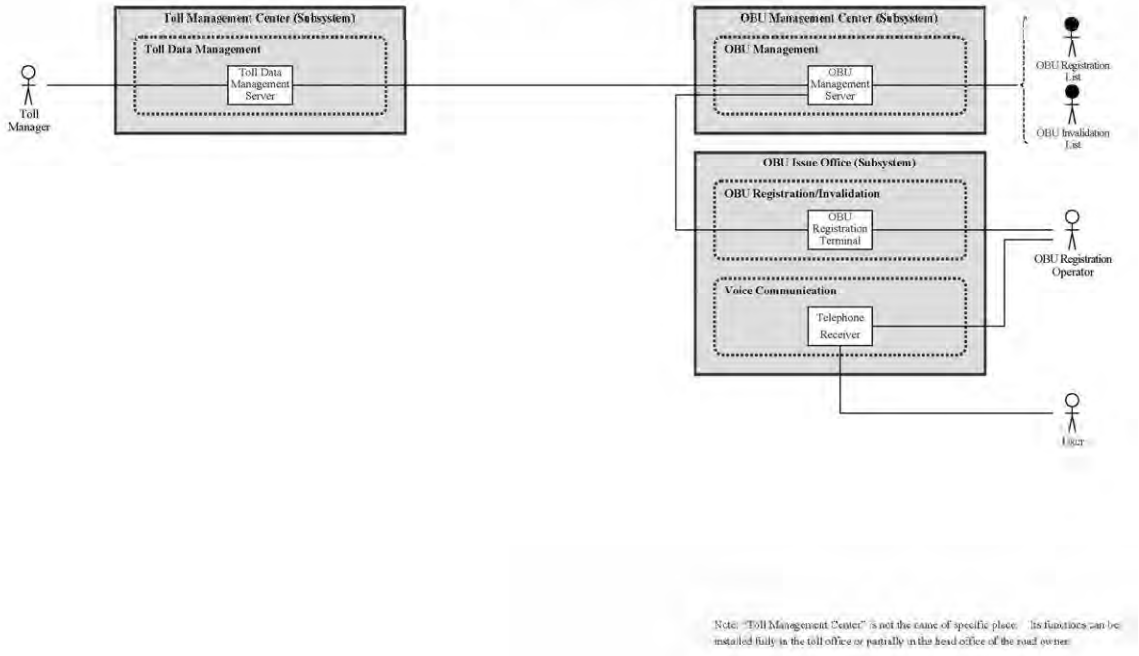
Source: ITS Integration Project (SAPI) Study Team

Figure 11.15 Center-to-Center Data Exchange – (2) for IC-card Operation



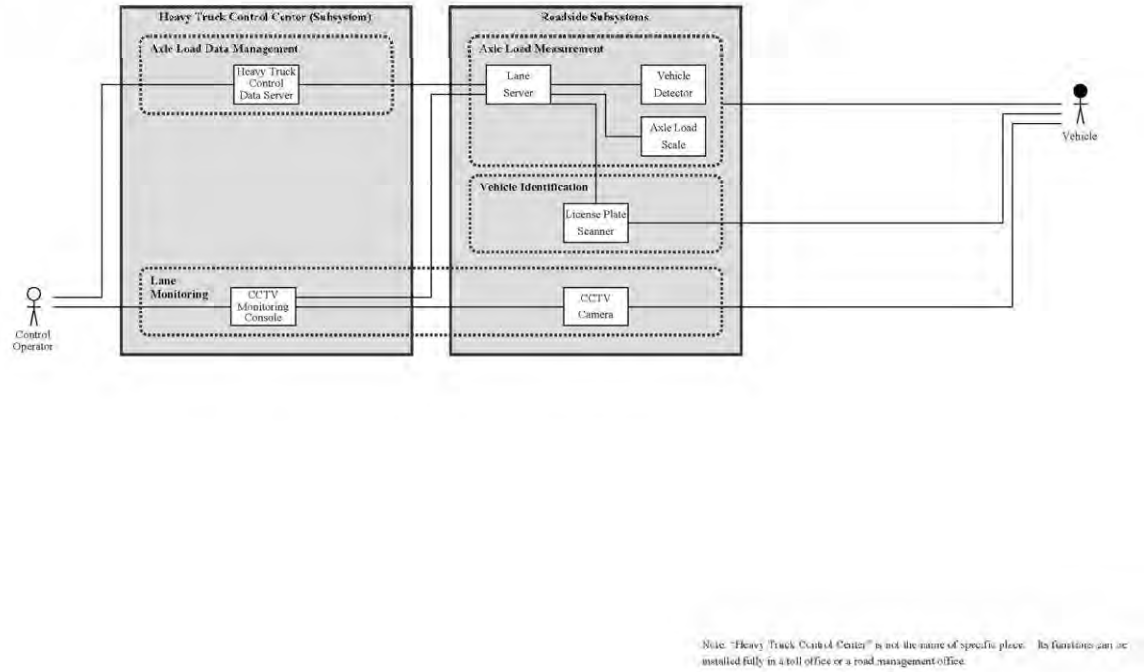
Source: ITS Integration Project (SAPI) Study Team

Figure 11.16 Center-to-Center Data Exchange – (3) for OBU Management



Source: ITS Integration Project (SAPI) Study Team

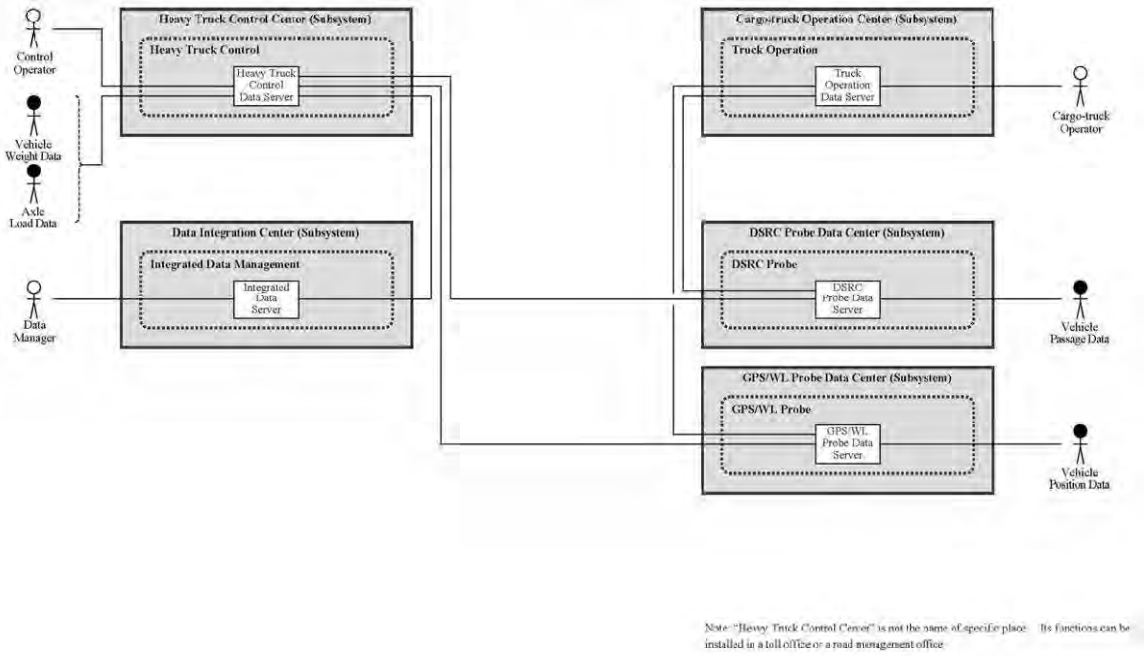
Figure 11.17 Vehicle Weighing – (1) by Axle Load Scale



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.

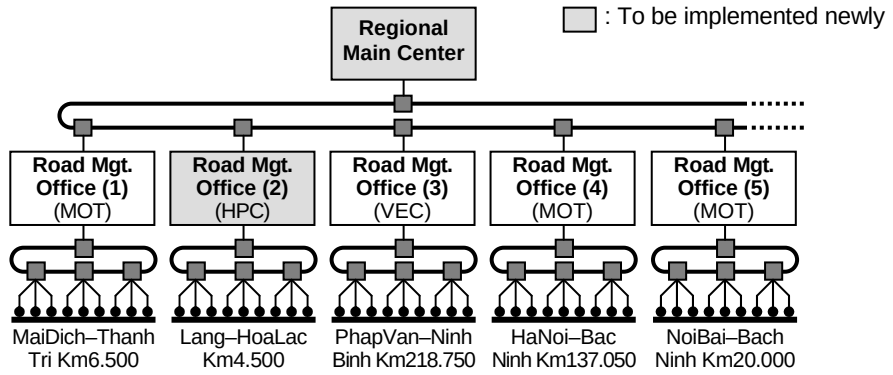
Source: ITS Integration Project (SAPI) Study Team

11.6.3 Center Equipment

1) Location of Northern Regional Main Center and Road Management Offices

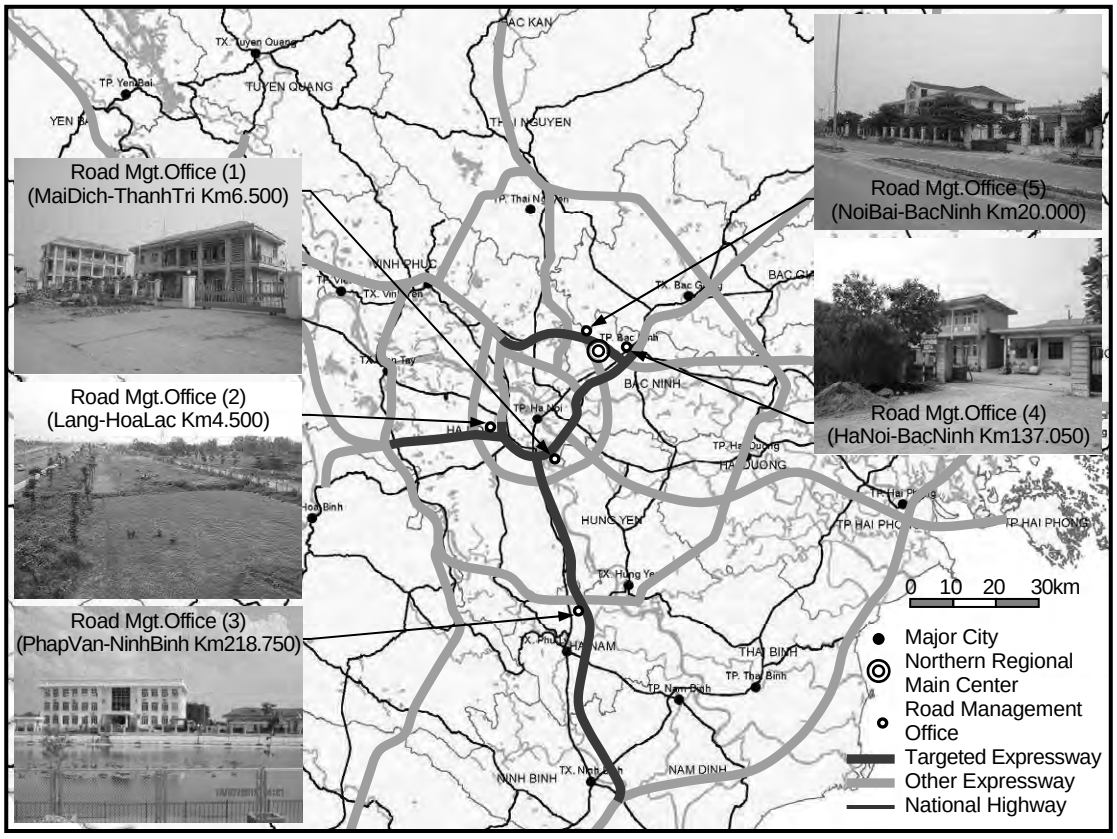
The structure and location of the Northern Regional Main Center and the road management offices are shown in the figures below. The center equipment for all of the Northern Regional Main Center and the road management offices needs to be implemented in the Project. The building construction only for 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

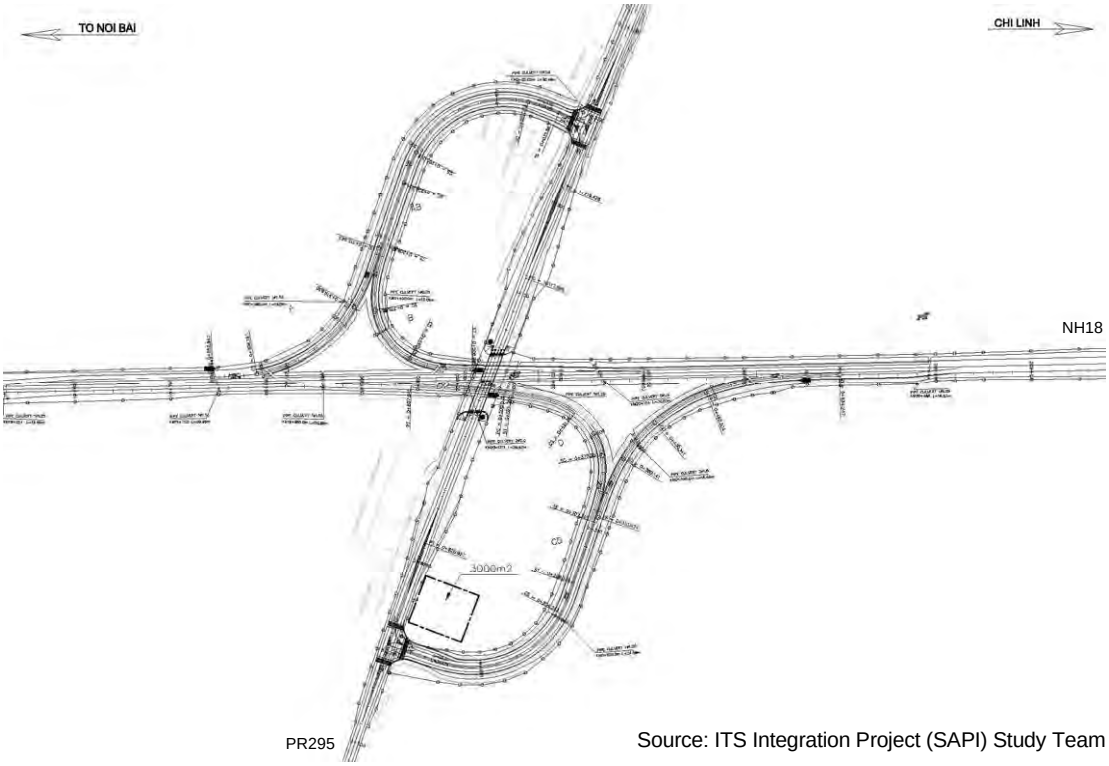
Figure 11.20 Location of Northern Regional Main Center and Road Management Offices



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.

