8. Location of Northern Regional Main Center and Offices

8.1 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.

8.2 Criteria for Eveluating Sites of Northern Regional Main Center and Offices

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.

8.3 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.

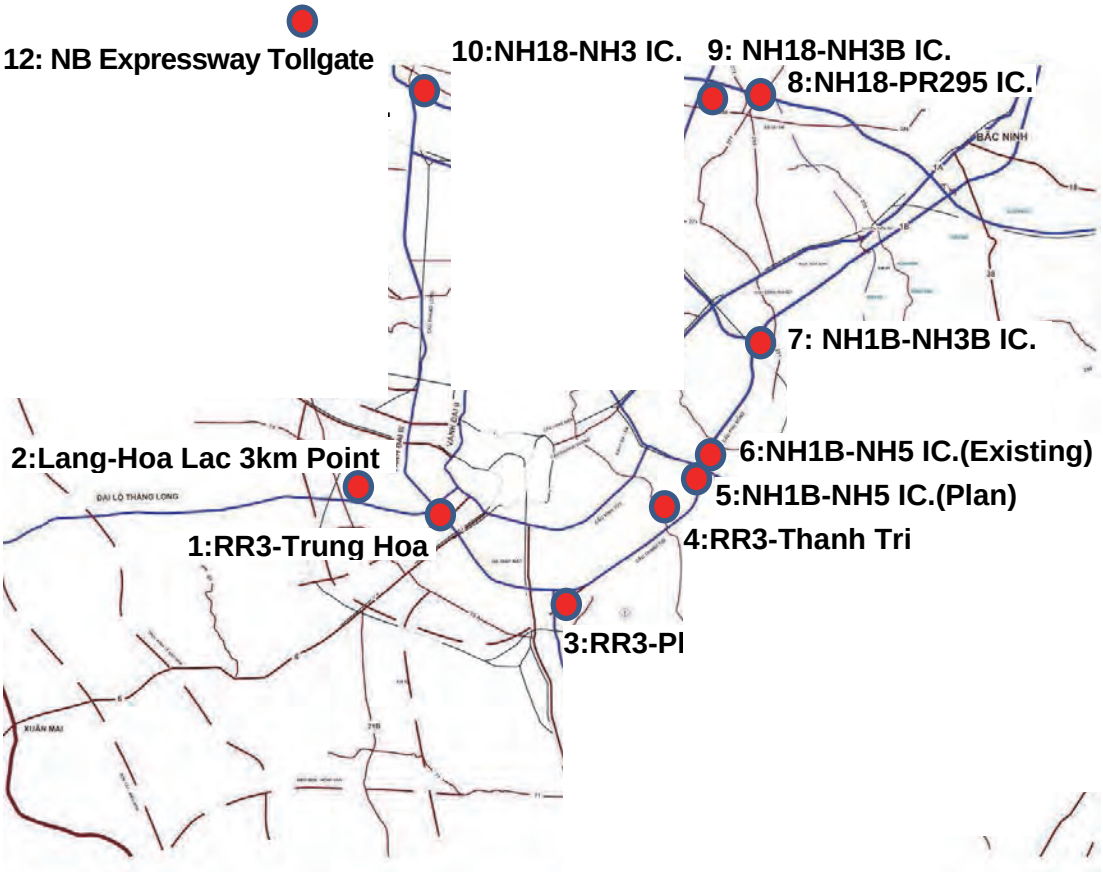
Basically all of twelve (12) candidate sites have consistency with broader plans and programs or already constructed/under way of road construction projects.

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 8.1 Location Map of Candidate Sites for Northern Regional Main Center

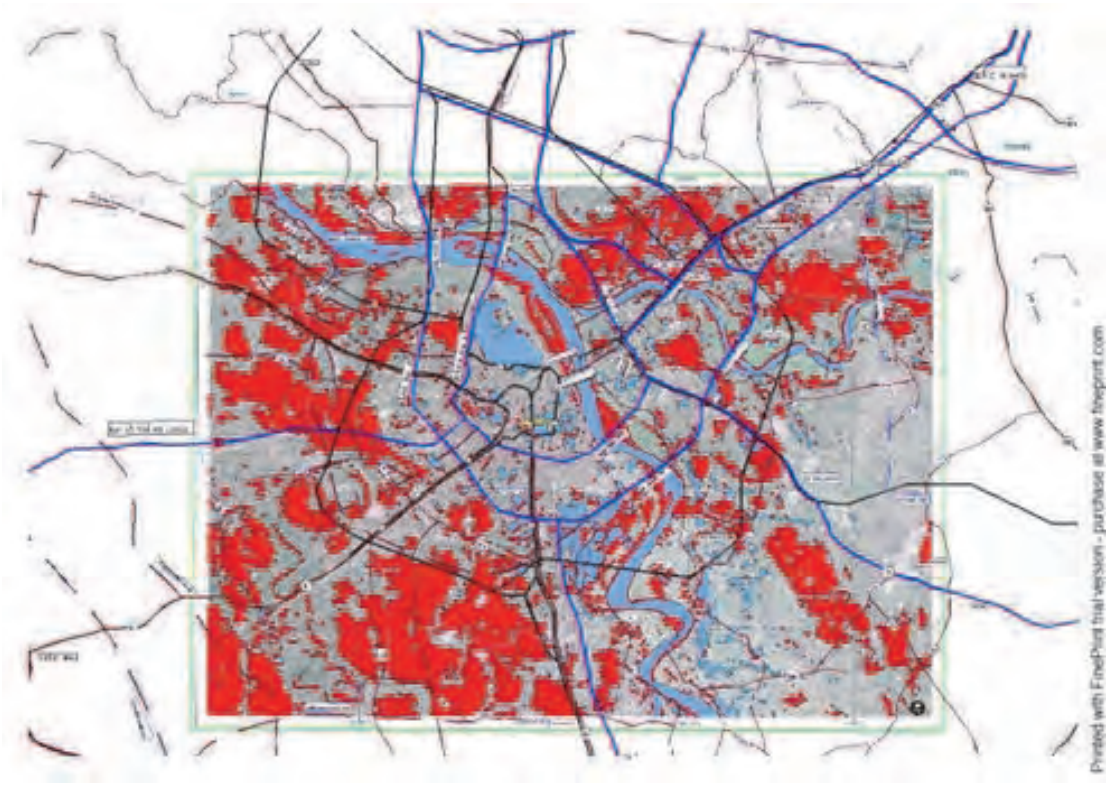


Source: ITS Integration Project (SAPI) Study Team

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 8.2 Flood Risk Area of Hanoi City



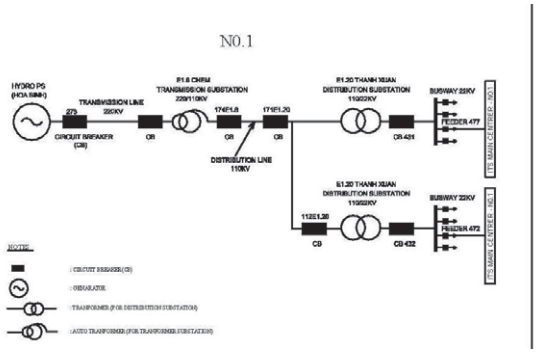
Source: ITS Integration Project (SAPI) Study Team

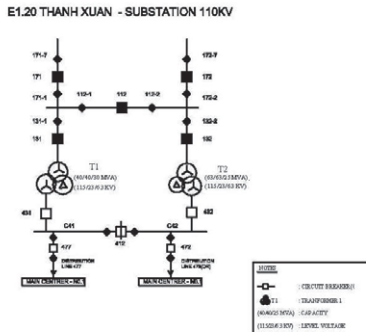
3) Power Supply Distribution to Candidate Sites

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.

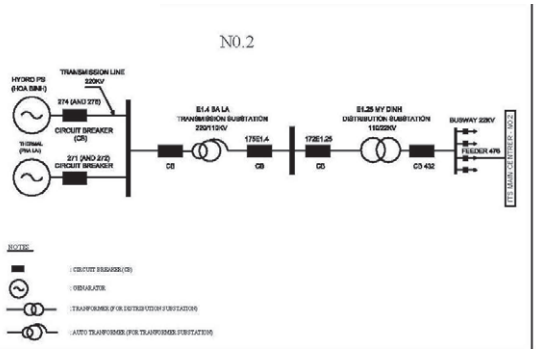
Table 8.1 Candidate Sites and Power Distribution System

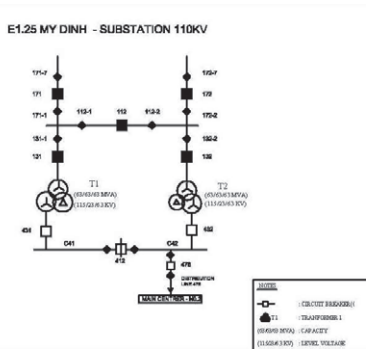
Candidate site 1: RR3–Trung Hoa



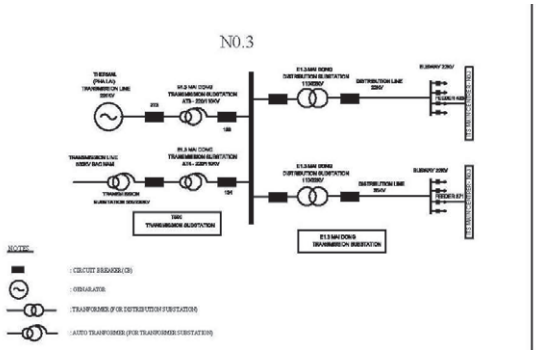


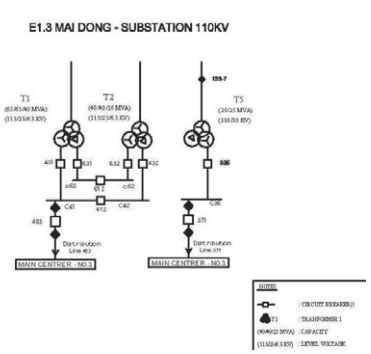
Candidate site 2: Lang–Hoa Lac 3km Point



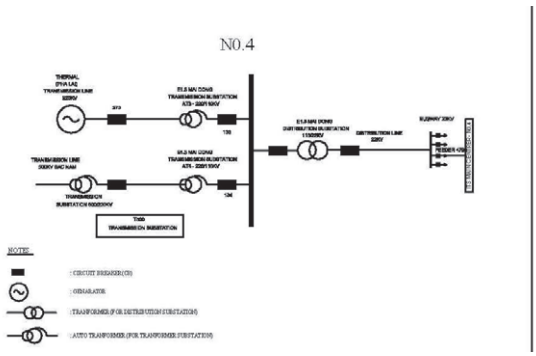


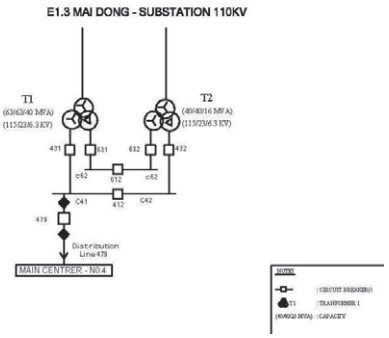
Candidate site 3: RR3–Phap Van IC



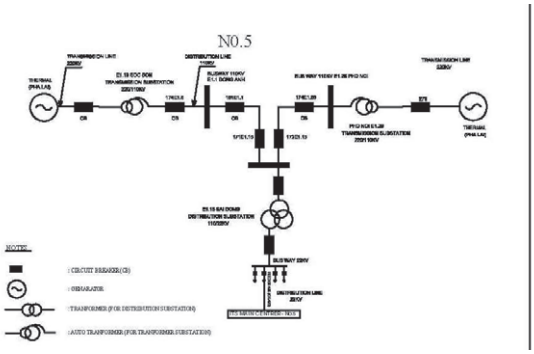


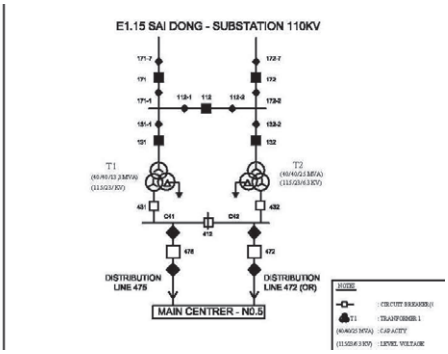
Candidate site 4: RR3 – Thanh Tri



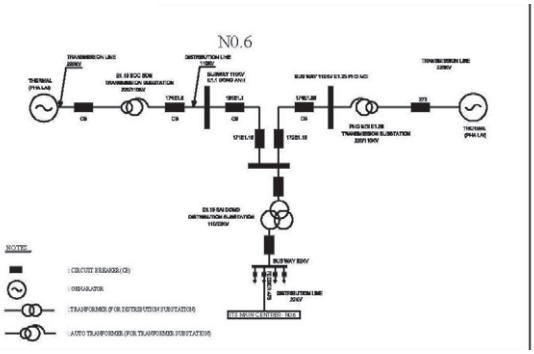


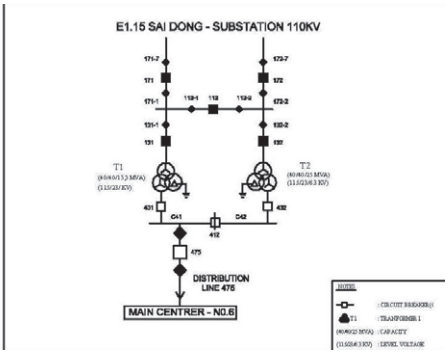
Candidate site 5: NH1B–NH5 IC. (Plan)



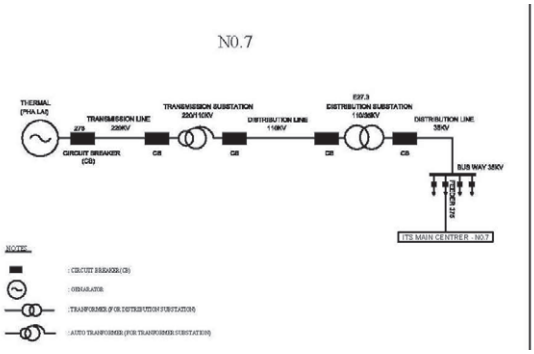


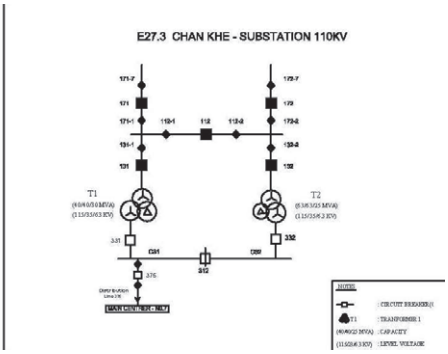
Candidate site 6: NH1B–NH5 IC. (Existing)



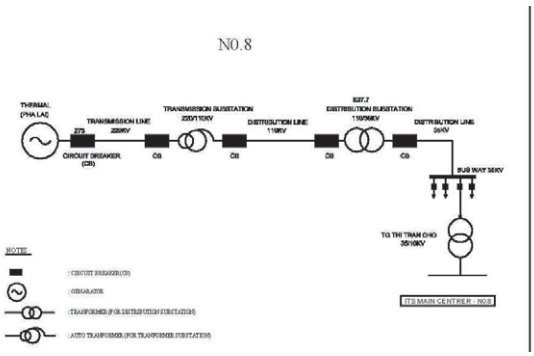


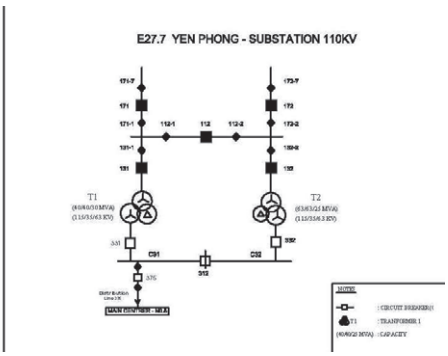
Candidate site 7: NH1B–NH3B IC



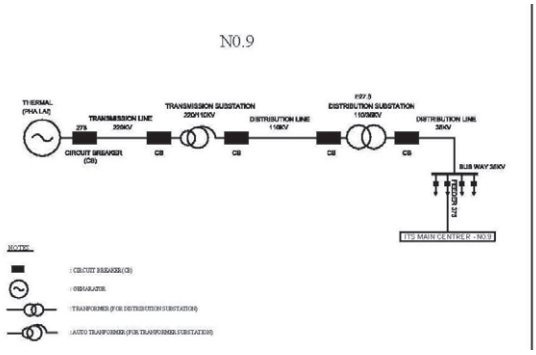


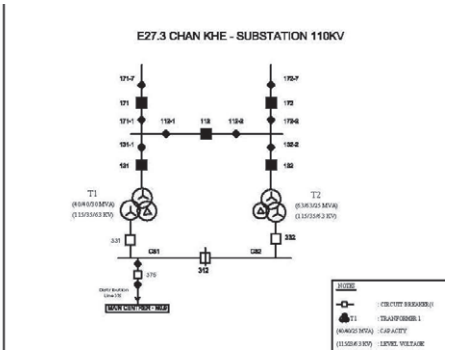
Candidate site 8: NH18–PR295 IC



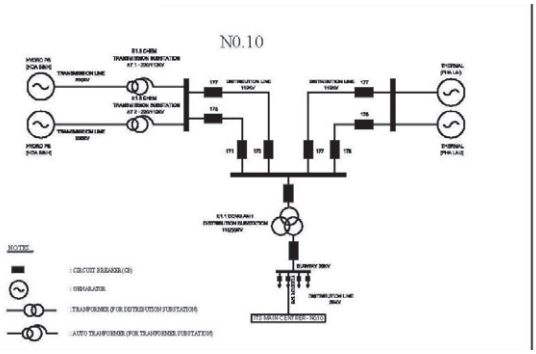


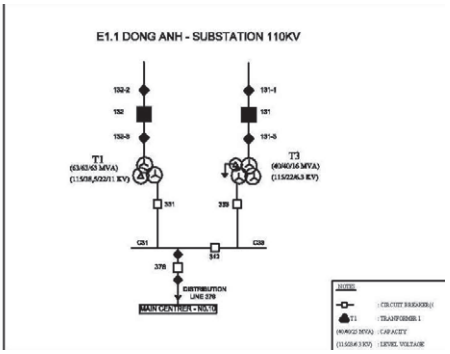
Candidate site 9: NH18–NH3B IC



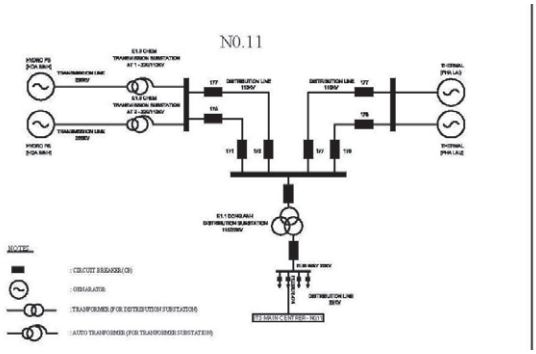


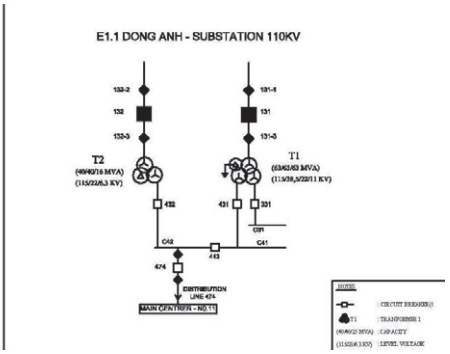
Candidate site 10: NH18–NH3 IC



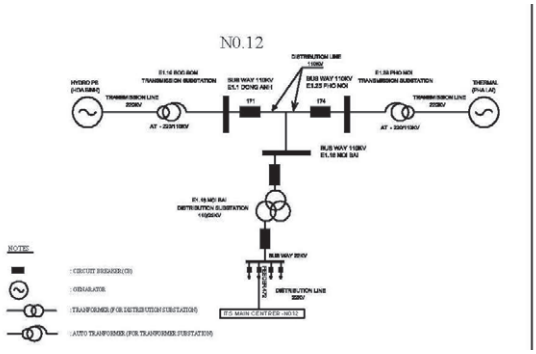


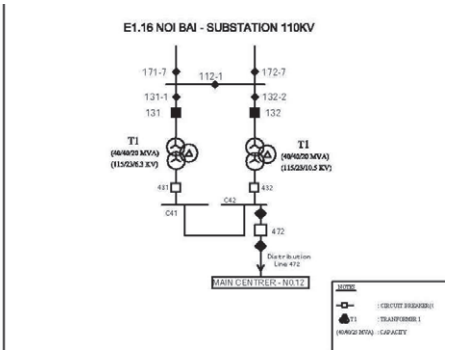
Candidate site 11: Thang Long–NH18 IC





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 8.2 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

5) 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 8.3 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. **Connectivity 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. **Connectivity 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. **Connectivity 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.