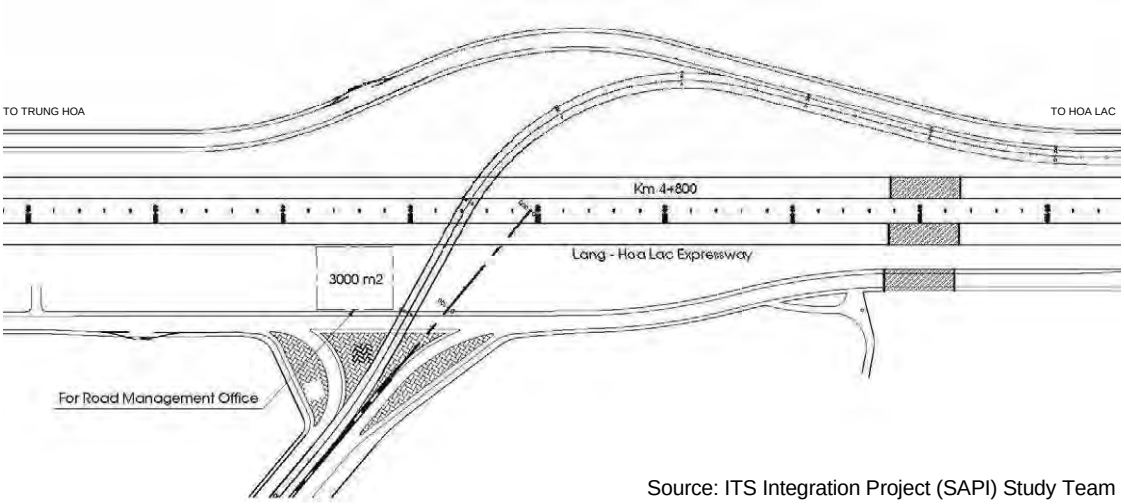
Figure 11.21 Location of Northern regional Main Center



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

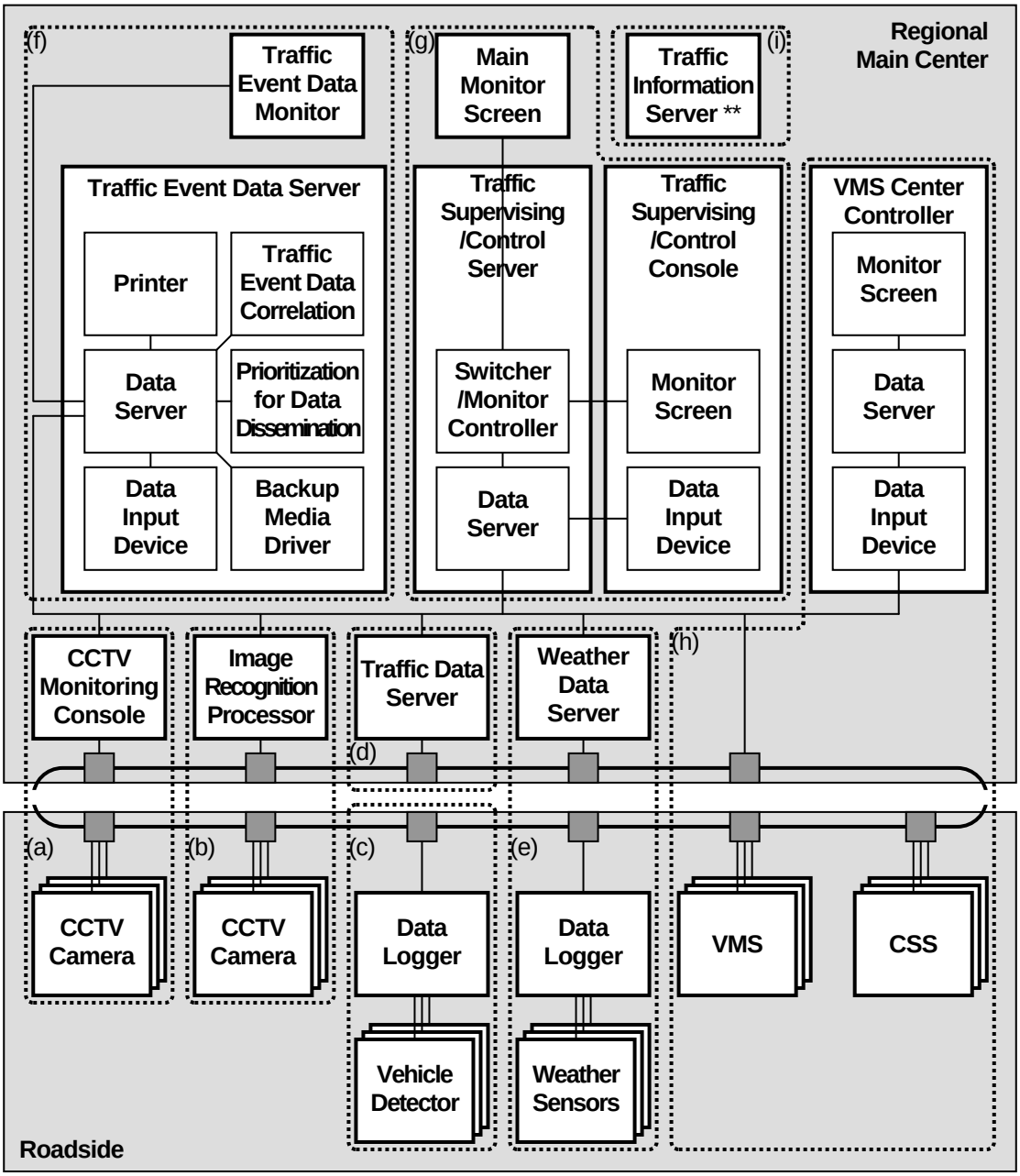
System architectures and the functional packages required for the Northern Regional Main Center and the road management offices are to be mentioned in the following.

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

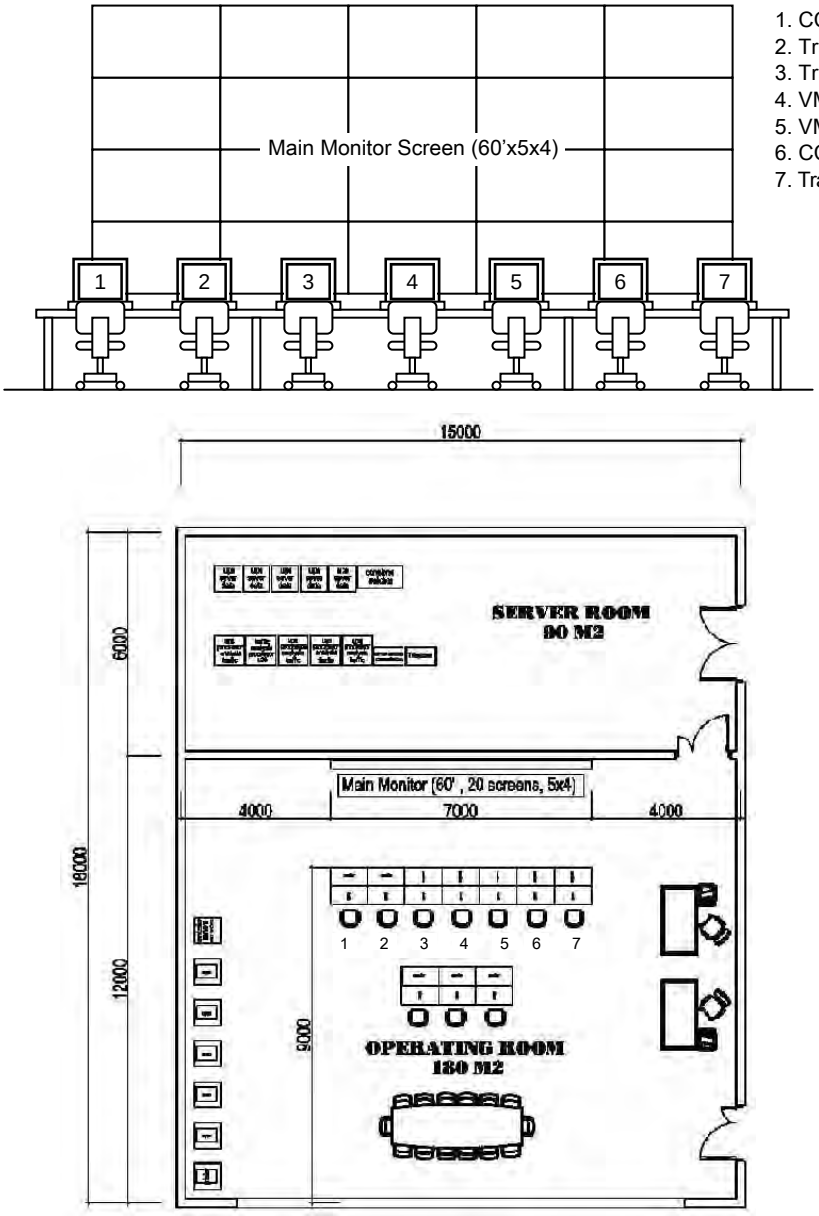


Note, ⬚: Functional package, ** : Protected by a firewall for connecting to the Internet and stored data in it is to be copied from the traffic event data server.

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



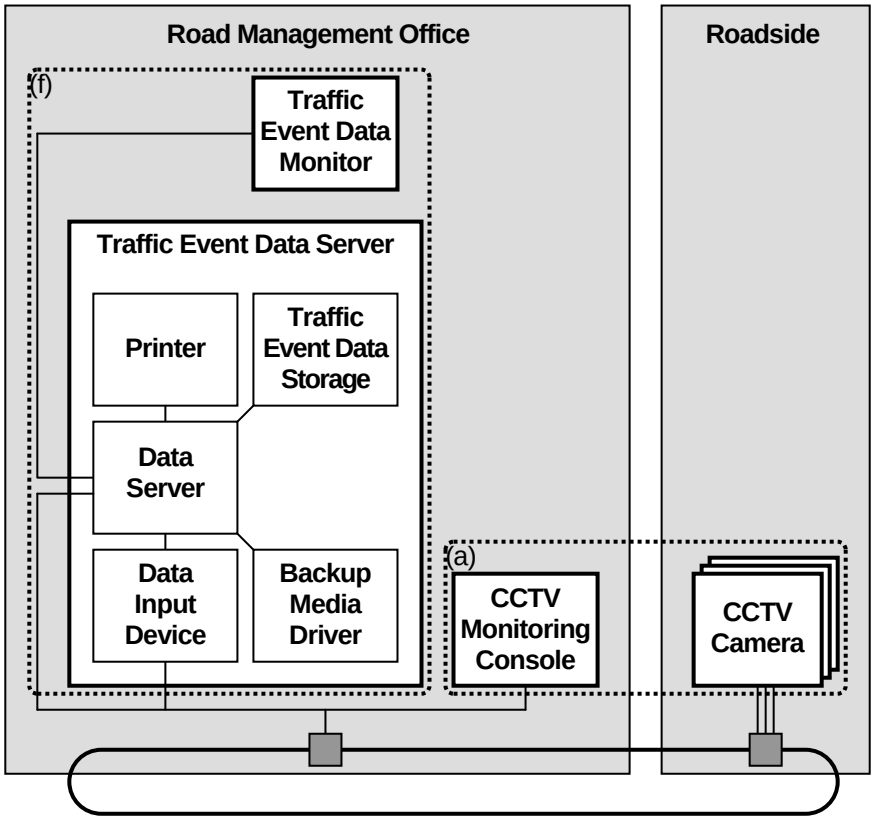
1. CCTV Center Controller Console
2. Traffic Event Data Input Device
3. Traffic Event Data Input Device
4. VMS Center Controller Console
5. VMS Center Controller Console
6. CCTV Center Controller Console
7. Traffic Supervising/Control Console

Source: ITS Integration Project (SAPI) Study Team

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.

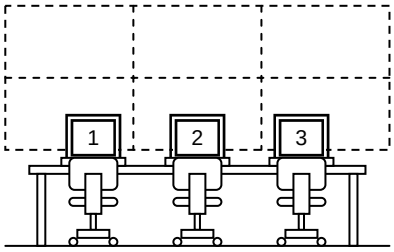
Figure 11.25 System Architecture for Road Management Office



Note: : Functional package

Source: ITS Integration Project (SAPI) Study Team

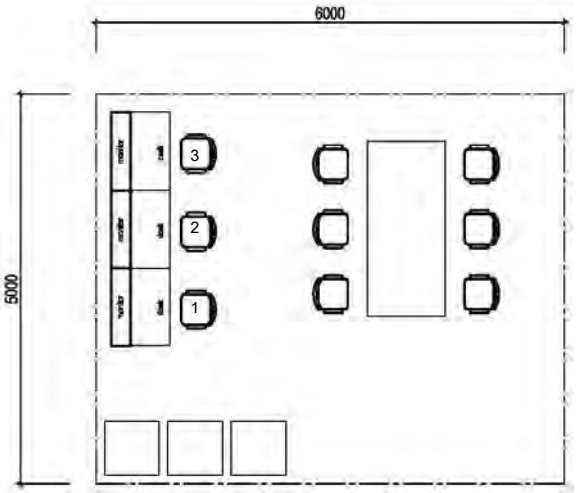
Figure 11.26 Equipment Overview in Road Management Office



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

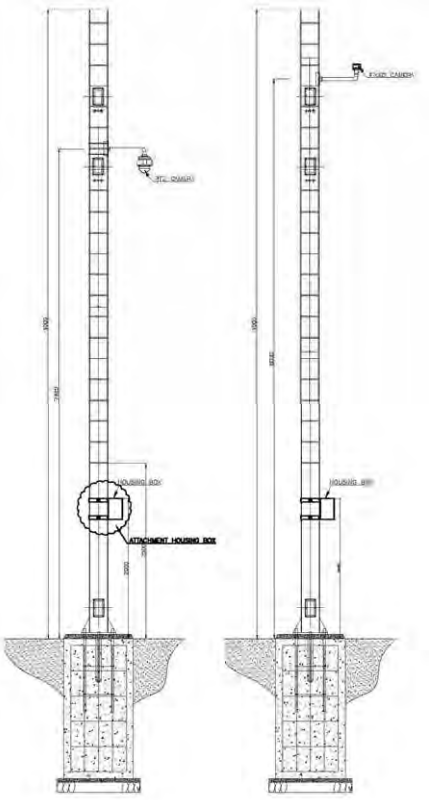
11.6.4 Roadside Equipment

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

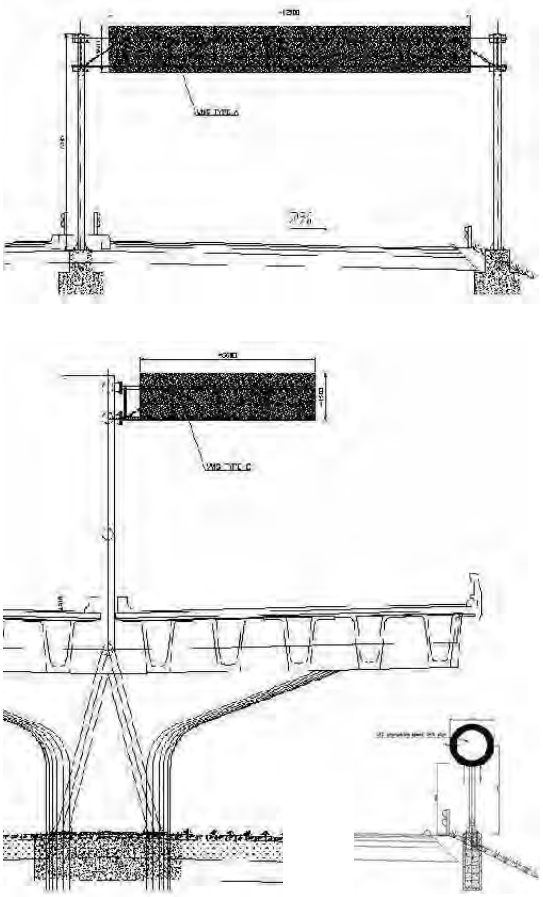
Typical installation of roadside equipment components are shown in the following figures and the arrangement on the road network is shown in the following tables.

Figure 11.27 Installation of CCTV Camera



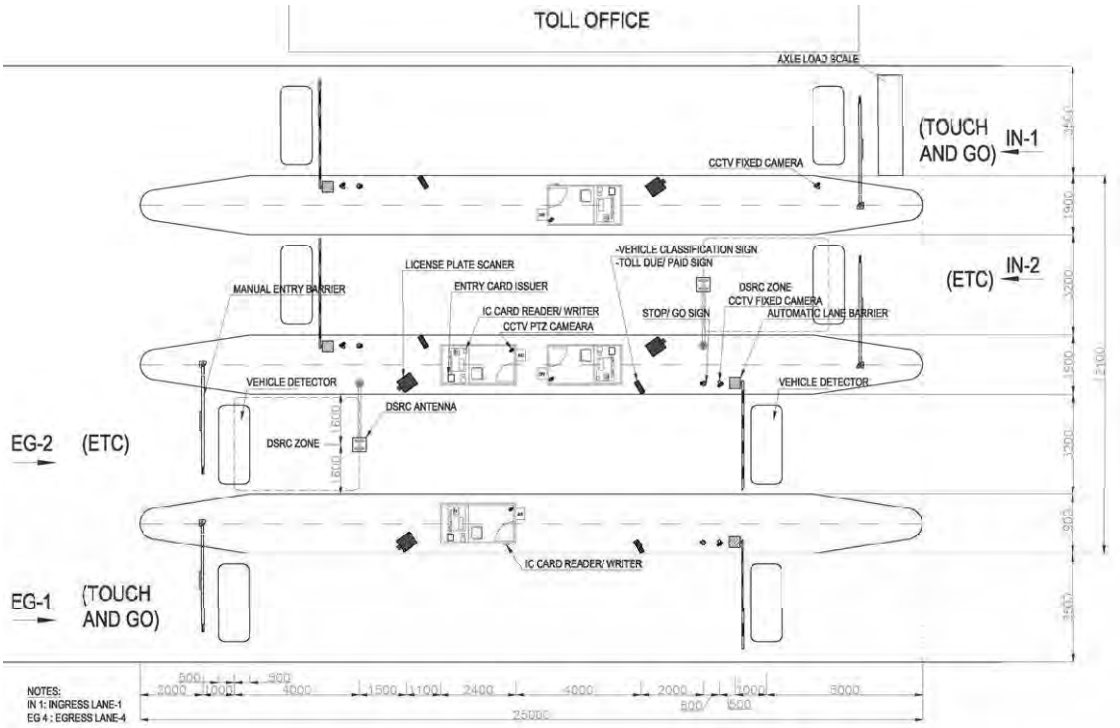
Source: ITS Integration Project (SAPI) Study Team

Figure 11.28 Installation of VMS/CSS



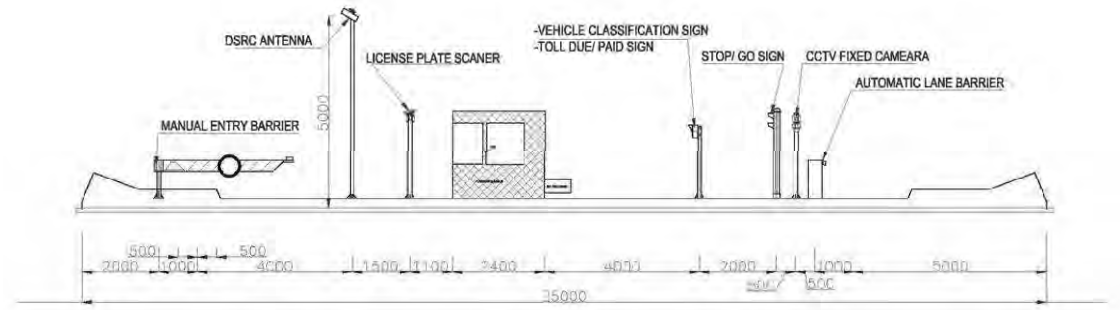
Source: ITS Integration Project (SAPI) Study Team

Figure 11.29 Installation of Roadside Equipment for Toll Collection



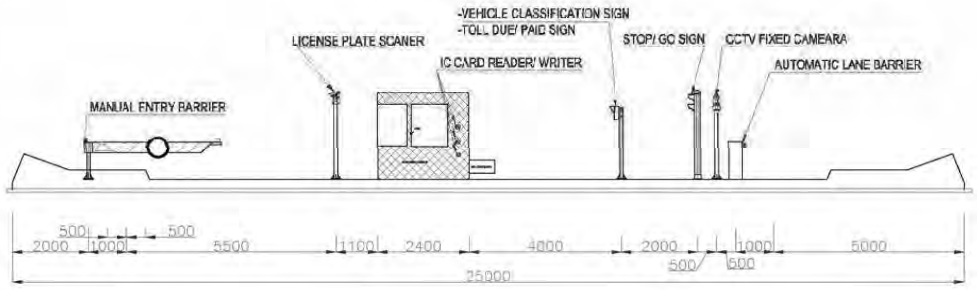
Source: ITS Integration Project (SAPI) Study Team

Figure 11.30 Installation of Roadside Equipment for ETC



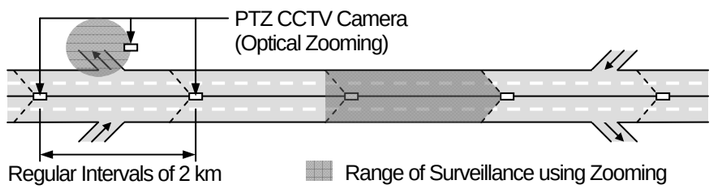
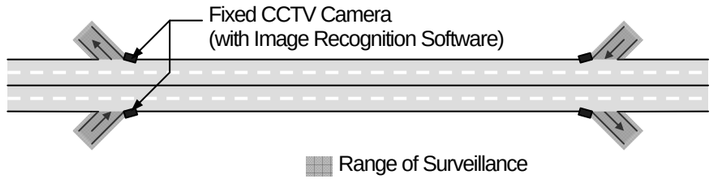
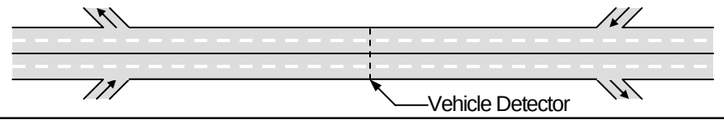
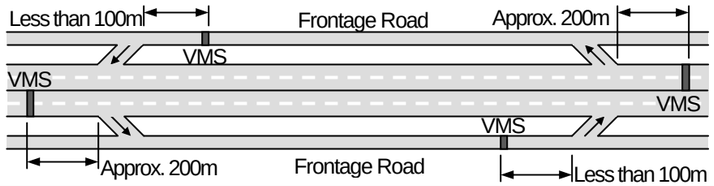
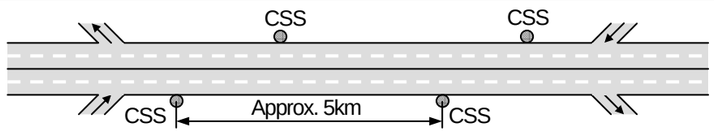
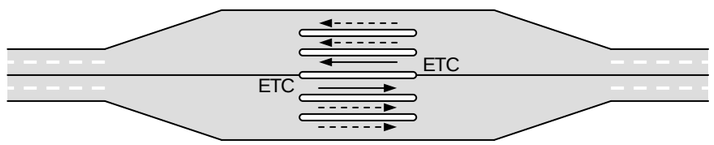
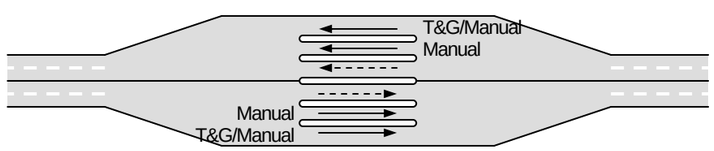
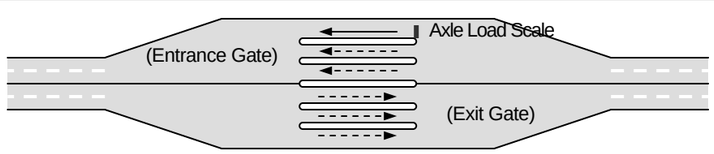
Source: ITS Integration Project (SAPI) Study Team

Figure 11.31 Installation of Roadside Equipment for Touch&Go/Manual



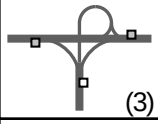
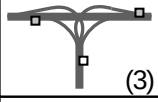
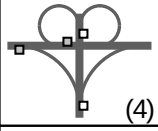
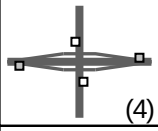
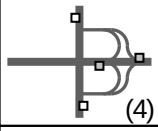
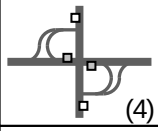
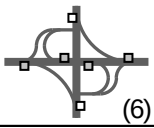
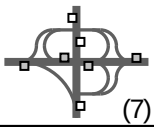
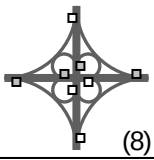
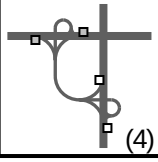
Source: ITS Integration Project (SAPI) Study Team

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

Arrangement of Roadside Equipment	Hoa Lac / Phu Cat / Dong Mo / Dai Mo / Trung Hoa Hoa Lac – Lang
1. PTZ Camera: for Monitoring (in Practical Use)	14 sets / 20 sets / 4 sets
2. Fixed Camera: for Event Detection (in Trial Use)	8 sets / 2 sets / 4 sets / 4 sets / 2 sets
3. Vehicle Detector (in Practical Use)	2 sets / 2 sets / 2 sets (+2 sets: Loop-coil) / 2 sets
4. VMS: for Traffic Information (in Practical Use)	5 sets / 1 sets / 4 sets / 4 sets / 2 sets
5. CSS: for Speed Limitation (in Practical Use)	4 sets / 3 sets / 2 sets
6. ETC: for Toll Collection (in Practical Use)	
7. Touch&Go/ Manual: for Toll Collection (in Practical Use)	
8. Axle Load Scale: for Overloading Regulation (in Practical Use)	

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	Phuong Nhi / Khe Hoi / Van Diem / Dai Xuyen / Vuc Vong / Liem Tuyen / Cao Bo Phap Van – 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

Arrangement of Roadside Equipment	Phuc Loi / Ha Noi	Den Do	Tu Son	Tien Son	Lien Bao	Nam Bac Ninh / Bac Ninh
1. PTZ Camera: for Monitoring (in Practical Use)	12 sets	4 sets	2 sets	4 sets	8 sets	1 sets
2. Fixed Camera: for Event Detection (in Trial Use)	7 sets	4 sets	4 sets	8 sets	4 sets	
3. Vehicle Detector (in Practical Use)	2 sets	2 sets	2 sets	2 sets	2 sets (+2 sets :Loop-coil)	
4. VMS: for Traffic Information (in Practical Use)	4 sets	4 sets	3 sets	4 sets	3 sets	
5. CSS: for Speed Limitation (in Practical Use)	2 sets	2 sets	2 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)	2 sets					

Source: ITS Integration Project (SAPI) Study Team

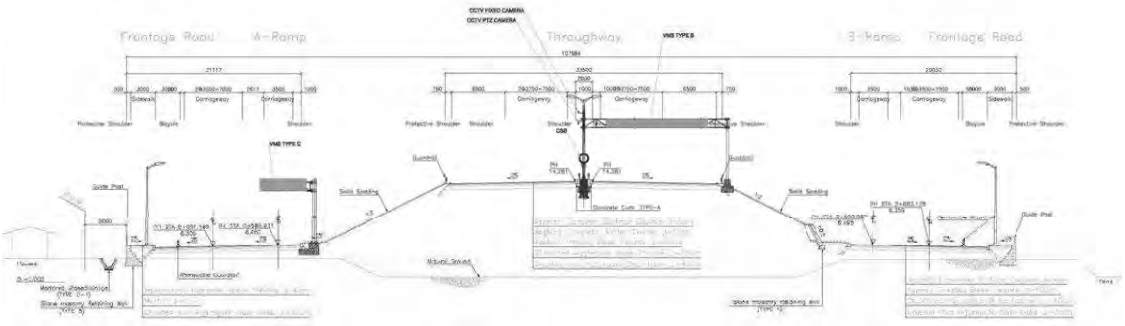
Table 11.7 Arrangement of Roadside Equipment Components on Noi Bai – Bac Ninh Section

Arrangement of Roadside Equipment	ThanhLong–Noi Bai / Noi Bai	NH3–Phu Lo	Ca Lo	PR295–Cho / Bac Ninh
1. PTZ Camera: for Monitoring (in Practical Use)	4 sets	10 sets	12 sets	4 sets	14 sets
2. Fixed Camera: for Event Detection (in Trial Use)	4 sets	4 sets	2 sets	4 sets
3. Vehicle Detector (in Practical Use)	2 sets	2 sets	2 sets (+2 sets :Loop-coil)
4. VMS: for Traffic Information (in Practical Use)	4 sets	4 sets	2 sets	4 sets
5. CSS: for Speed Limitation (in Practical Use)	2 sets	6 sets	1 sets	8 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)	2 sets

Source: ITS Integration Project (SAPI) Study Team

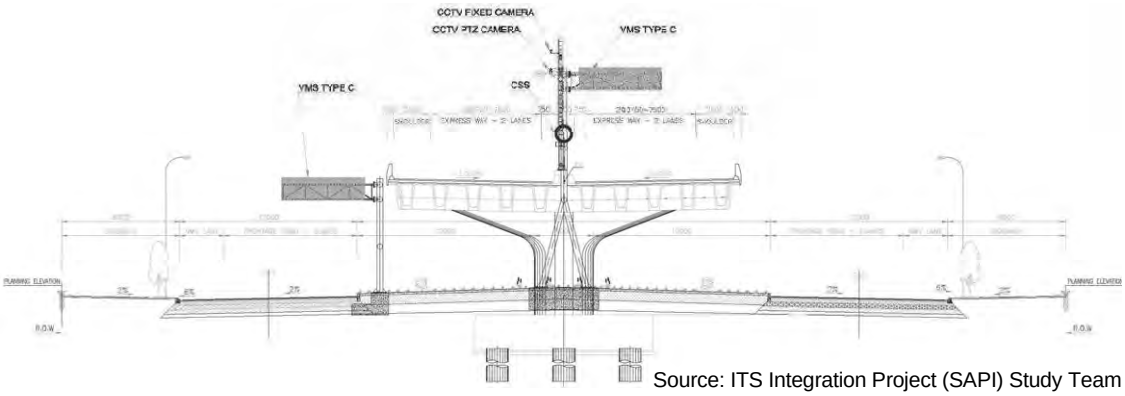
Typical cross sections of the installation of VMS, CSS and CCTV camera respectively at earthwork section, viaduct section and bridge section are shown in the following figures.

Figure 11.32 Typical Cross Section of Roadside Equipment Installation at Earthwork Section



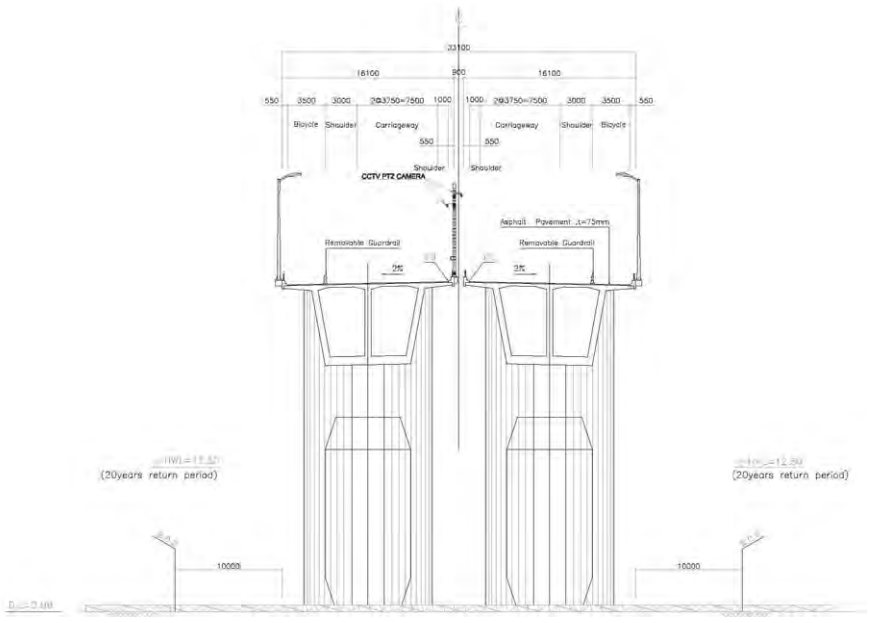
Source: ITS Integration Project (SAPI) Study Team

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



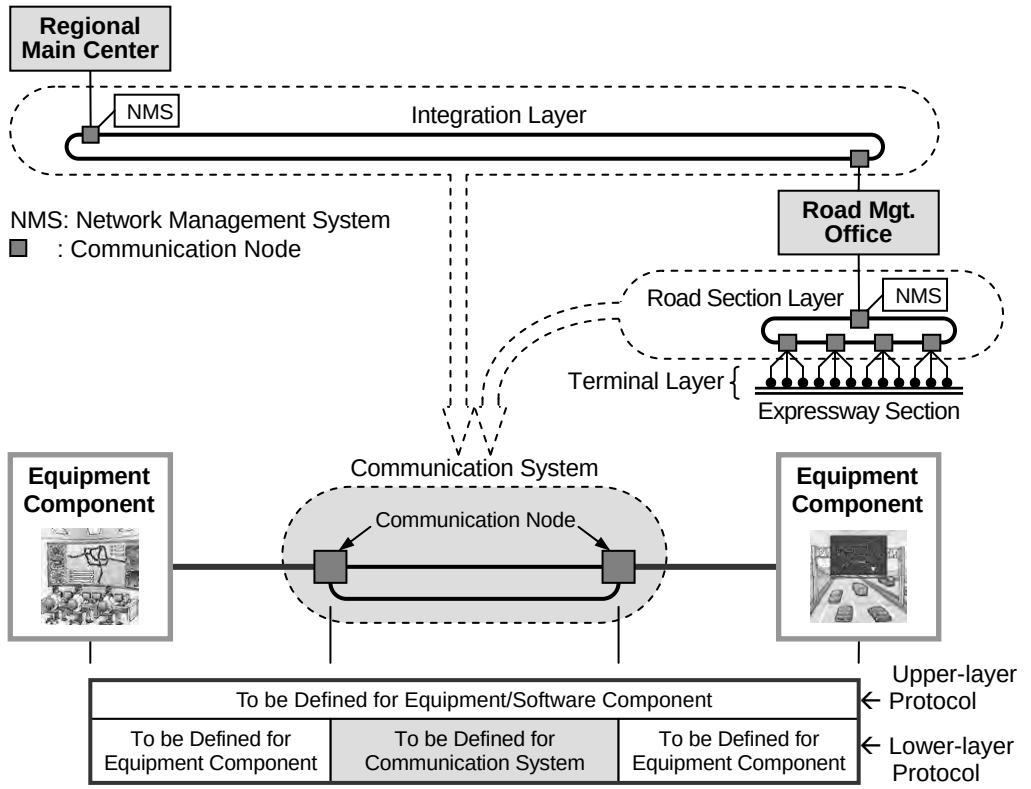
Source: ITS Integration Project (SAPI) Study Team

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



Source: ITS Integration Project (SAPI) Study Team

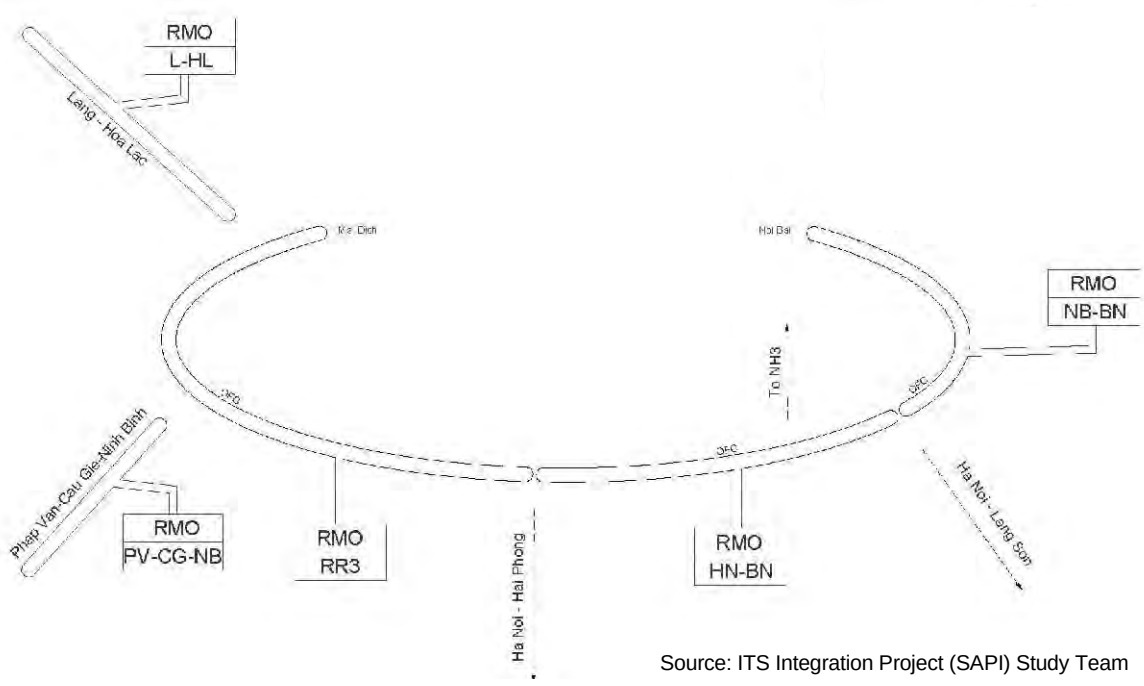
Discussion items on the communication system (only in the case wired) are as follows:

- 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.