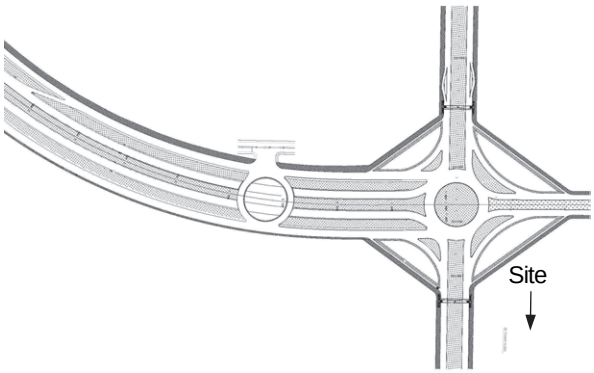
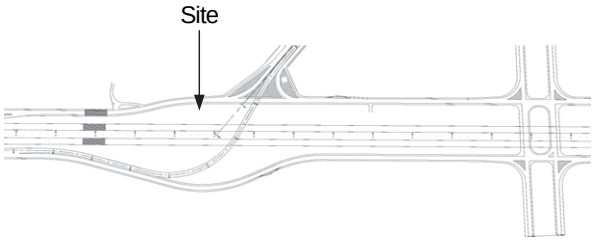
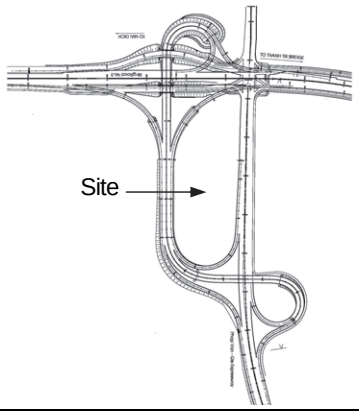
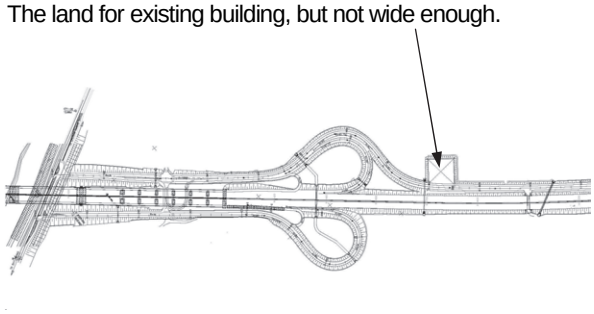
Candidate site 4: RR3 – Thanh Tri 	**Land use and land property:** Surrounding area of the proposed site is agricultural land use. The proposed site is in the vicinity of the Thanh Tri Bridge across the Red River and is the land for a building with narrow parking space managemend by PMU-TL. **Socioeconomic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

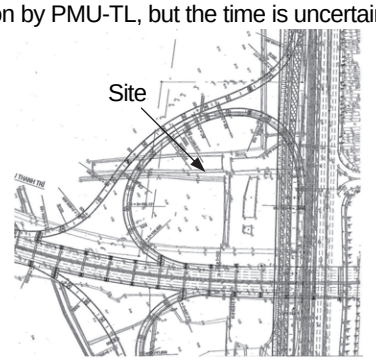
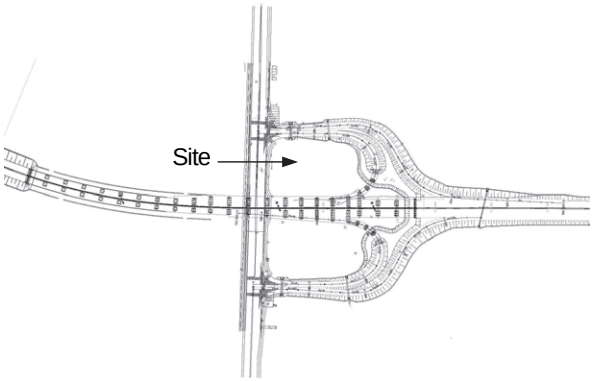
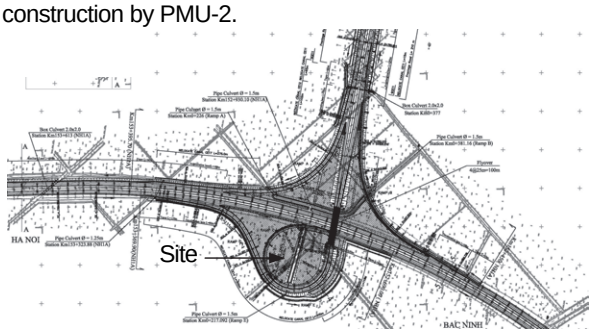
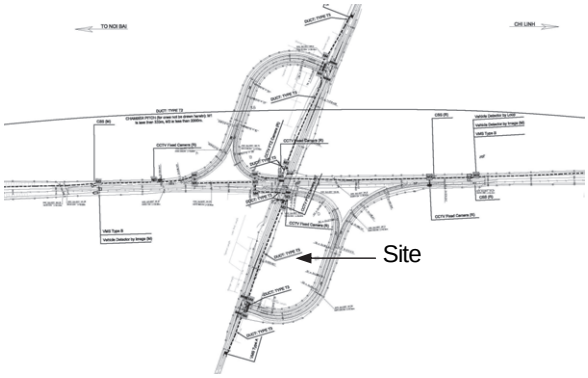
Candidate site 7: NH1B–NH3B IC. 	**Land use and land property:** The proposed area is agricultural use and ponds. Almost there is no residential area existed in surrounding. The proposed site will be within round shaped interchange access circuit. The proposed site will be owned by PNU-2 temporarily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

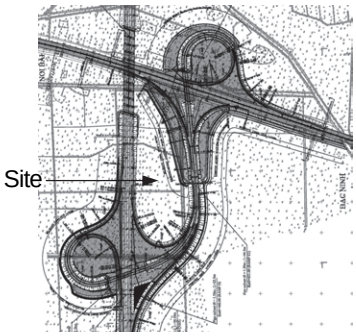
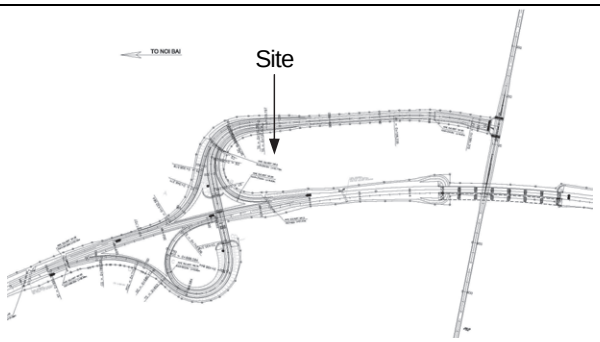
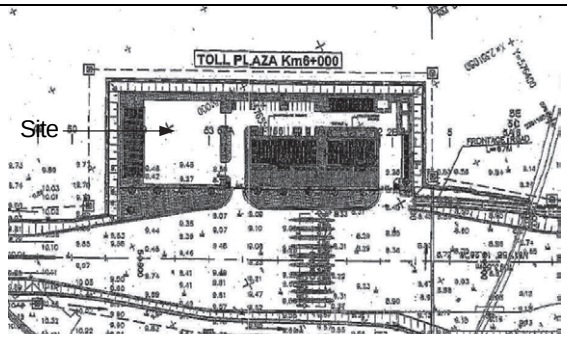
Candidate site 10: NH18–NH3 IC. 	**Land use and land property:** The proposed site and surrounding area is agricultural land use, ponds and a few residential area. The proposed site is within round shaped interchange access circuit. This area is many plots of agriculture and these landowner/stake holders 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. **Connectivity 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. **Connectivity 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. **Connectivity 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 connectivity. **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 8.4 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

8.4 Evaluation of Sites for Northern Regional Main Center

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 8.5 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