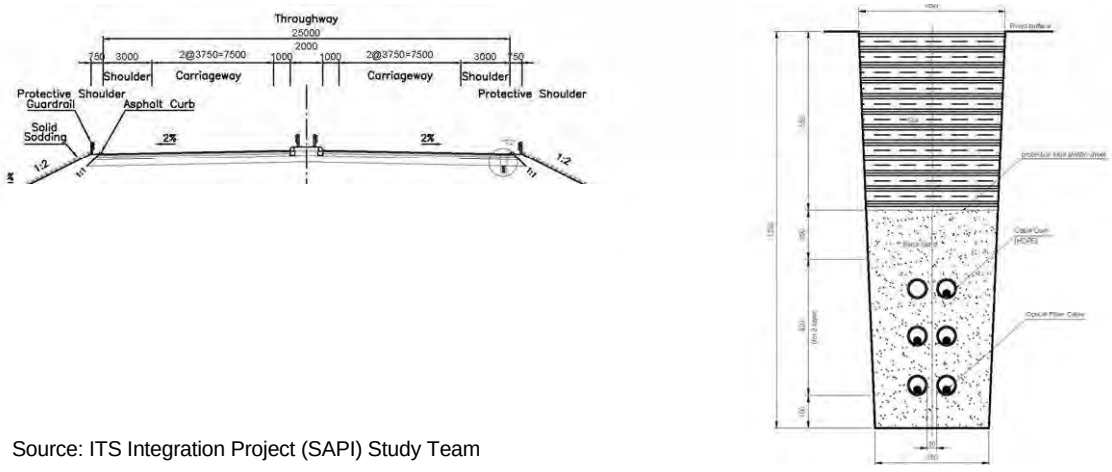
Communication network is to be implemented in ring shape along the expressway network as shown in the figure below.

Figure 11.36 Outline of Communication Network



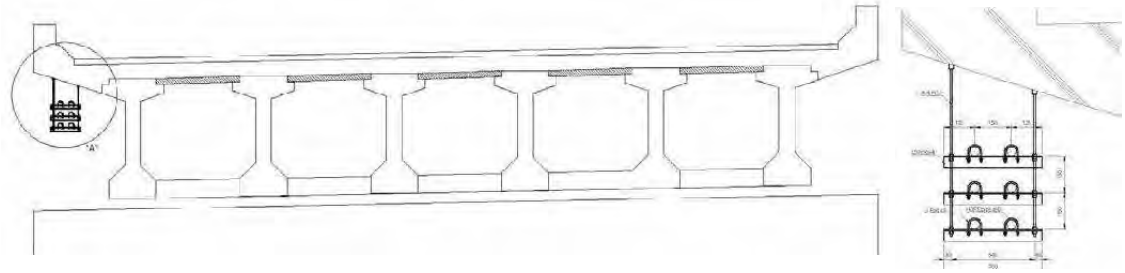
Source: ITS Integration Project (SAPI) Study Team

Figure 11.37 Installation of Communication Duct at Earth Section



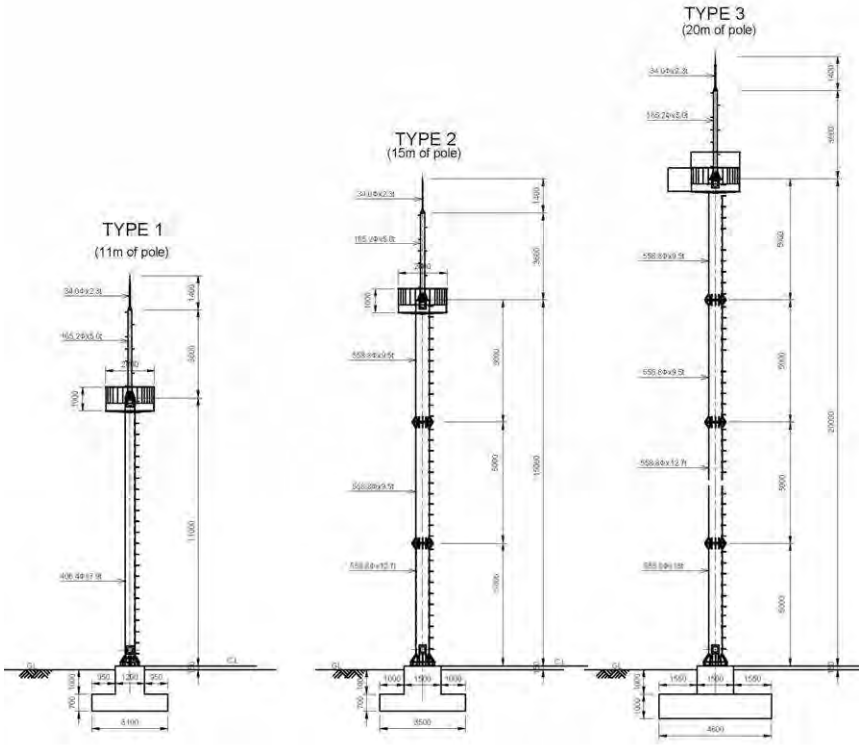
Source: ITS Integration Project (SAPI) Study Team

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.

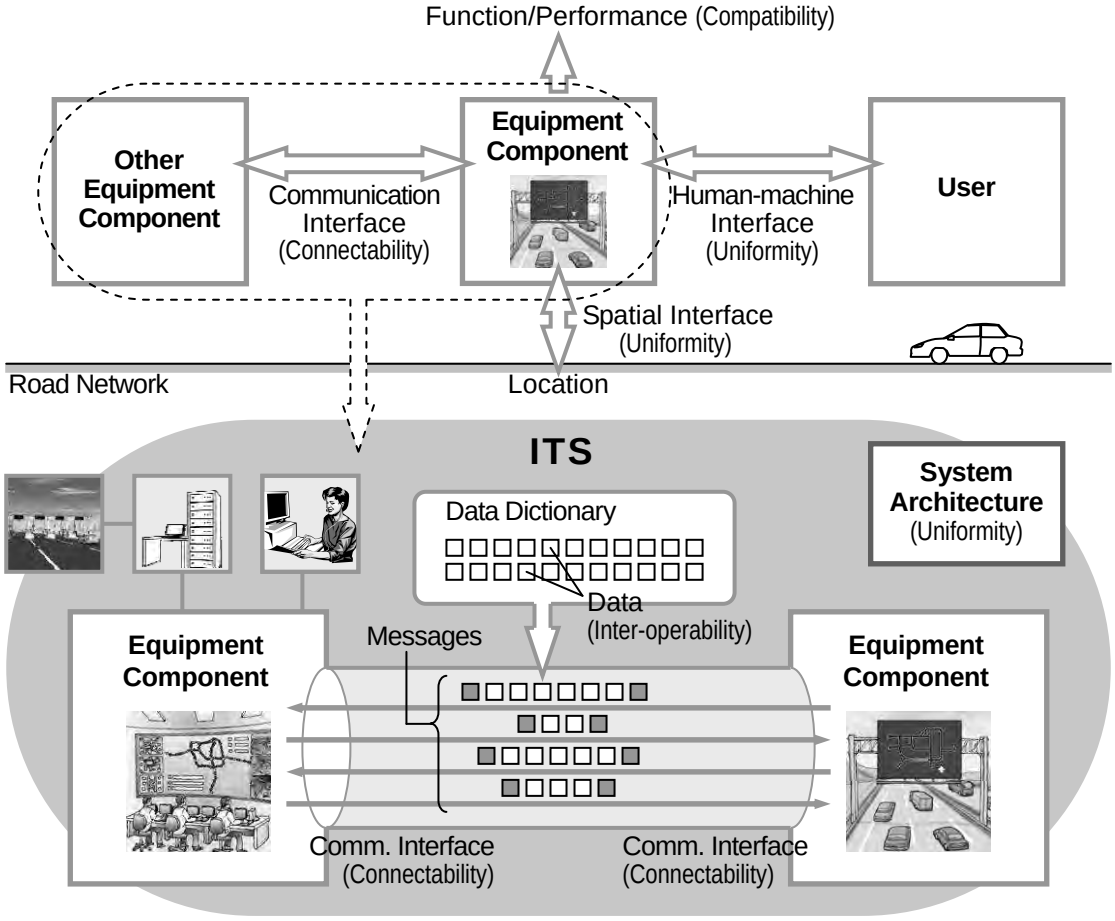
- Basic principle for design
- The survey on power supply status
- Responsibility demarcation point
- Power receiving capacity
- Voltage drop
- Northern Regional Main Center
- Road management office
- Toll office
- Roadside equipment

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 11.16 Project Cost

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:

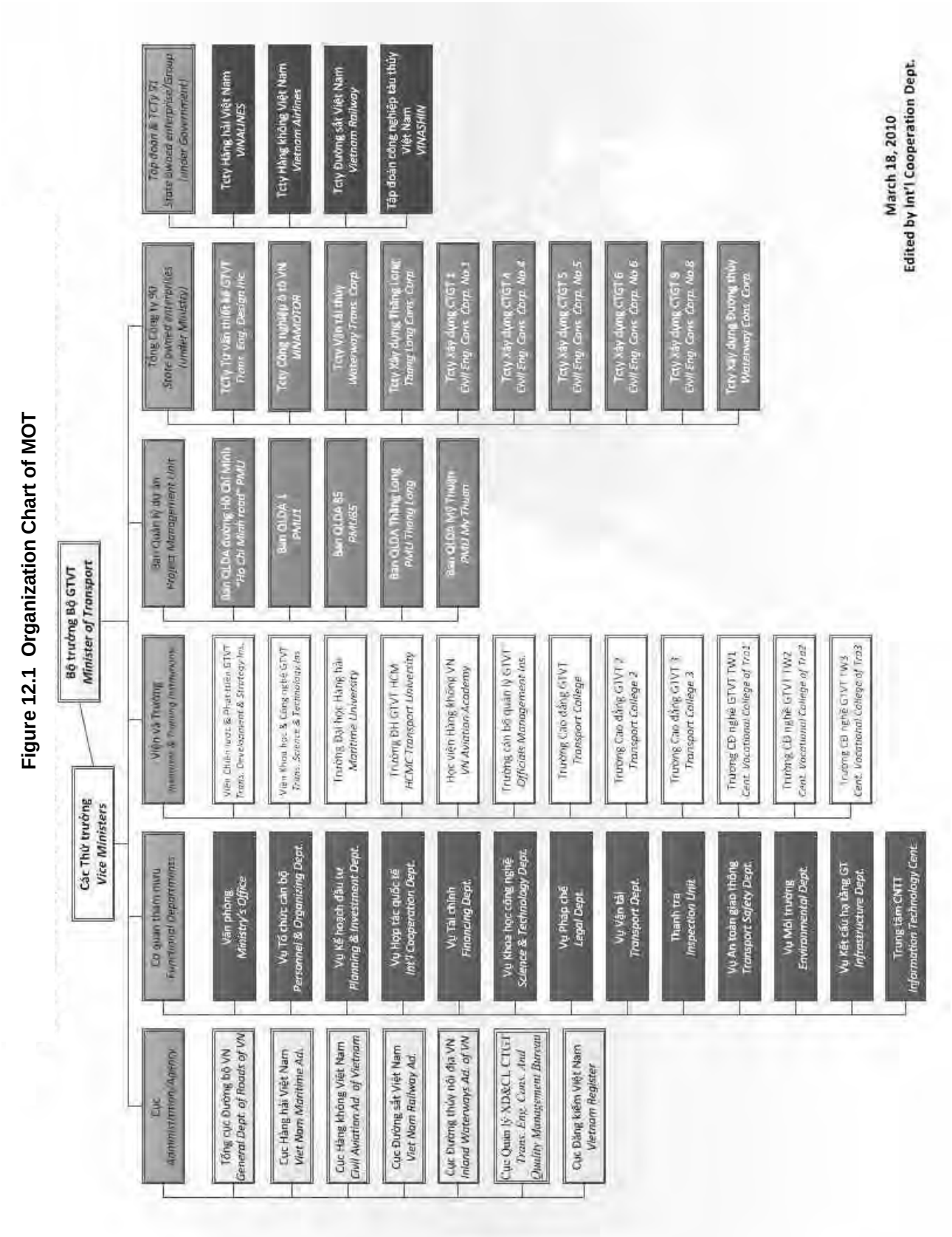
- Department of Transport Infrastructure
- Department of Planning & Investment

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



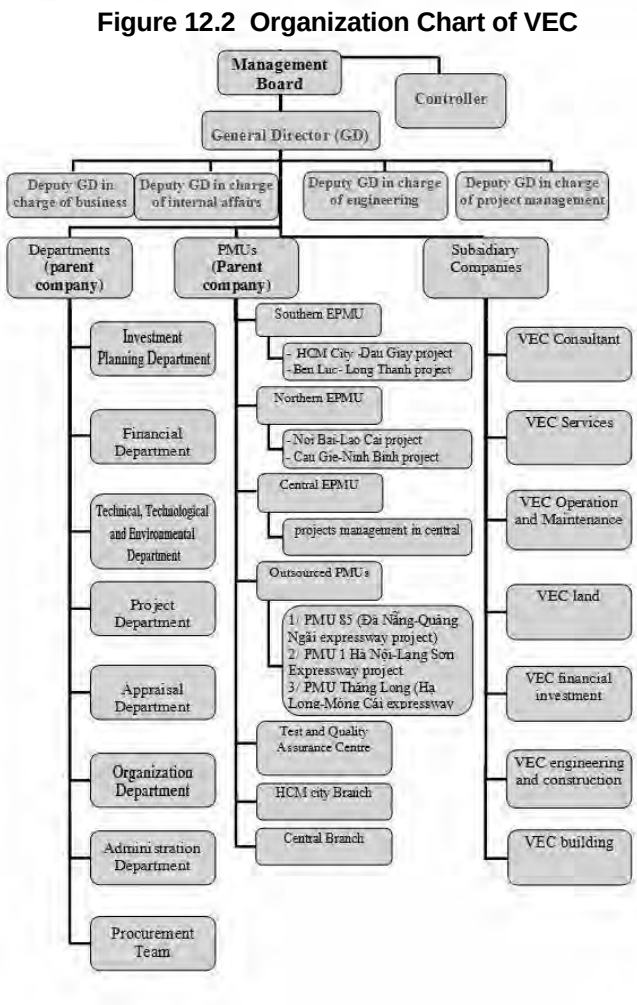
(2) VEC (Vietnamese Expressway Corporation)

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.

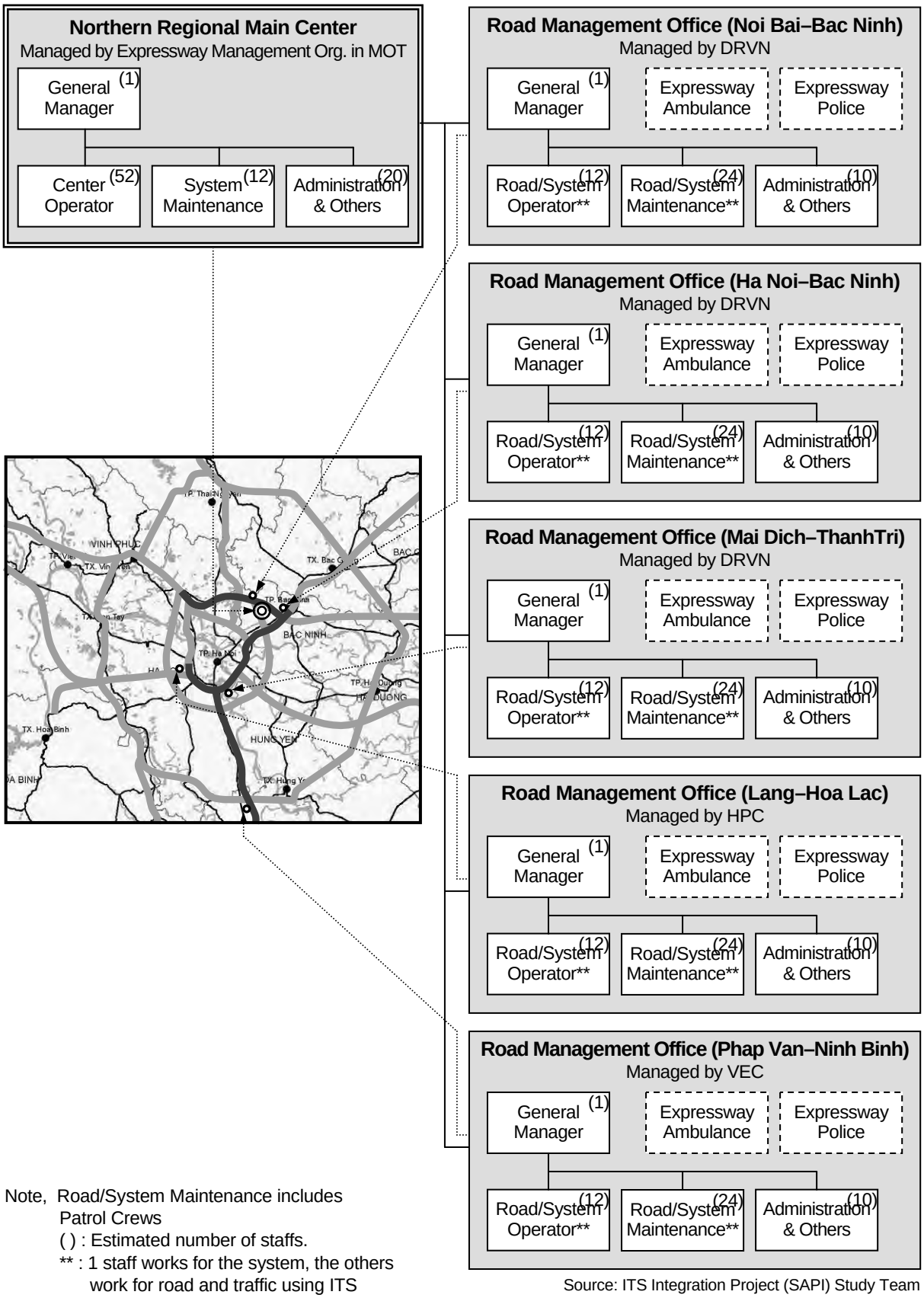
Each road management office is owned and managed by the road owner and comprises the units of system operators, Road/system maintenance, under the General Manager. The expressway sections in the Project Area are operated respectively by the Road Owners as shown below.

- 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

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

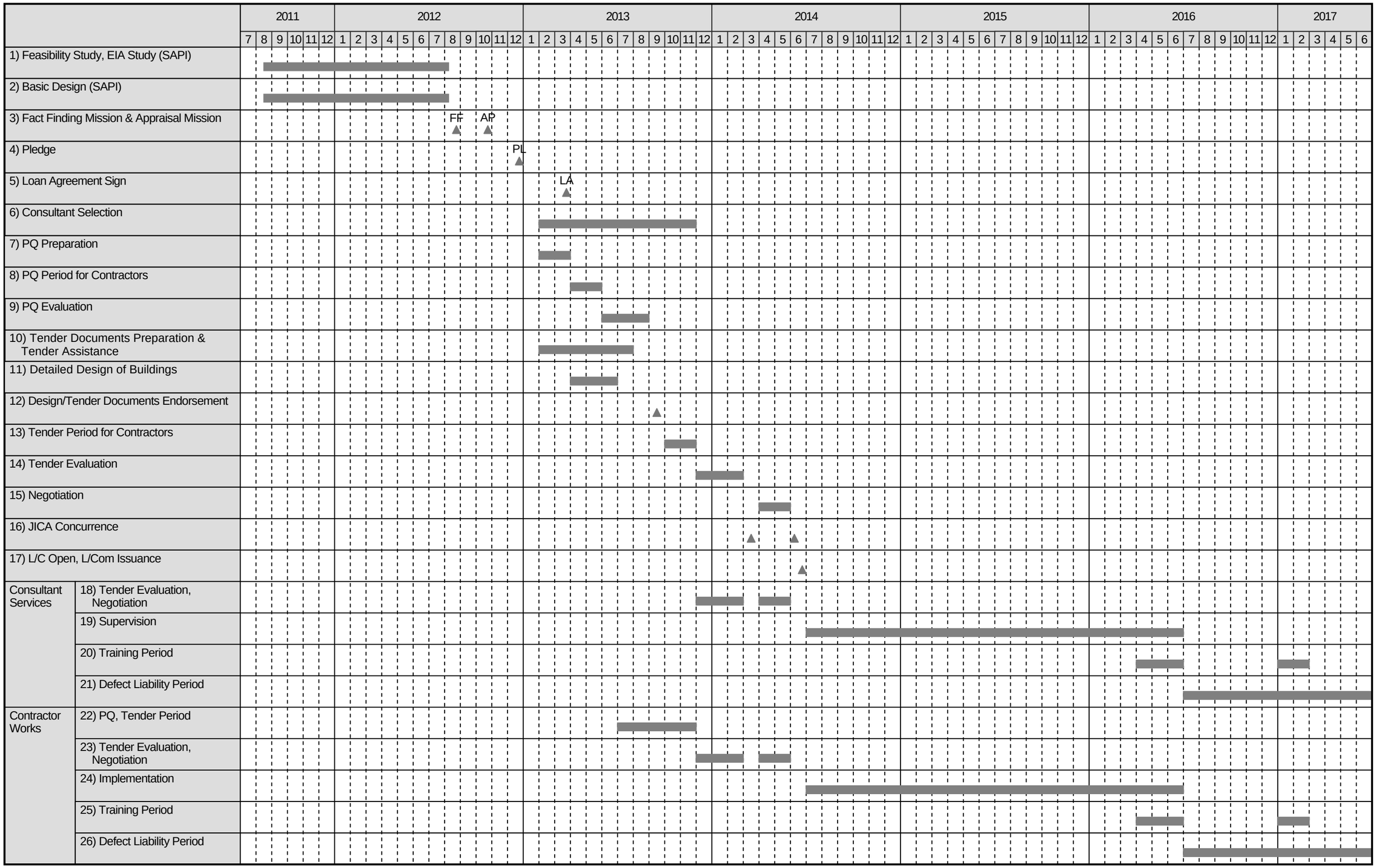
Additionally, the items below are to be completed in advance of the project implementation.

- 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)	Invest	Loan Repay	Interest Pay	O/M Costs for ITS	Replace Cost of Equipment	(Total)	
	(Disbursed)	(IDC)	(C.C.)	(Total Disbursed)	Equity	Required Fund after Operation	(Total)	(Million Yen)						(Million Yen)	
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**

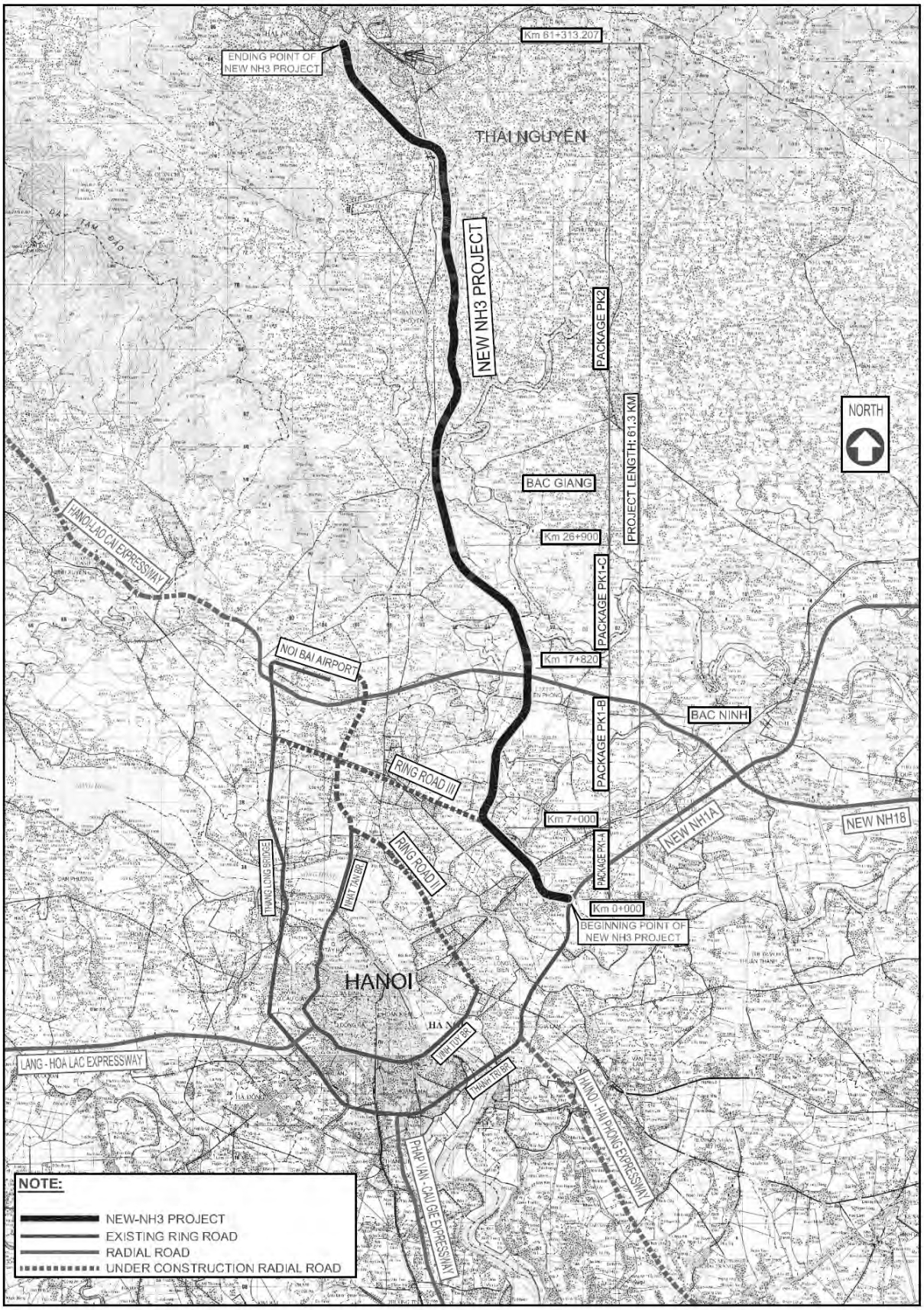
Table 13.1 Traffic Demand Forecast on NH-3 (PCU)

	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.

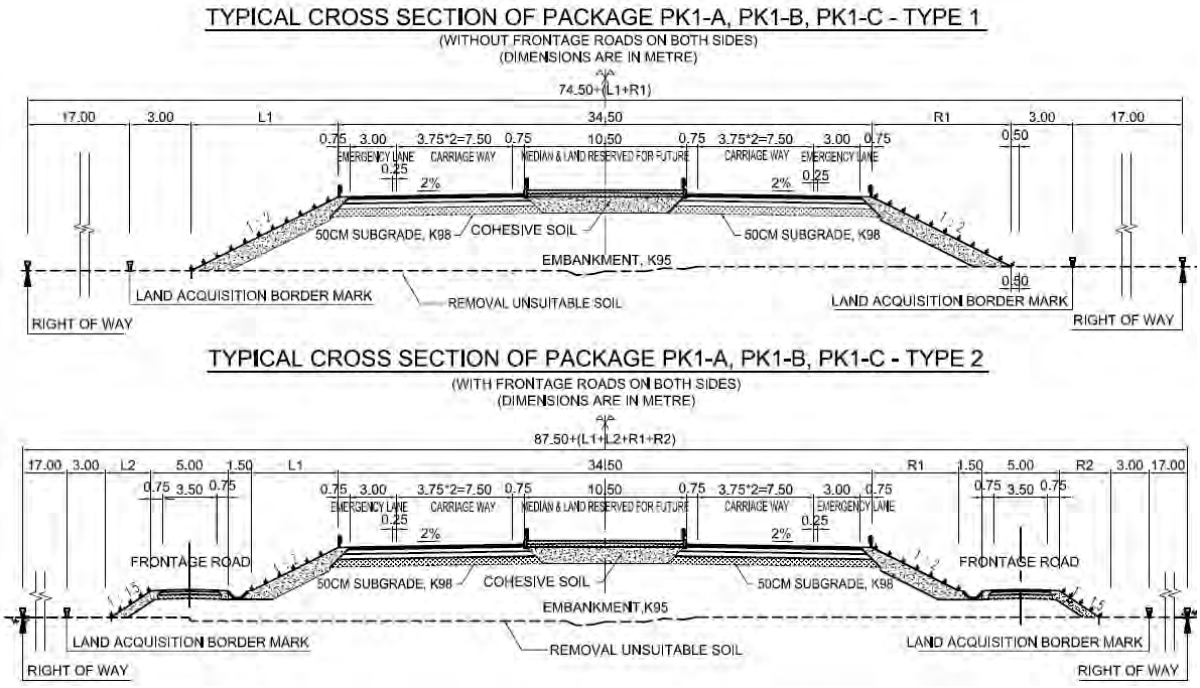
Figure 13.1 Location Map of New National Highway No.3



Source: Consultant of the New NH3 Project

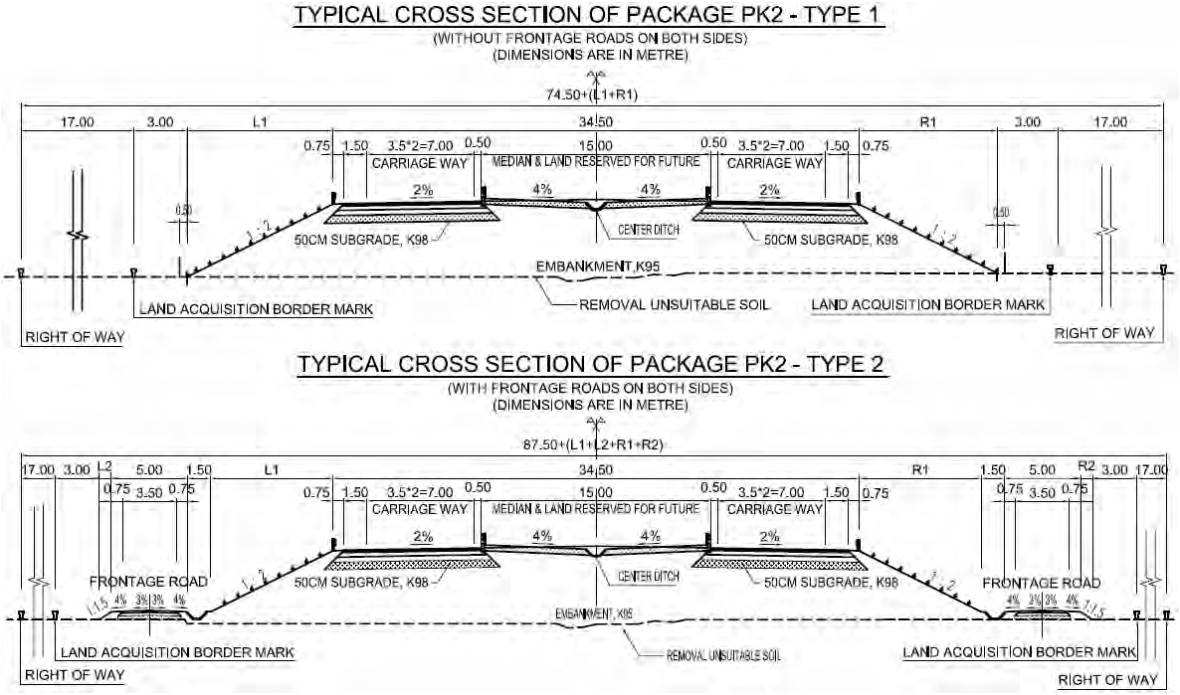
Implementing Package:	Package 1-A	Gia Lam–Dong Anh section (KM0+000–KM7+000)
	Package 1-B	Dong Anh–Yen Phone section (KM7+000–KM17+820)
	Package 1-C	Yen Phone–Soc Son section (KM17+820–KM26+900)
	Package 2	Soc Son–Thai Nguyen section (KM26+900–KM61+313.21)
	Package 3-A	Toll Plaza, Operation Office, Michi 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