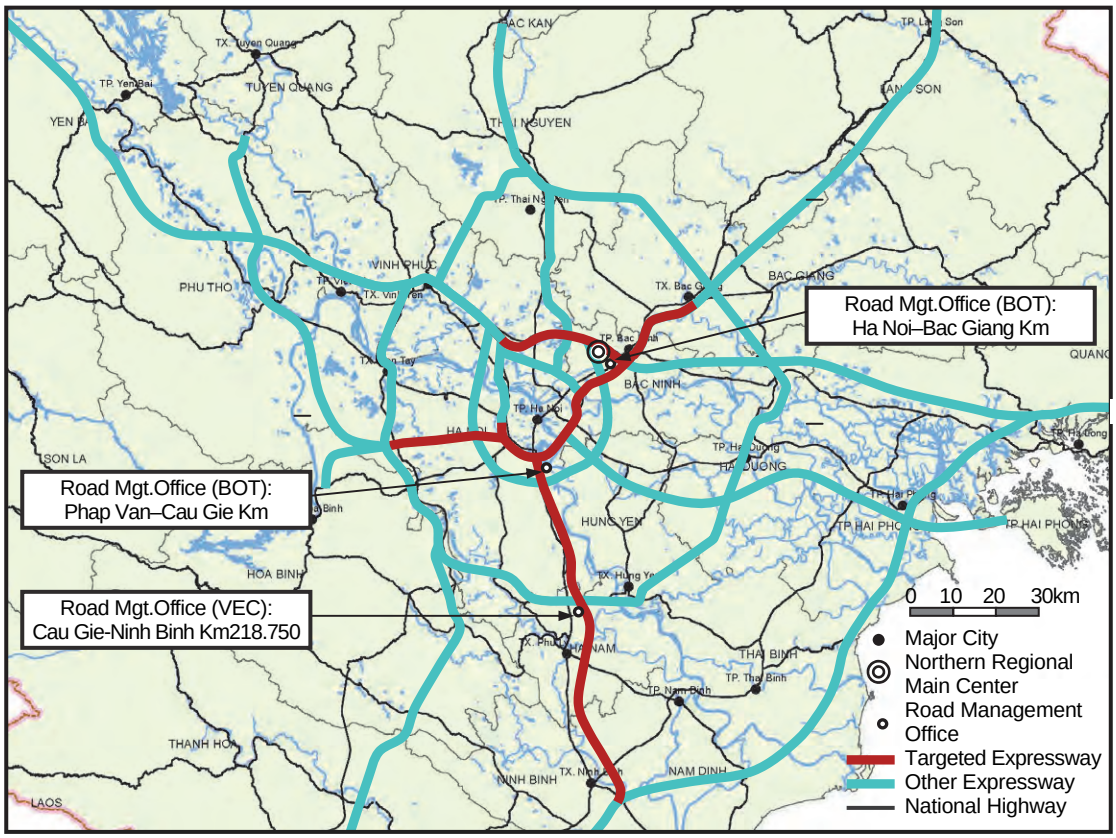
8.5 Existing Condition of Road Management Offices

The locations of the road management offices of the following three sections, which are included in the target road network of the Project, are shown in the figure below:

- Phap Van – Cau Gie
- Cau Gie – Ninh Binh
- Ha Noi – Bac Giang.

For these three sections, buildings of the road management offices are to be prepared in advance of the Project.

Figure 8.3 Location of Road Management Offices



Source: The Study Team

The existing conditions of the road management offices are to be mentioned, for all sections of the target road network of the Project, in the following.

1) Mai Dich – Thanh Tri (Ring Road 3), Lang – Hoa Lac and Noi Bai – Ca Lo Bridge

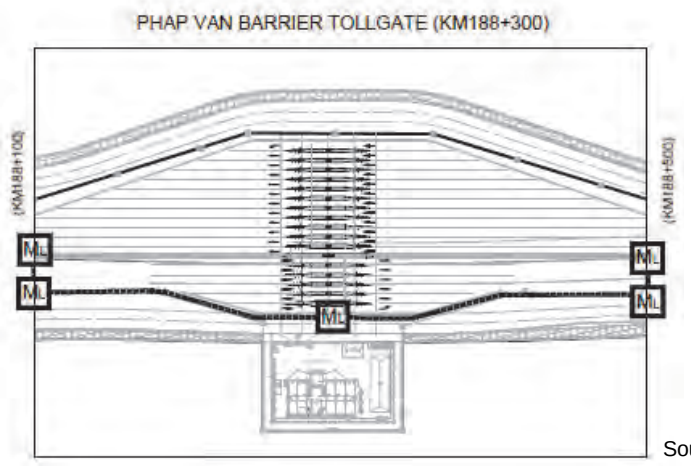
HPC is owner of these sections, road management and operation have been conducted by HPC. However, HPC doesn't have a plan of Road Management Office under existing condition, therefore the functions required for Road Management Office of these sections will be set and installed tentatively in a part of space of Regional Main Center.

2) Phap Van – Cau Gie

As mentioned in above chapter, road management and operation in this section has been

conducted by the BOT company under the concession contract with DRVN. The company has a plan of Road Management Office construction at km post 188+300 on this expressway. After construction of Road Management Office, road management and operation will be executed from this office. However, current ITS facility management and operation developed by the Grant Aid of Japan has been conducted tentatively by the VEV O&M at a road management office in Vuc – Vong, it is not included in a current concession contract.

Figure 8.4 Location of Road Management Office in Phap Van – Cau Gie Section

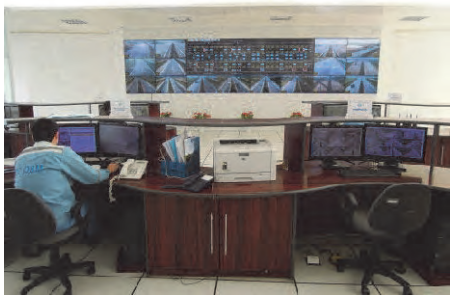


Source: The Study Team

3) Cau Gie – Ninh Binh

As mentioned in above chapter, road management and operation in this section has been conducted by VEC O&M. After construction of the road management office, road management and operation will be executed from this office. On the other hand, although management and operation of ITS facility has been conducted by VEC O&M, the BOT company of Phap Van – Cau Gie is requesting a transfer of that right.

Figure 8.5 Location of Road Management Office in Cau Gie – Ninh Binh Section

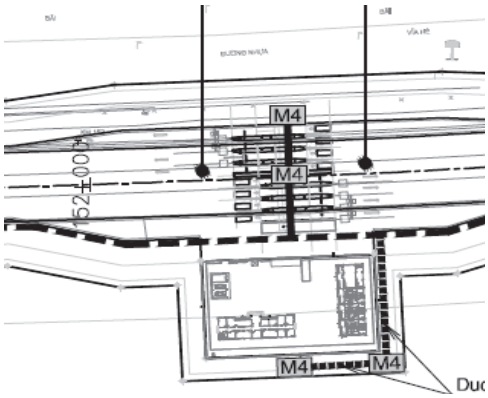


Source: The Study Team

4) Ha Noi – Bac Giang

As mentioned in above chapter, road O/M in this section has been conducted by the BOT company under the concession contract with DRVN. The company has a plan of road management office construction at km post 152+080 on this expressway. After construction of the road management office, management and operation of road and ITS facility will be executed from this office.

Figure 8.6 Location of Road Management Office in Ha Noi – Bac Giang Section



Source: The Study Team

5) Ca Lo Bridge – Bac Ninh

This section was transferred to Bac Ninh Province, it has conducted road management and operation. Bac Ninh Province doesn't have a plan of the Road Management Office under existing condition, therefore the functions required for Road Management Office of these sections will be set and installed tentatively in a part of space of Regional Main Center.

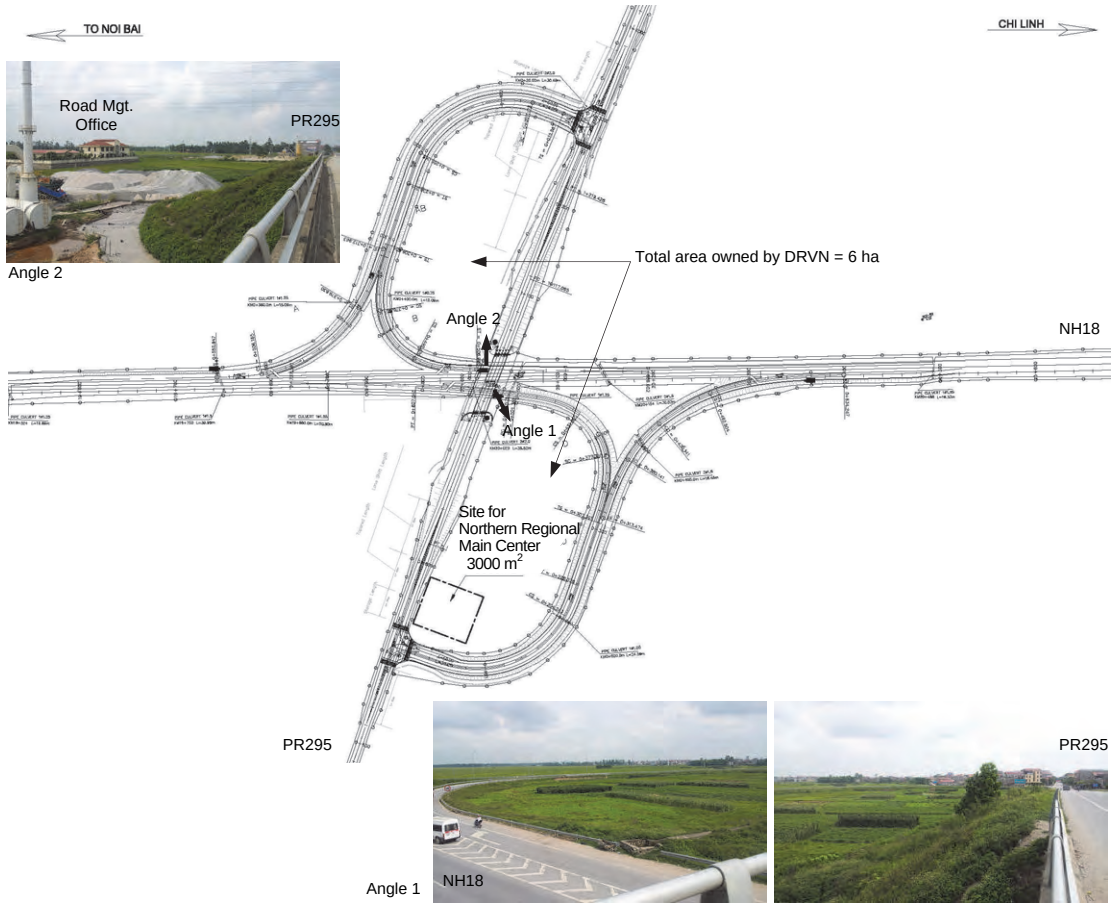
8.6 Conclusion

1) Location of Northern Regional Main Center

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 9.7 Location of Northern regional Main Center



Source: ITS Integration Project (SAPI) Study Team

2) Location of Road Management Offices

In addition, it is concluded that the System is to be installed in the road managrement offices of the following three sections, which locations are shown in the map foregoing:

- Phap Van – Cau Gie
- Cau Gie – Ninh Binh
- Ha Noi – Bac Giang.