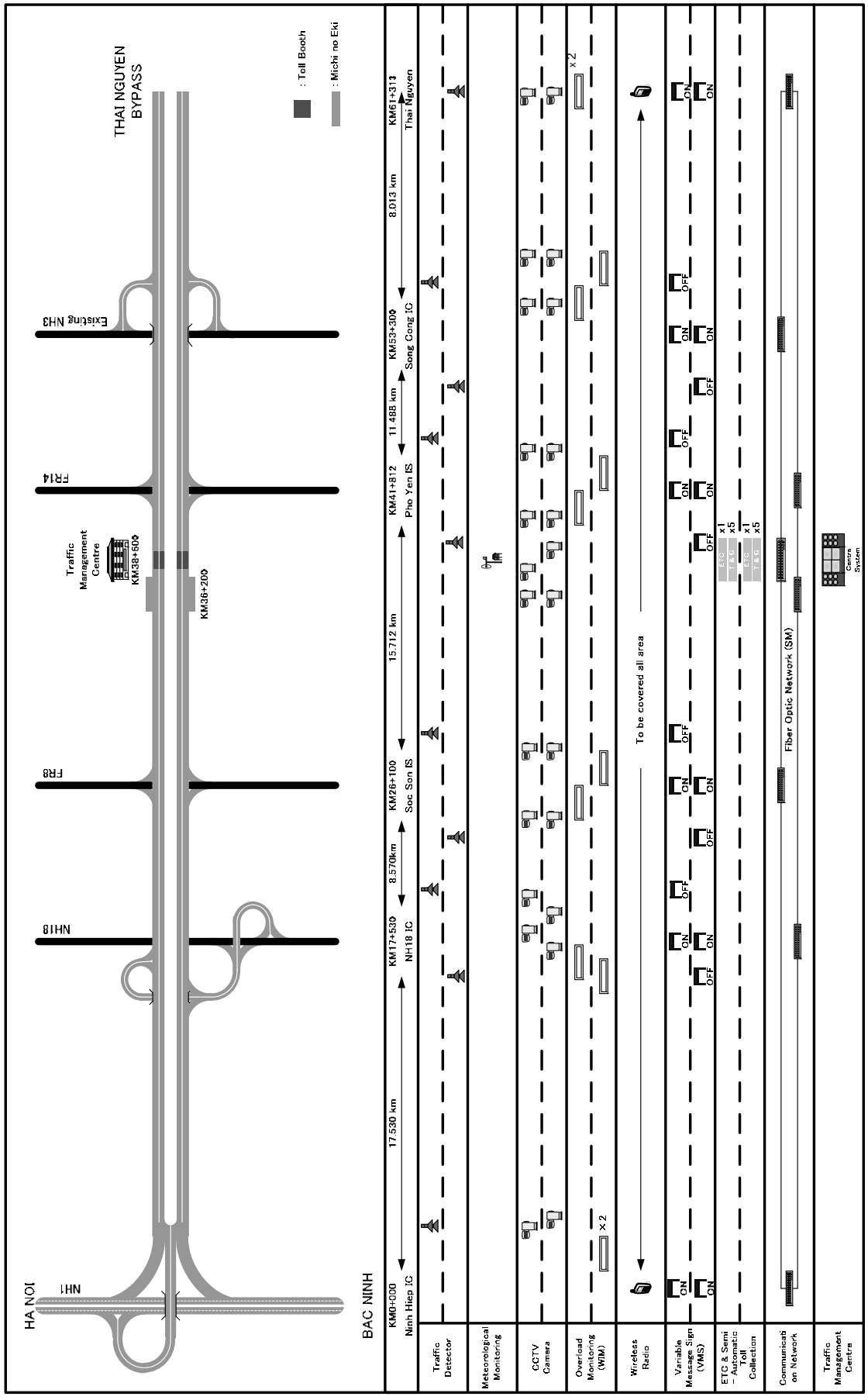
Present ITS Plan: See **Table 13.2** and **Figure 13.4**

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

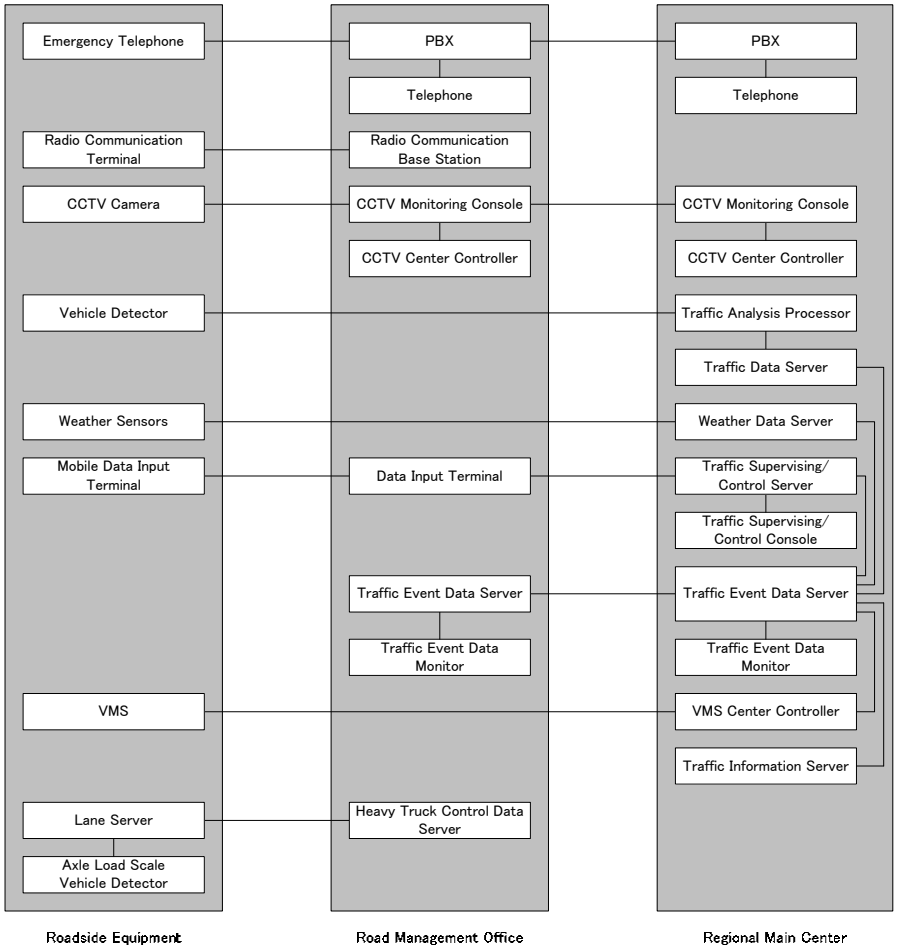
The JICA draft ITS Standard sets up five (5) expressway operational frameworks for the traffic control and management using ITS, that is, “Incident Notification”, “Road/Traffic Monitoring”, “Traffic Event Data Management”, “Traffic Information Dissemination” and “Heavy Truck Control”, and defines the 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.

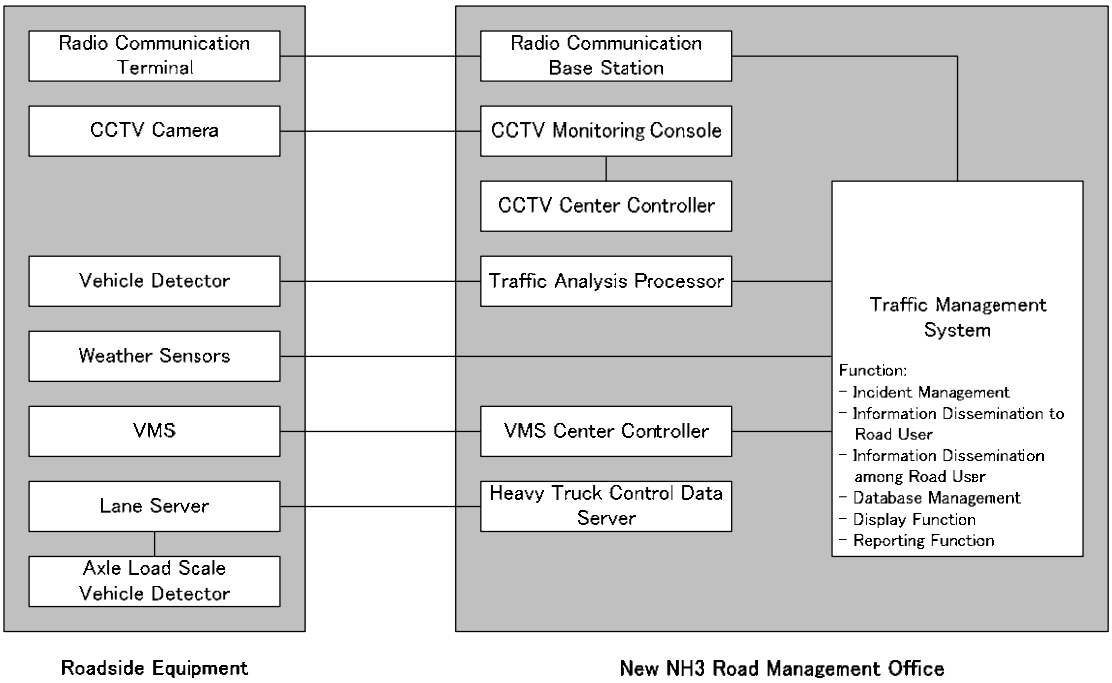
- Incident Notification
- Road/Traffic Monitoring
- Traffic Event Data Management
- Traffic Information Dissemination
- Heavy Truck Control

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

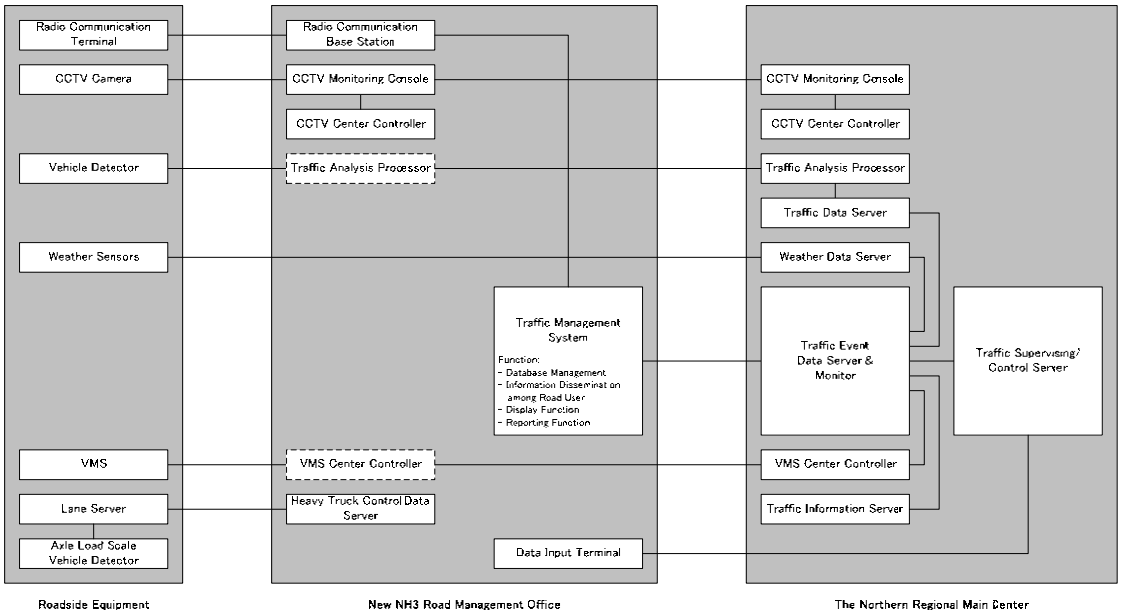
Coverage of the system

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.

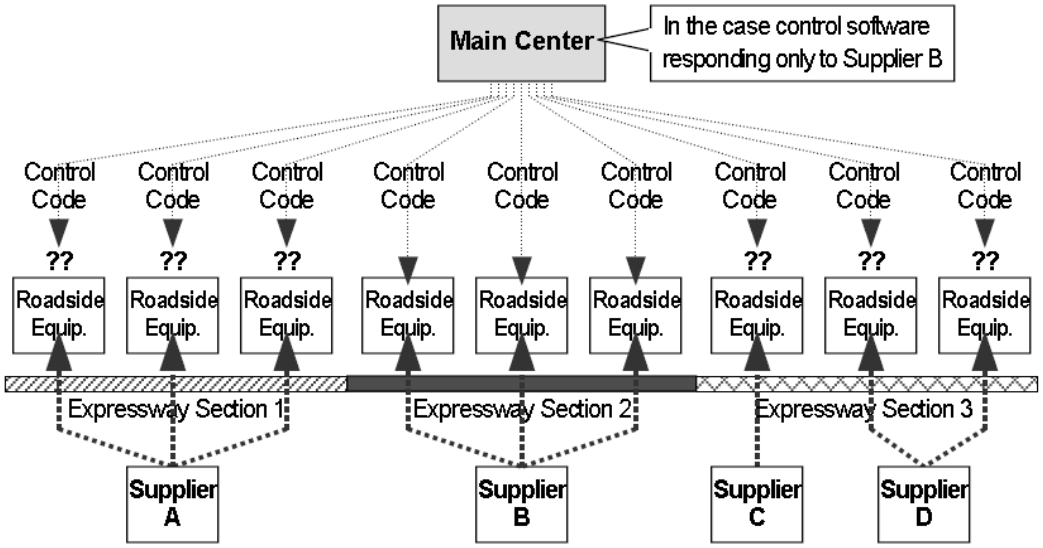
4) Considerations on Future Expandability and Compatibility with the Northern Regional Main Center

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



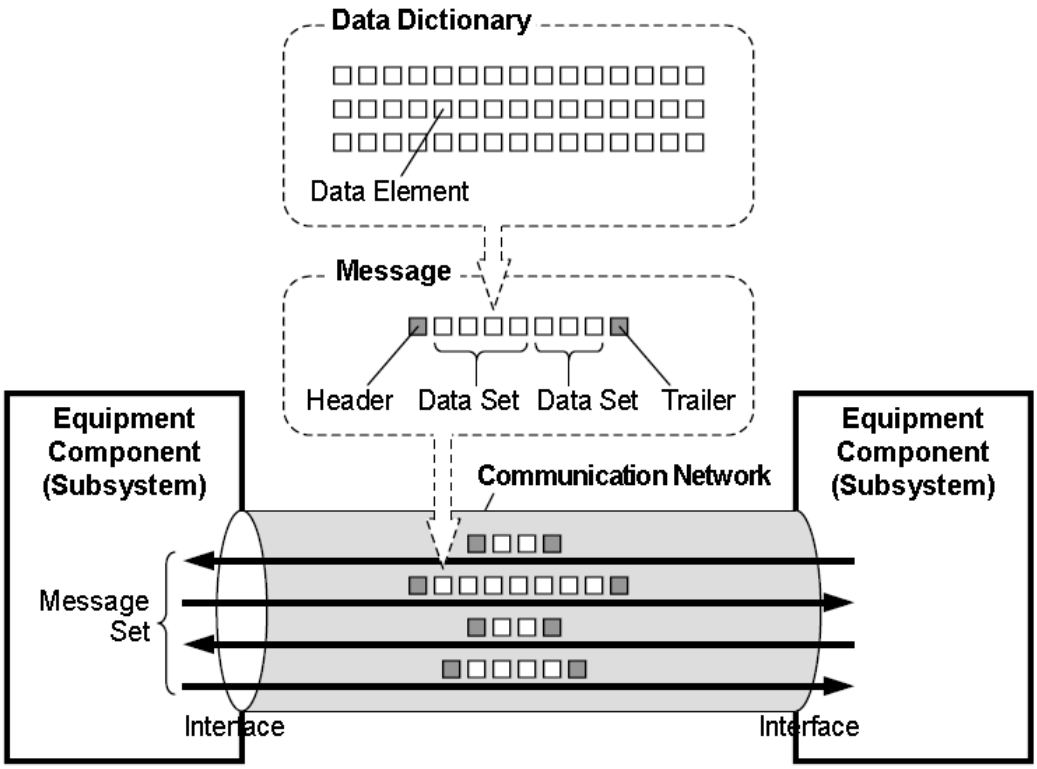
Source: ITS Standards & Operation Plan Study Team

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.