9. Basic Design of Project

9.1 General

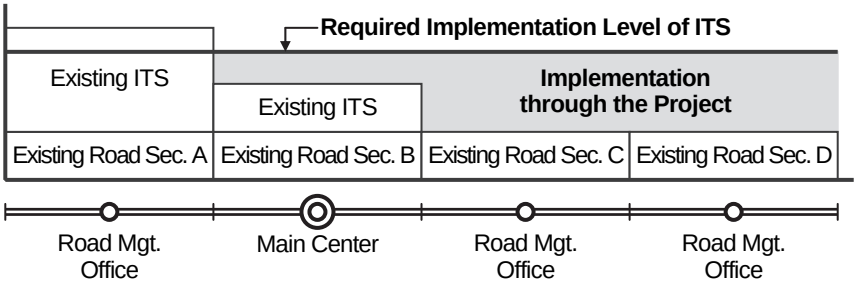
In this chapter, the items below are discussed. The objective and the Scope of the Project are to be mentioned at the outset, and outlines of the Project are to be clarified, Consequently, the discussion results of the cost, packages and schedule of the Project implementation are shown according to the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

- Objective of Project
- Project Scope
- Standards and regulations
- General notes
- System design
- Structures and ohters
- Summary of specifications
- Quantities
- Project cost

9.2 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.

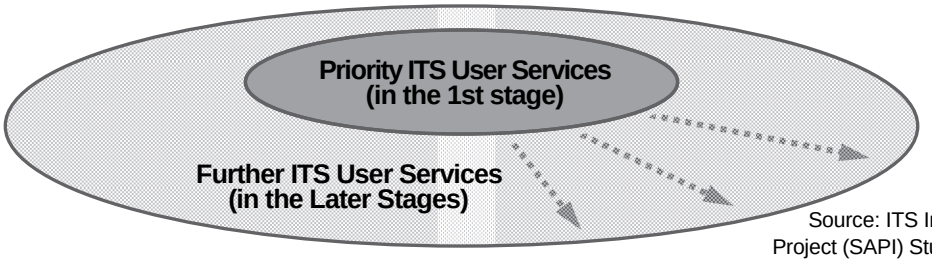
Figure 9.1 Unification of Implementation Levels through the ITS Integration Project



Source: The 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 9.2 Initiation of ITS User Services



Source: ITS Integration Project (SAPI) Study Team

9.3 Project Scope

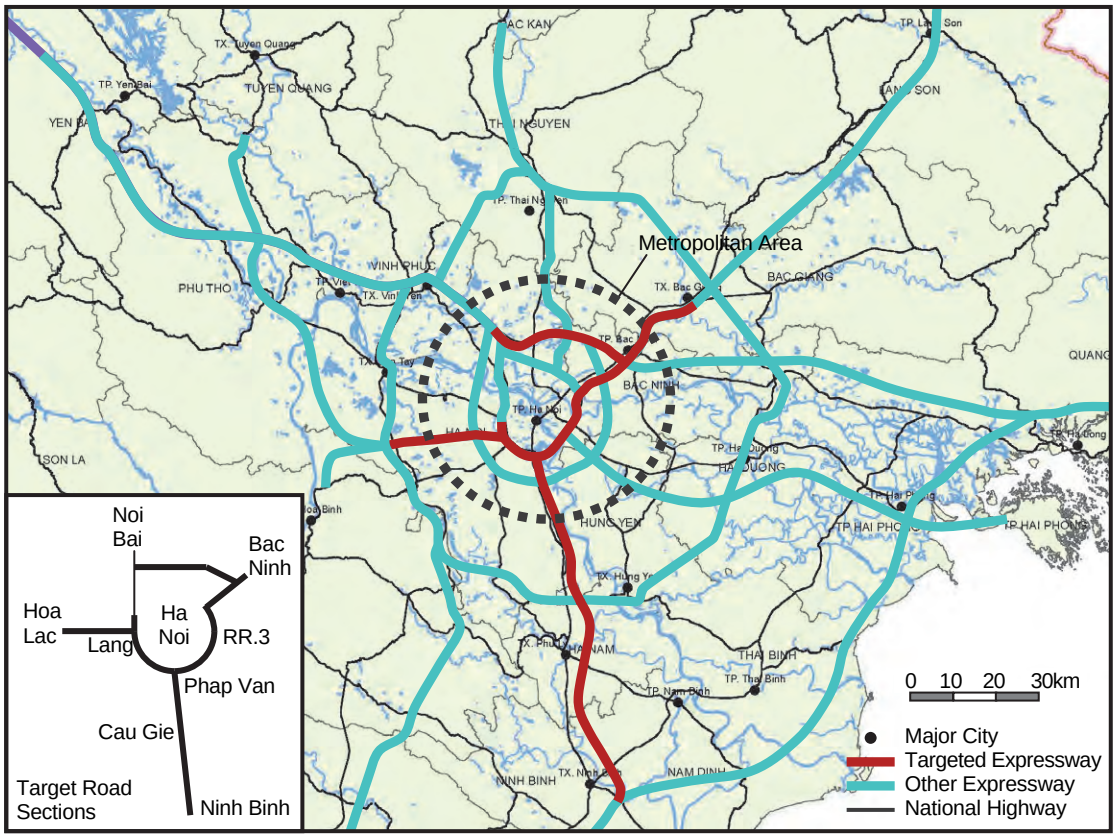
1) Project Area

The target road network of the ITS Integration Project is formed as follows:

The existing expressway sections including a ring-shape road, which provides driving route selectivity and consists partially of an unimproved existing arterial road section, and the connection to the location of Northern 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 9.3 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 Giang	46 km
Noi Bai–Ca Lo Bridge	16 km
Ca Lo Bridge–Bac Ninh	17 km
Total	214 km

Note: Discussion results of Noi Bai – Viet tri section is included in Appendix 4 only for reference.

Source: The Study Team

2) Systems to be Implemented

The following four systems are to be implemented in the Project:

- Traffic information/control system (←System for road traffic information/control)
- Toll collection/management system (←System for non-stop toll collection, For Reference)
- Vehicle weighing system (←System for heavy truck control, For Reference)
- Communication system.

9.4 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

9.5 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.

9.6 System Design

9.6.1 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 (For Reference)

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 (For Reference)

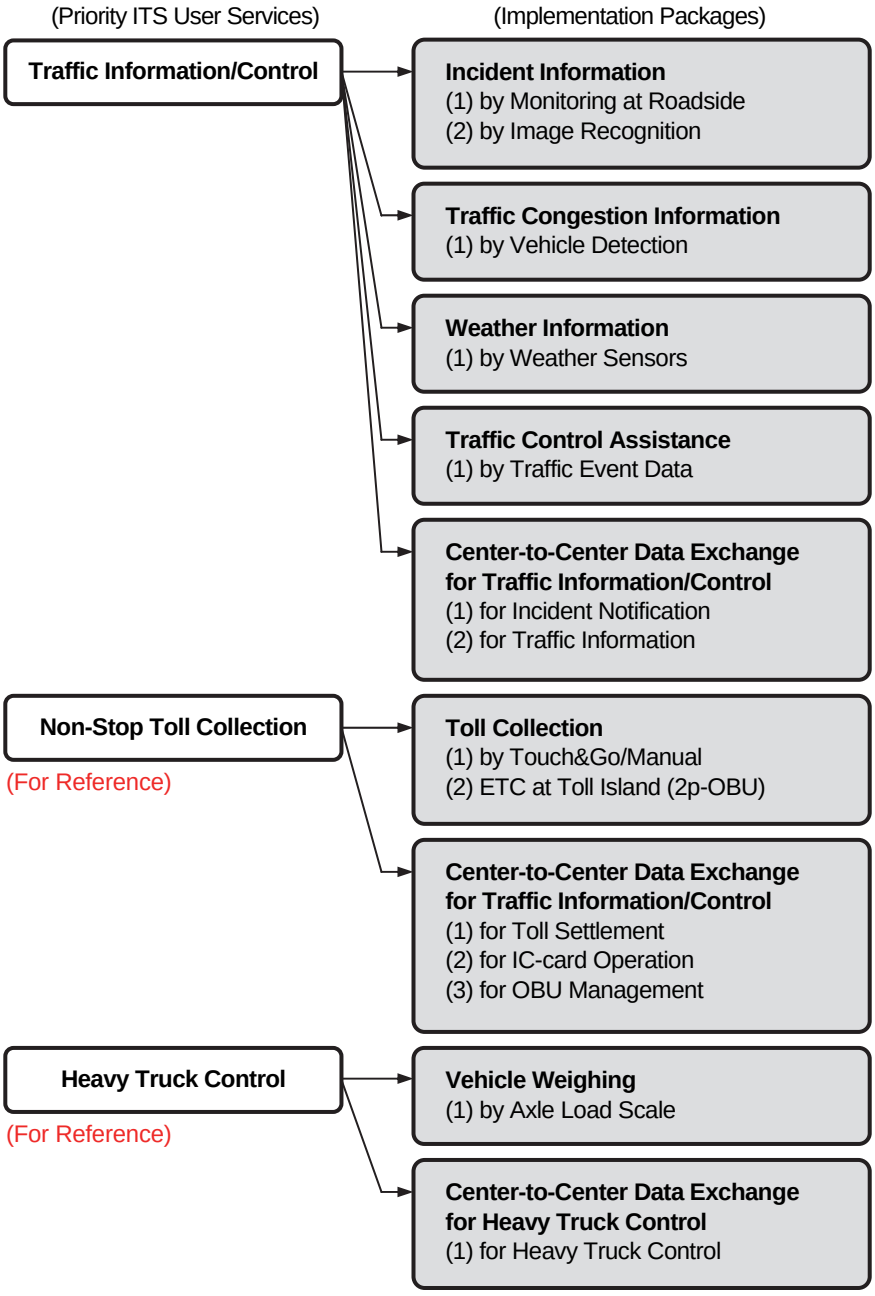
The following discussion results are to be shown for the design of the vehicle weighing system.

- 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.

9.6.2 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.

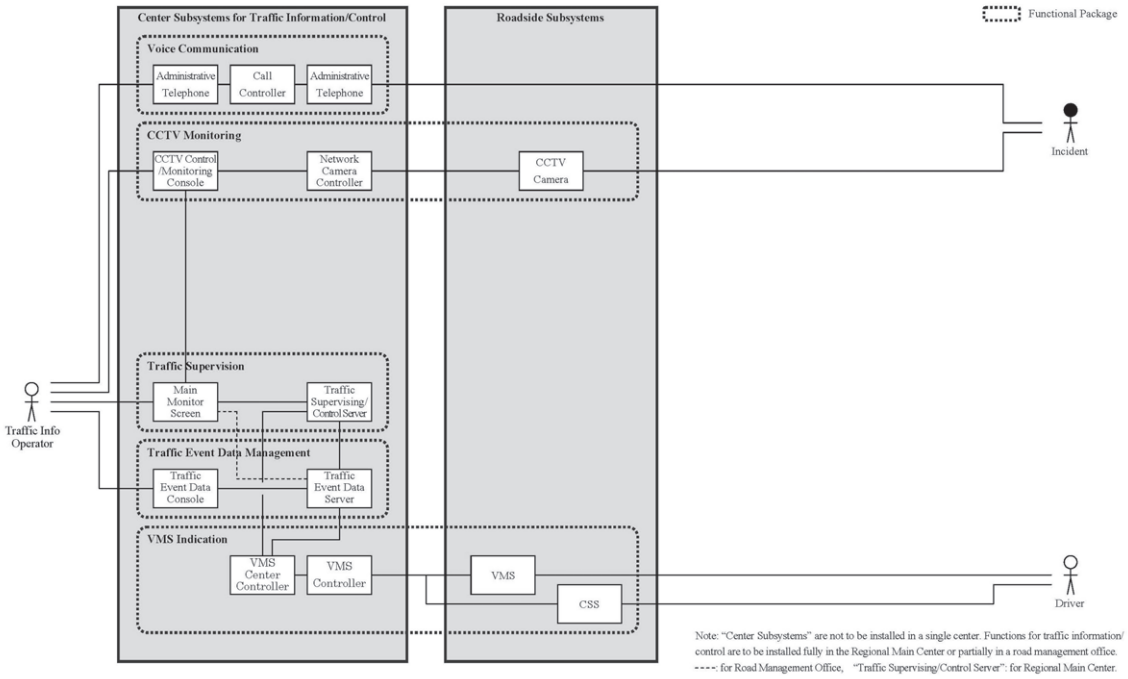
Figure9.4 Implementation Packages for Priority ITS User Services



Source: ITS Integration Project (SAPI) Study Team

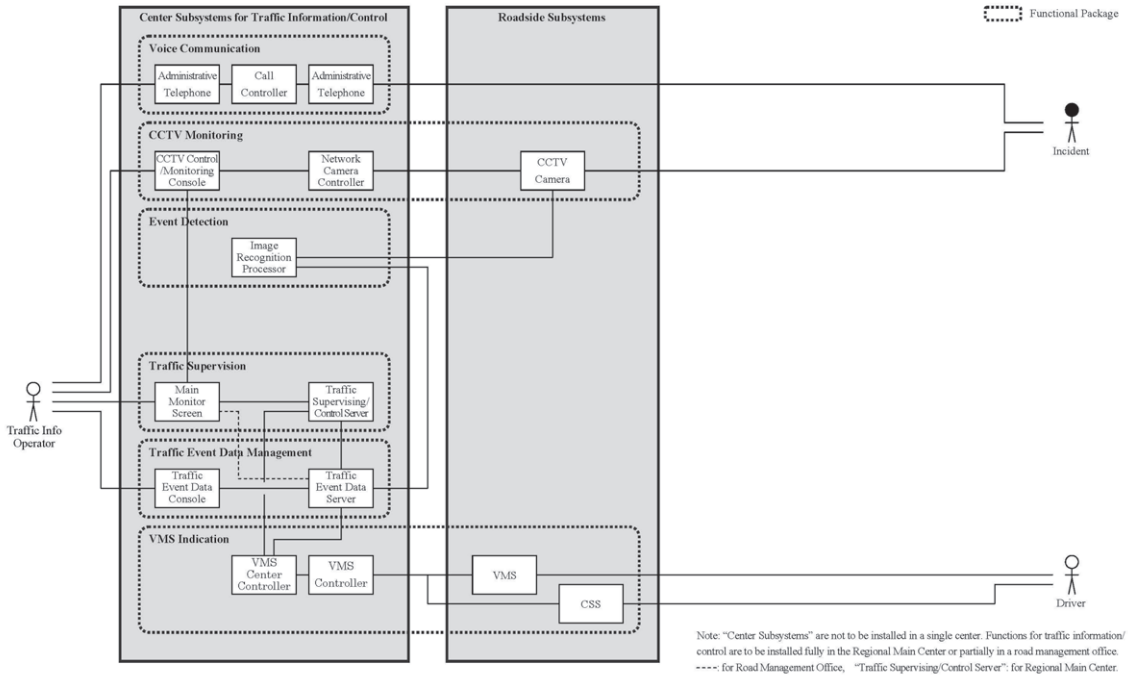
The system architecture is to be prepared for actualizing each implementation package being composed of subsystems as shown in the following pages.