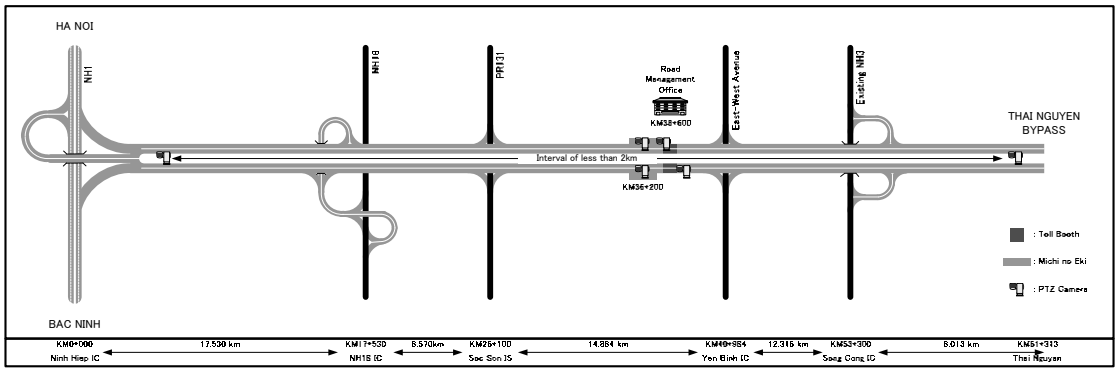
Table 13.5 Proposed CCTV Camera Location

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.

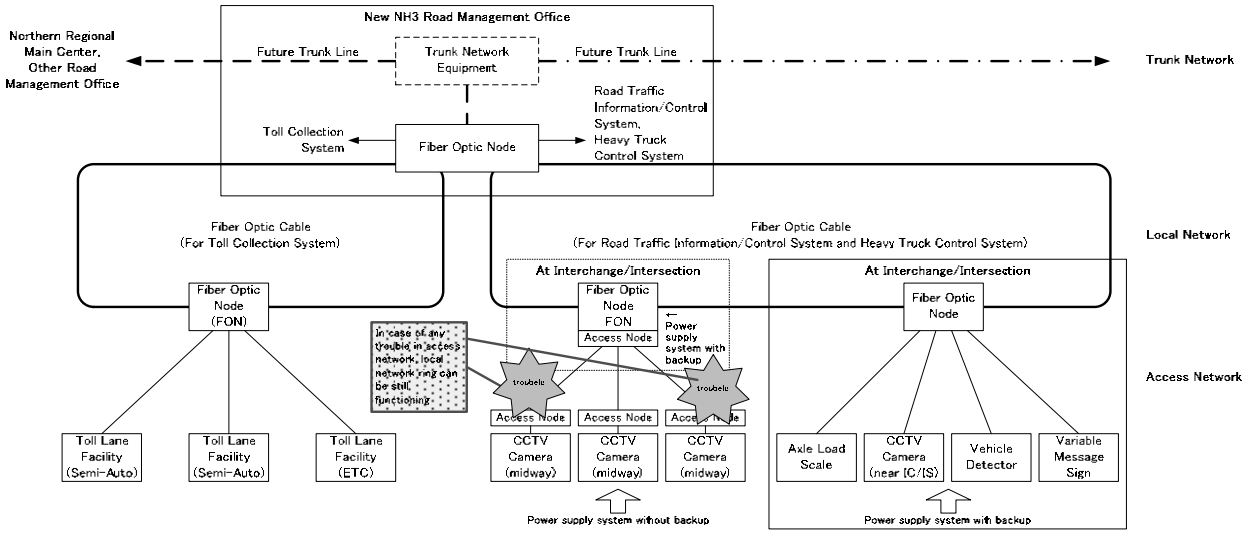
Table 13.6 Comparison of Power Supply System to CCTV Camera

Items \ Alternatives	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;

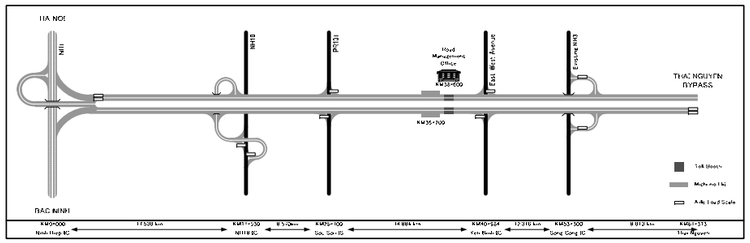
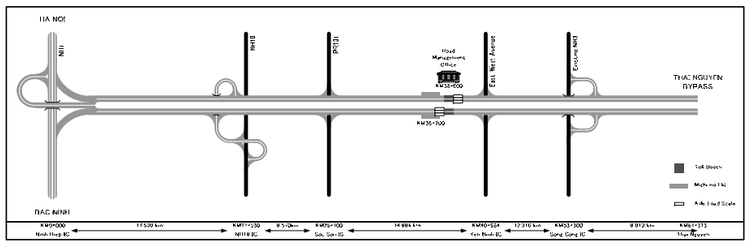
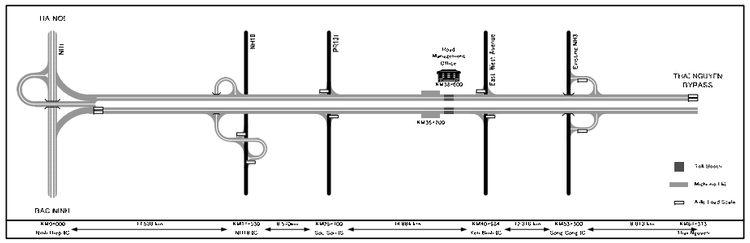
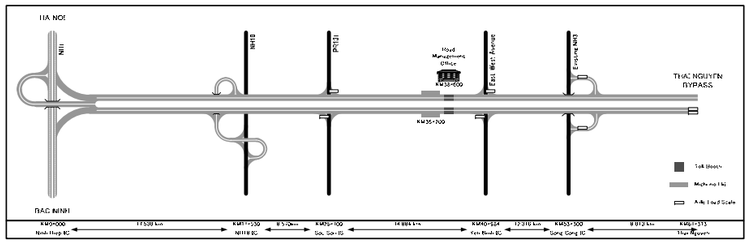
- Keeping measuring accuracy, such as
  - Tire passing track: all tires must be passing within the lane during vehicle photo taking time
  - Driving speed of vehicle: Maximum 40 km
  - Angle between lane direction and vehicle driving direction: within 5 degree
  - Angles of license-plate number fixing 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

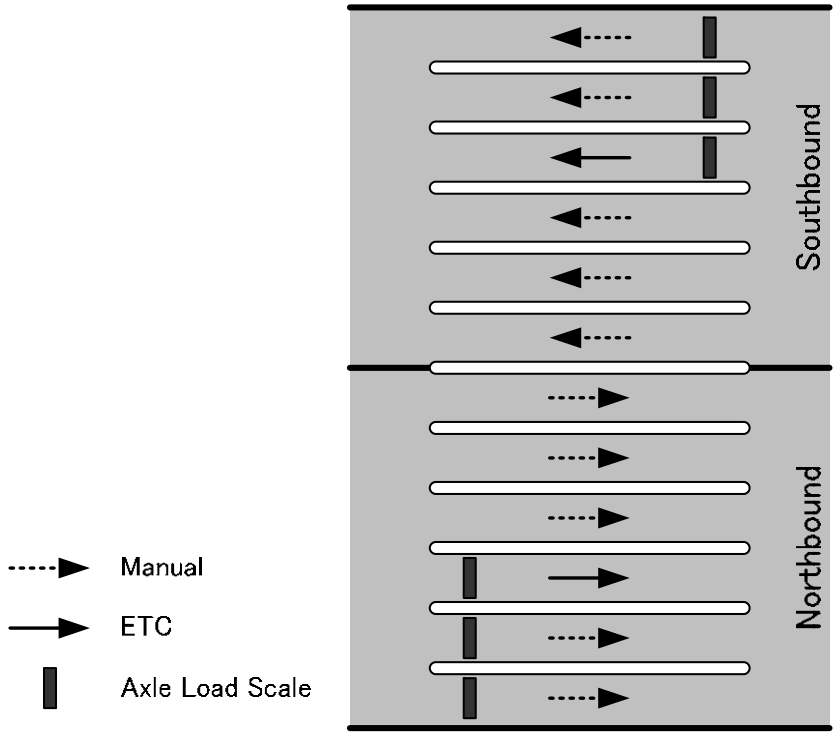
Source: ITS Integration Project (SAPI) Study Team

(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	

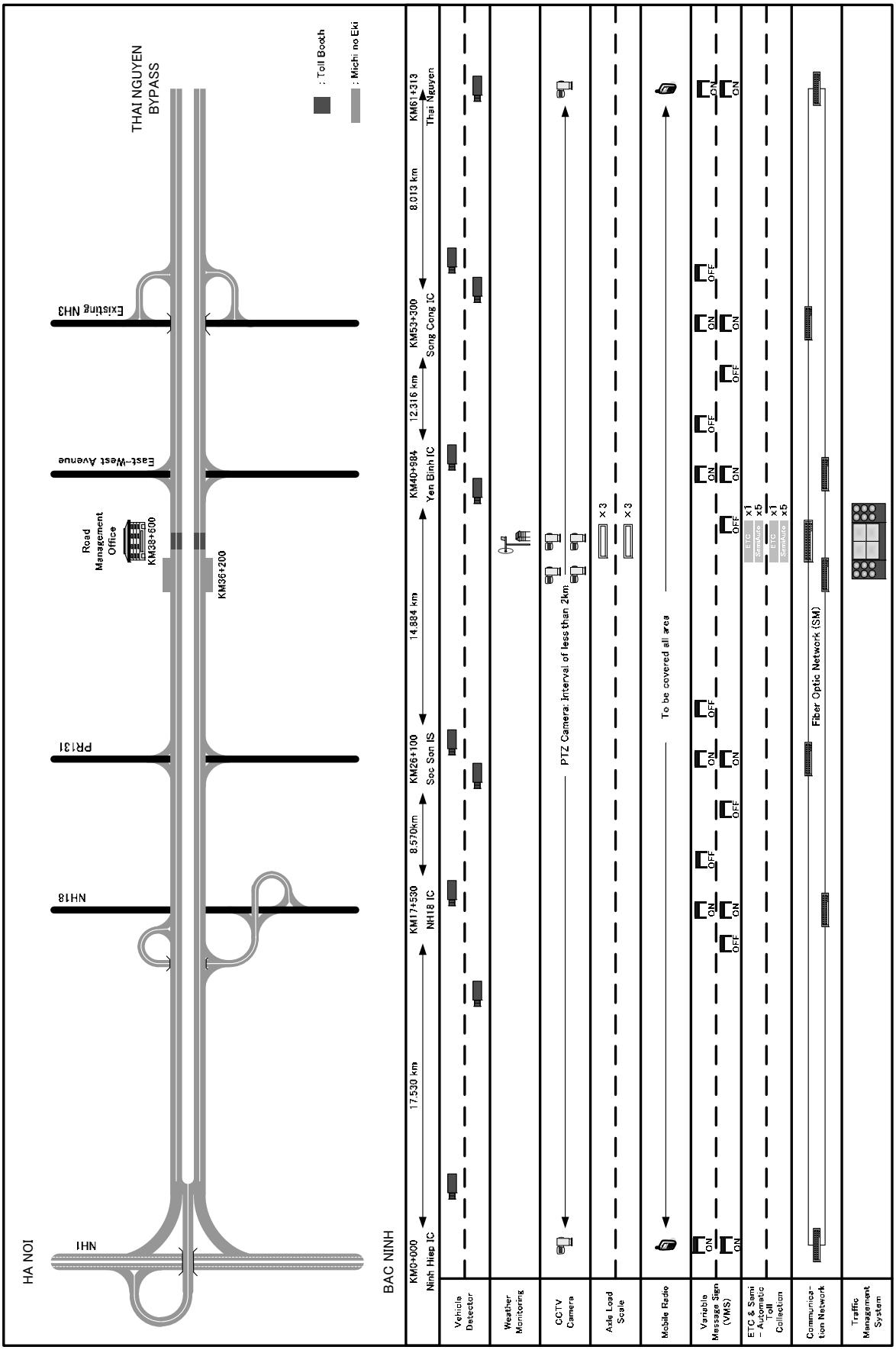
Source: Consultant of the New NH3 Project

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	2009		2010												2011												2012												2013												2014							
		11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
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																																																									

Approval of Basic Plan by MOT
Approval of P/Q Doc.
Approval of Bidding Doc.
Submission of P/Q Doc. by applicants
Approval of P/Q Evaluation
Bid Open
Approval of Bid Evaluation
Approval of Contract
Final Report of JICA draft ITS Standard
Intersim Report (Revised NH3 ITS Basic Plan) of JICA SAPI Project

B. Consultant Manning Schedule (ITS)

No	Position	2009		2010												2011												2012												2013												2014								M/M
		11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	
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.

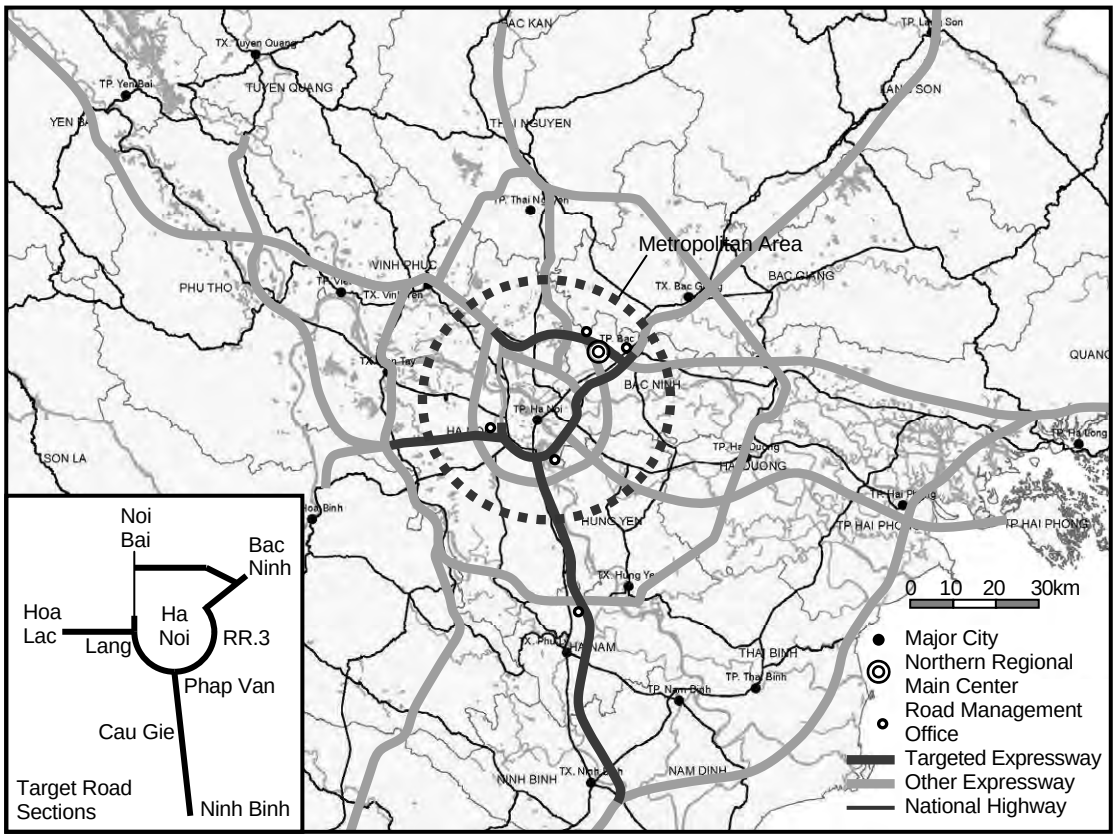
(10) The following legal systems are to be prepared:

- 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

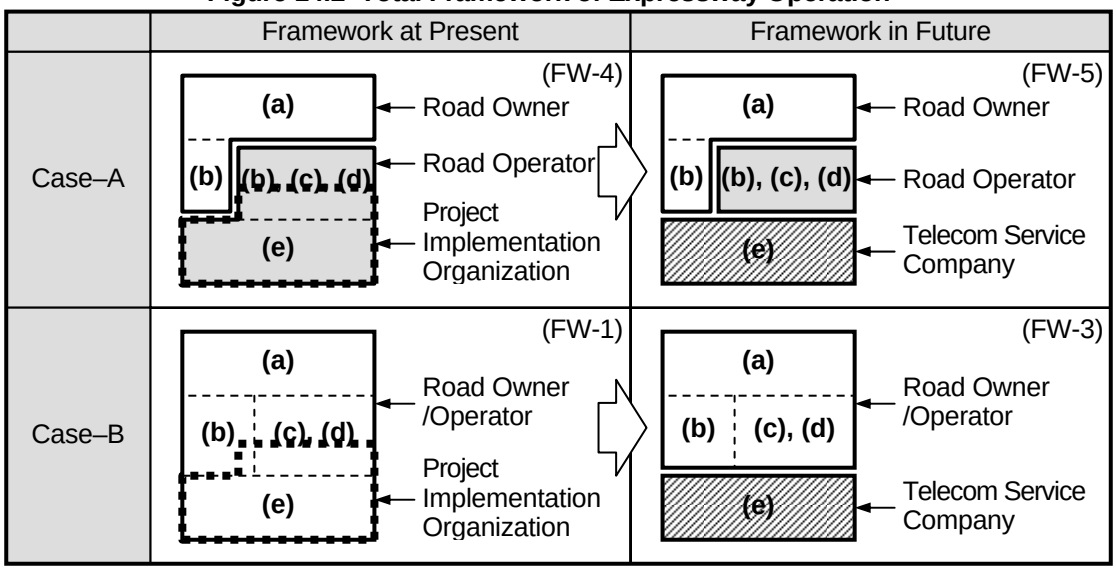
Note, ⬚ : Project implementation organization, which is necessary for implementing the Project covering the sections owned by the organization other than VEC, ** : See Figure 14.2 the

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.