Figure 9.5 Incident Information – (1) by Monitoring at Roadside



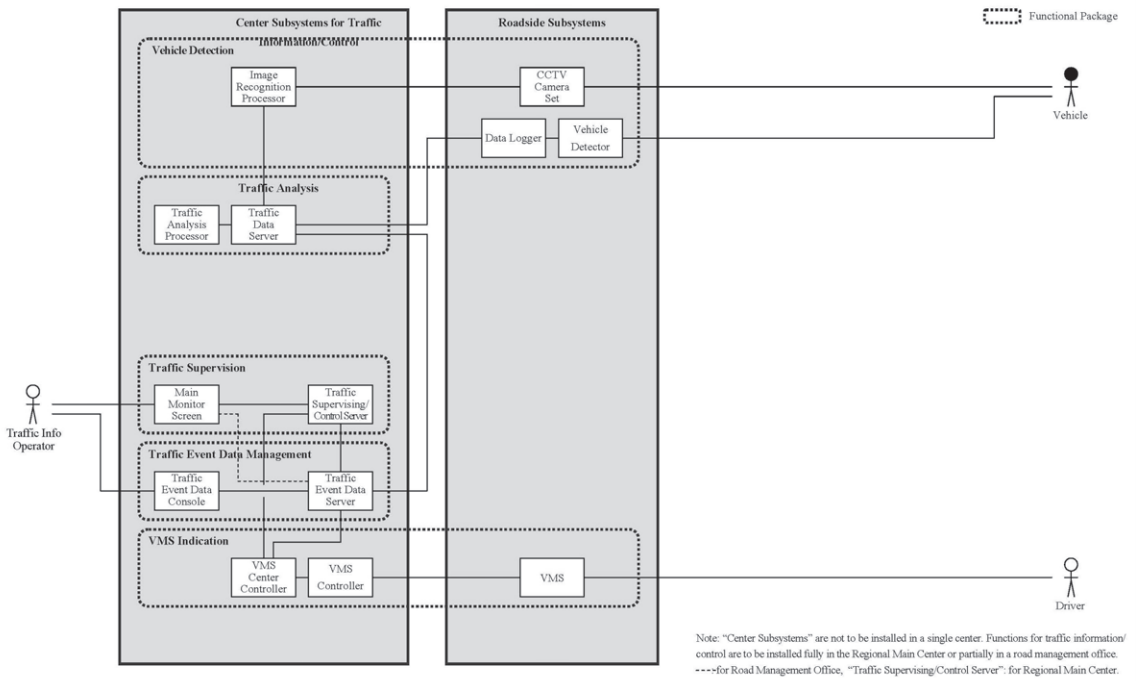
Source: The Study Team

Figure 9.6 Incident Information – (2) by Image Recognition



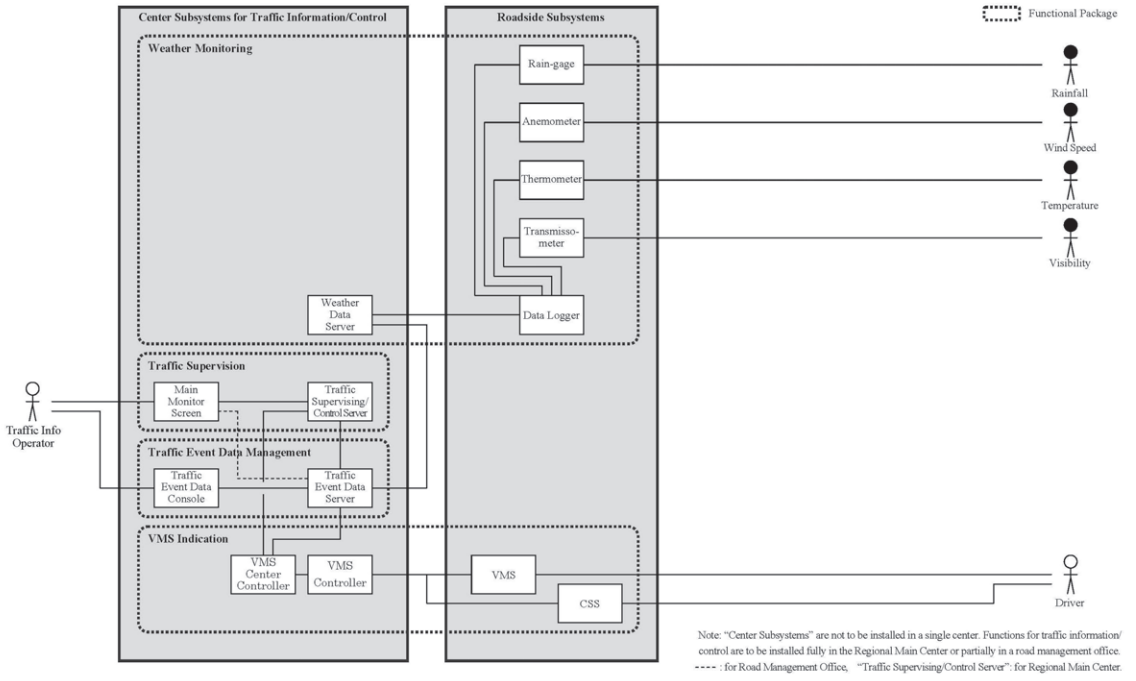
Source: The Study Team

Figure 9.7 Traffic Congestion Information – (1) by Vehicle Detection



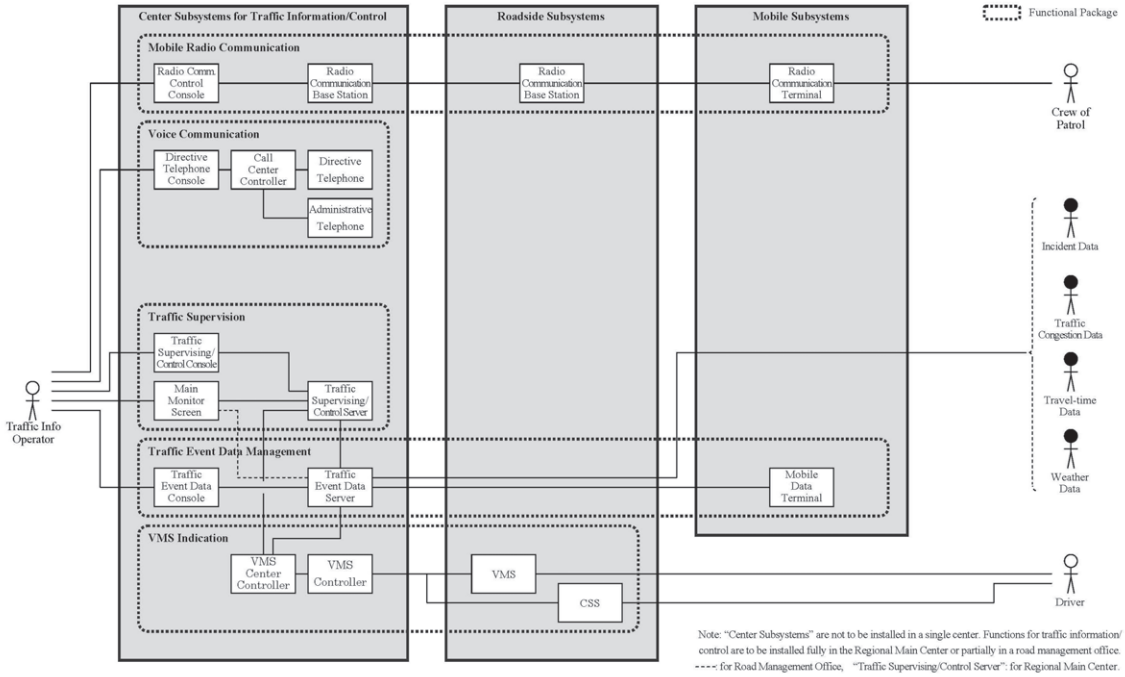
Source: The Study Team

Figure 9.8 Weather Information by – (1) Weather Sensors



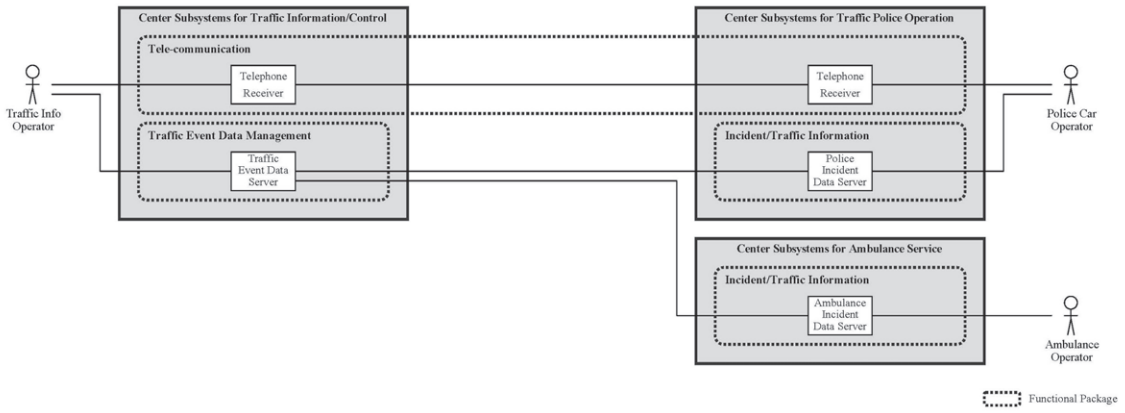
Source: The Study Team

Figure 9.9 Traffic Control Assistance – (1) by Traffic Event Data



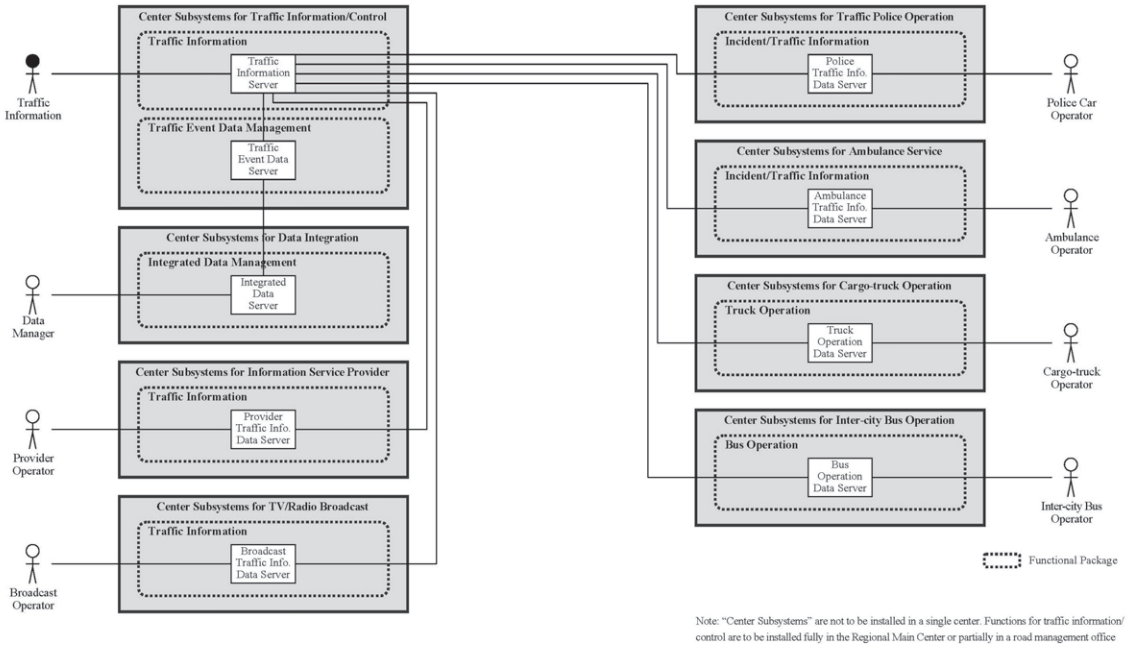
Source: The Study Team

Figure 9.10 Center-to-Center Data Exchange – (1) for Incident Notification



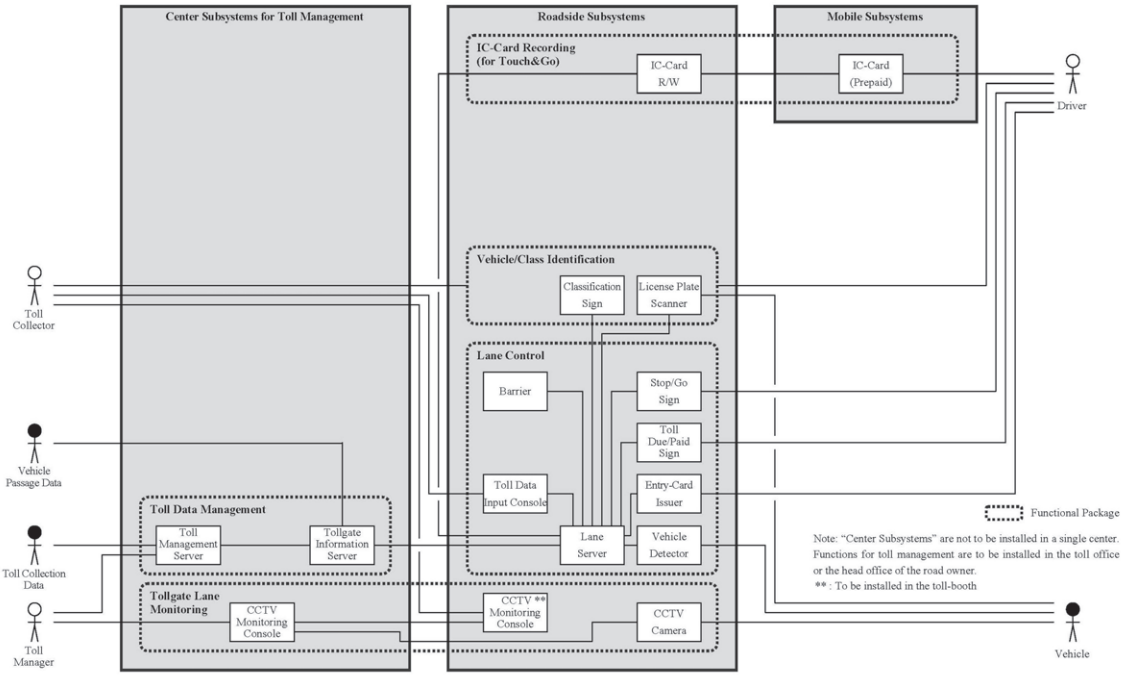
Source: The Study Team

Figure 9.11 Center-to-Center Data Exchange – (2) for Traffic Information



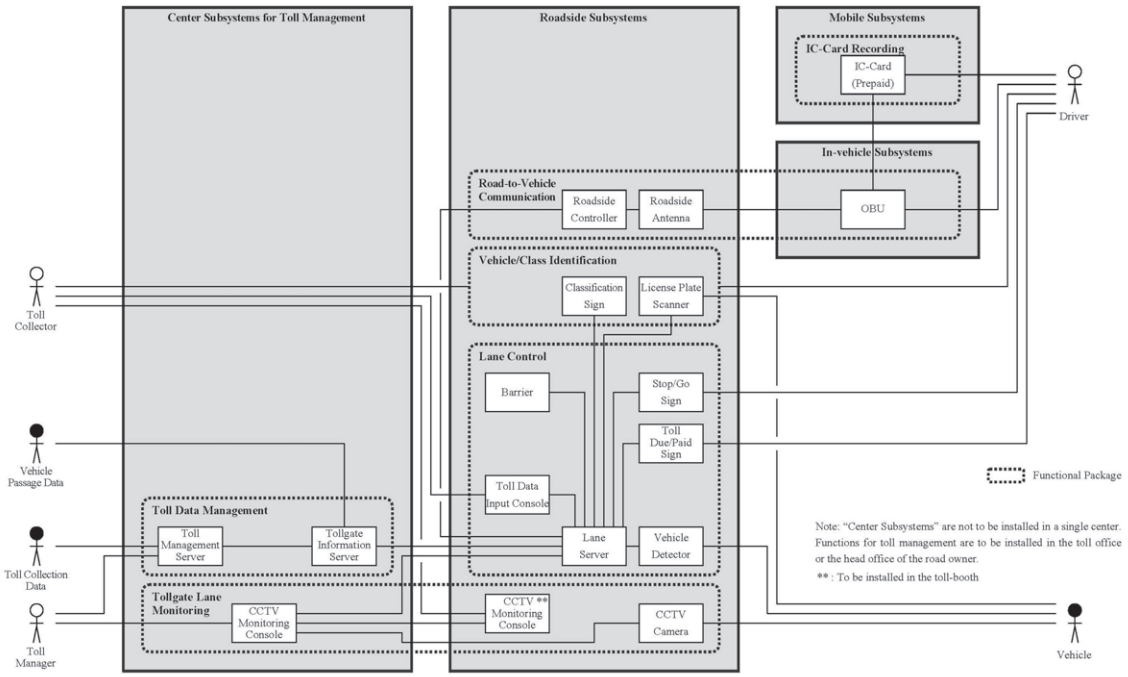
Source: The Study Team

Figure 9.12 Toll Collection – (1) by Touch&Go/Manual (For Reference)