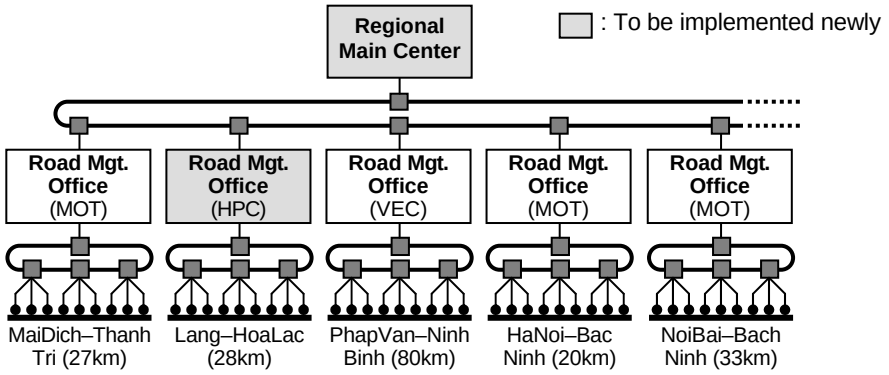
14.3 A Single Hierarchical Structure

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



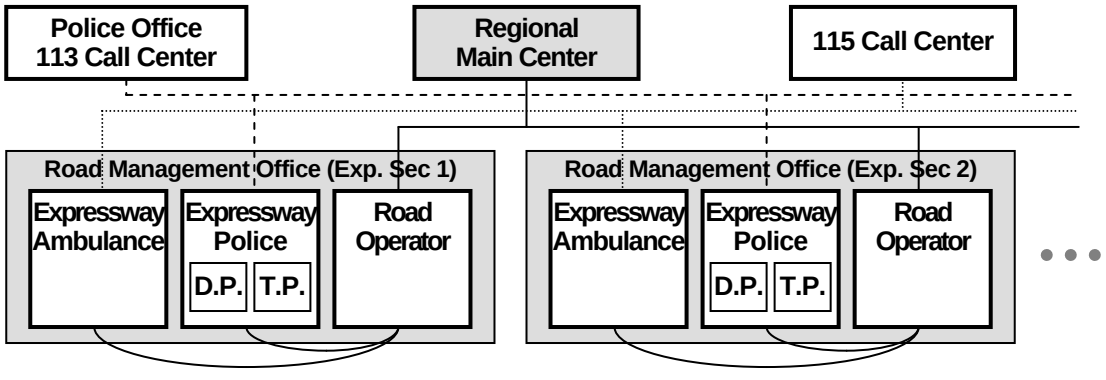
Source: ITS Integration Project (SAPI) Study Team

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



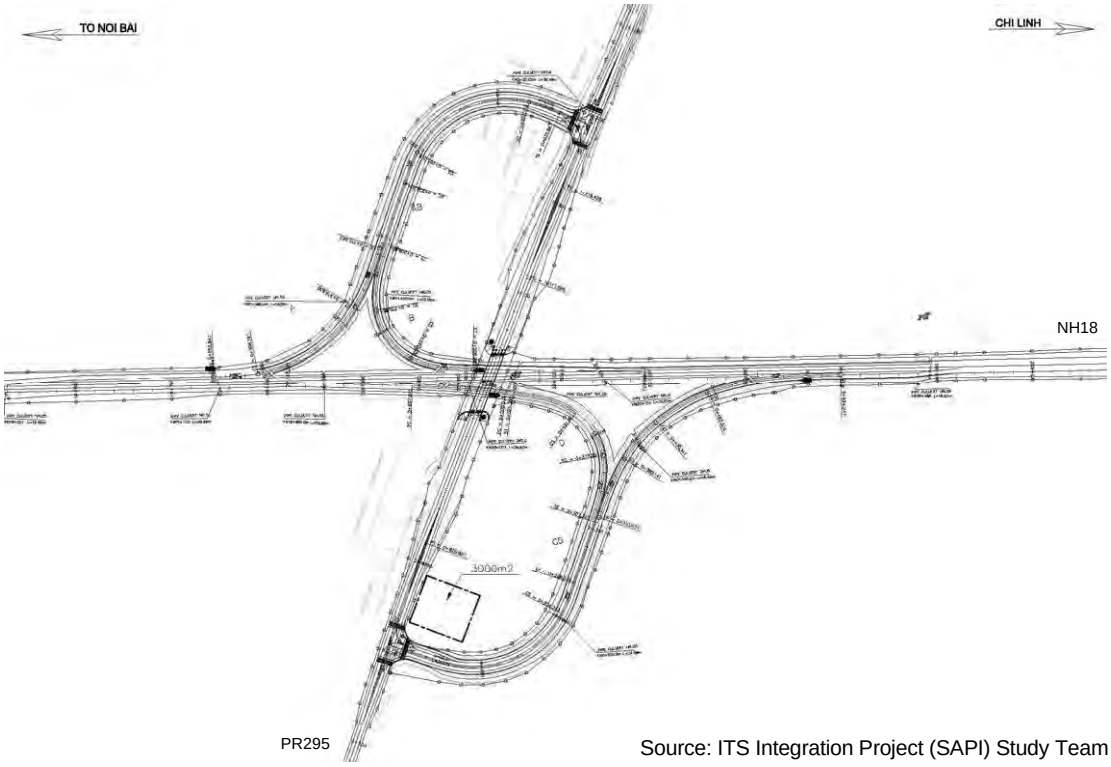
Source: ITS Integration Project (SAPI) Study Team

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



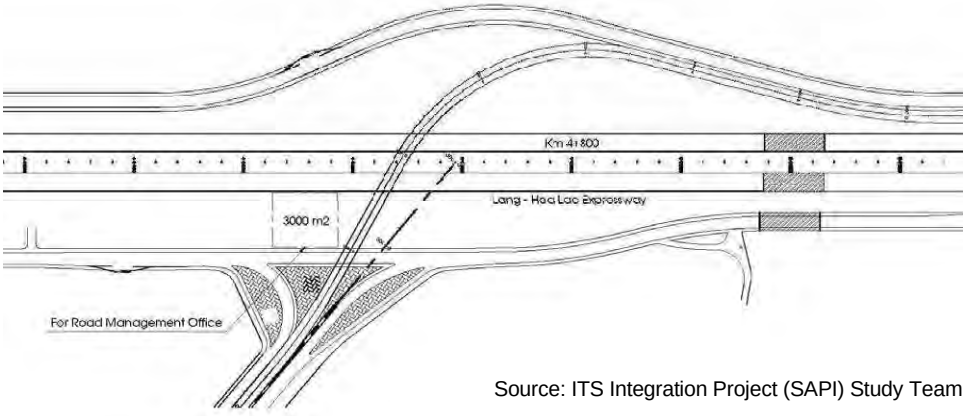
Source: ITS Integration Project (SAPI) Study Team

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

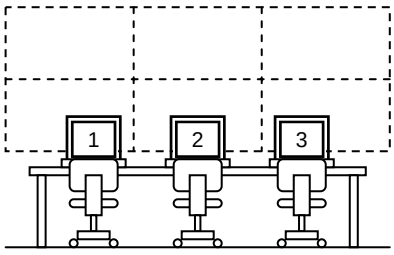
Required Condition:

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

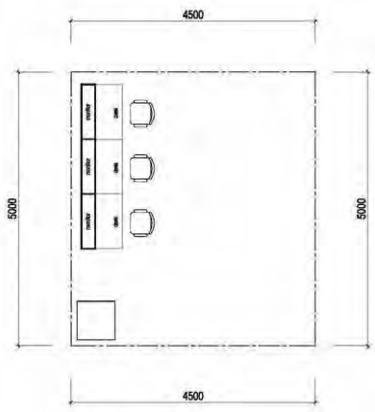
The space 22.5 m^2 for ITS operation is to be secured in all road management offices below.

- 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.

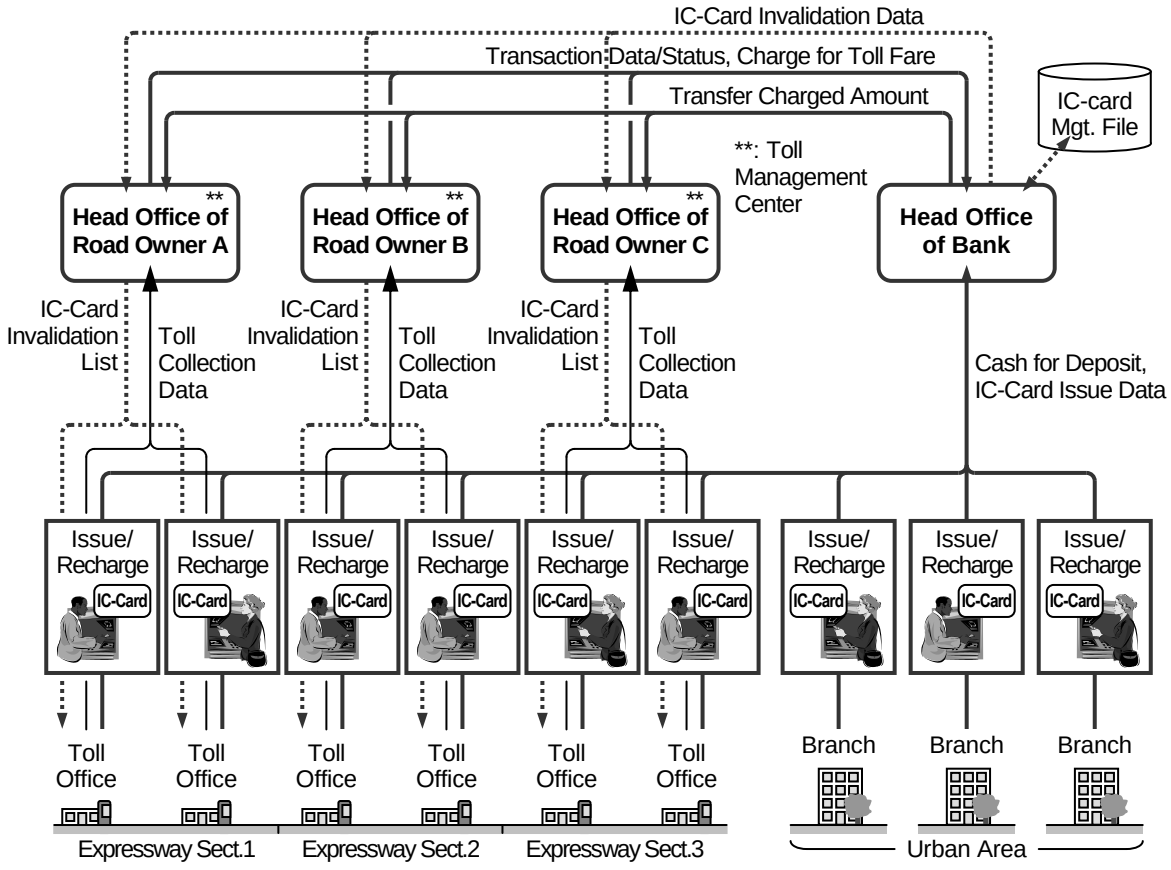
(1) Roles of Road Owner

- 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.

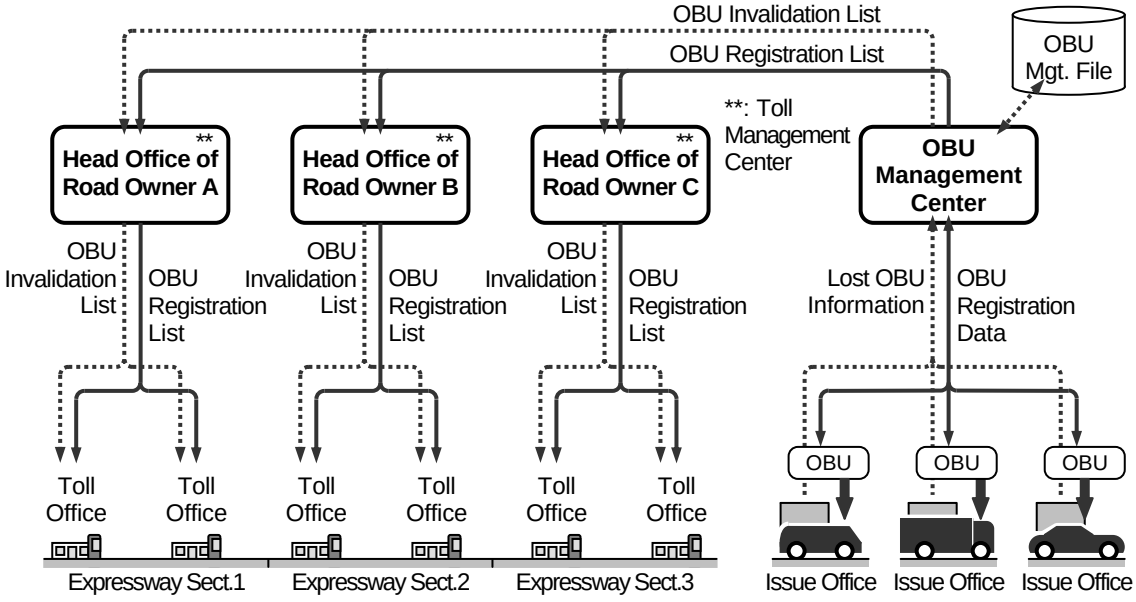
(2) Roles of Road Owner

- 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

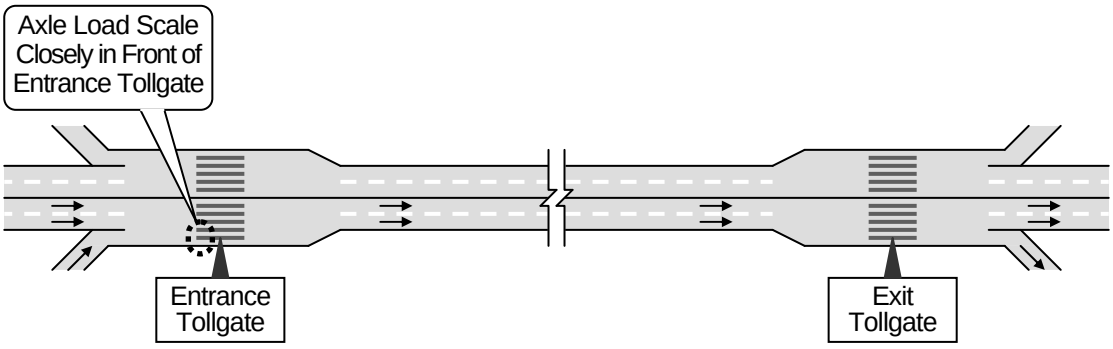
(1) Axle load scales are to be installed in front of the entrance tollgate.

(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: 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.

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) 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.

(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.

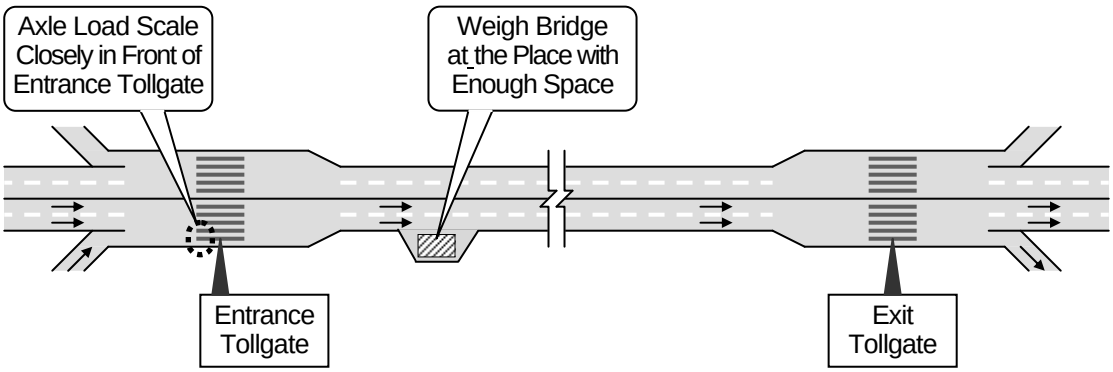
(3) A ticket for indicating measured weight is to be handed to the driver of the truck beyond the limit of measured weight, and the driver is required to go to the place of weighbridge

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 ignore payment of penalty (or toll).

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

Required Condition:

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