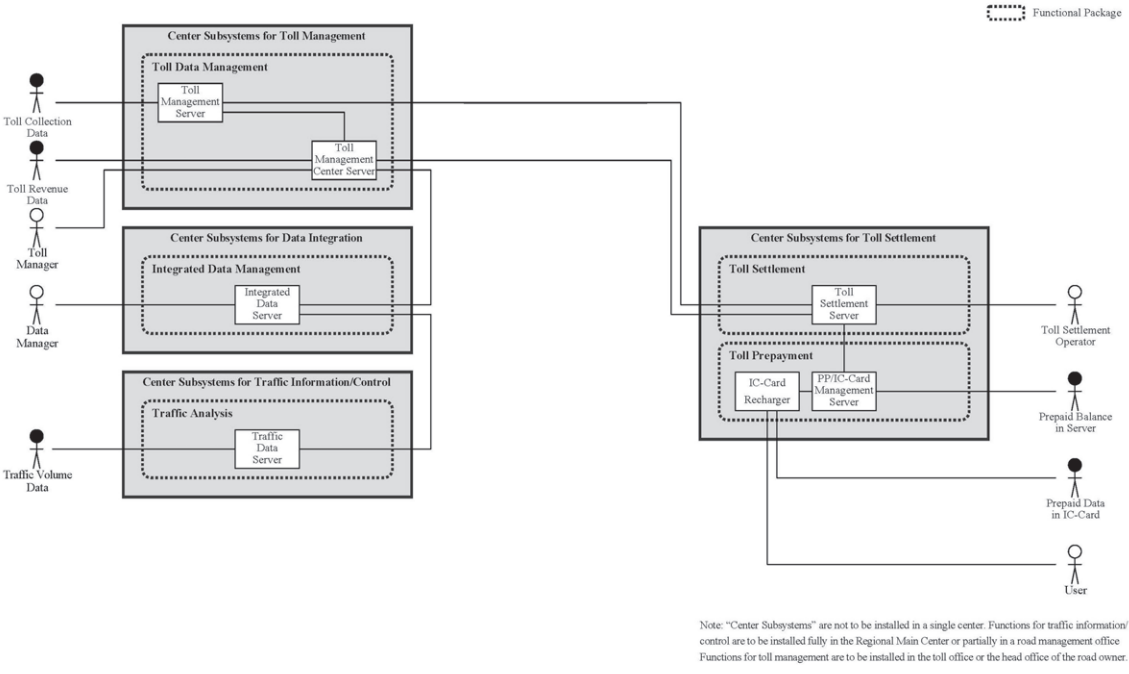
Source: The Study Team

Figure 9.13 Toll Collection – (2) by ETC at Toll Island (2p-OBU) (For Reference)



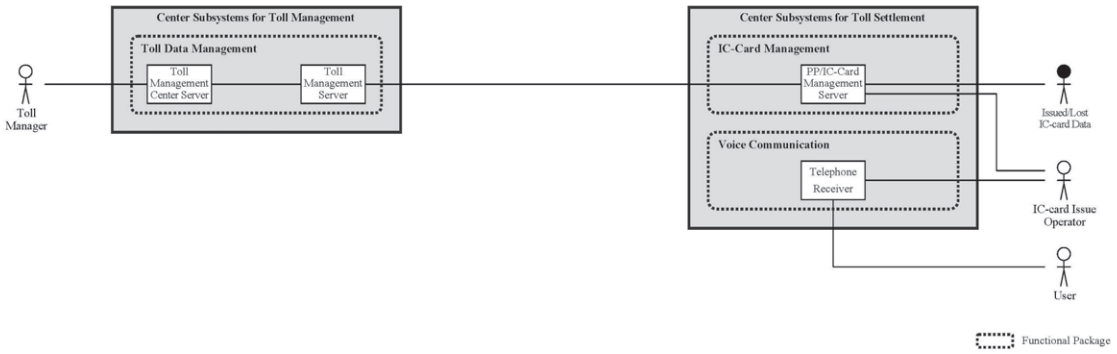
Source: The Study Team

Figure 9.14 Center-to-Center Data Exchange – (1) for Toll Settlement (For Reference)



Source: The Study Team

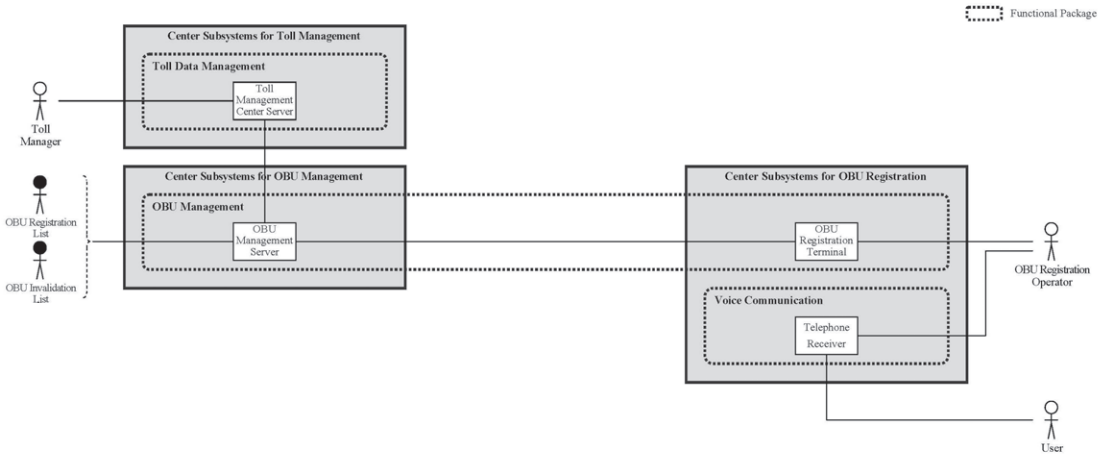
Figure 9.15 Center-to-Center Data Exchange – (2) for IC-card Operation (For Reference)



Note: "Center Subsystems" are not to be installed in a single center. Functions for toll management are to be installed in the toll office or the head office of the road owner.

Source: The Study Team

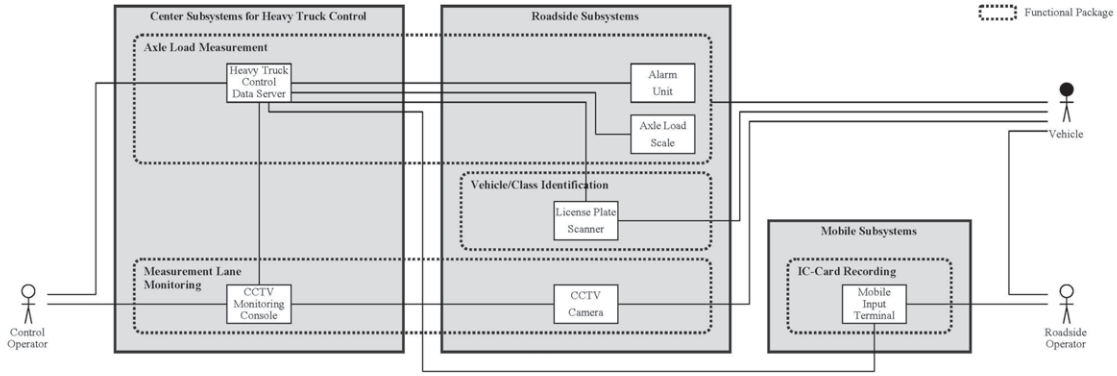
Figure 9.16 Center-to-Center Data Exchange – (3) for OBU Management (For Reference)



Note: "Center Subsystems" are not to be installed in a single center. Functions for toll management are to be installed in the toll office or the head office of the road owner.

Source: The Study Team

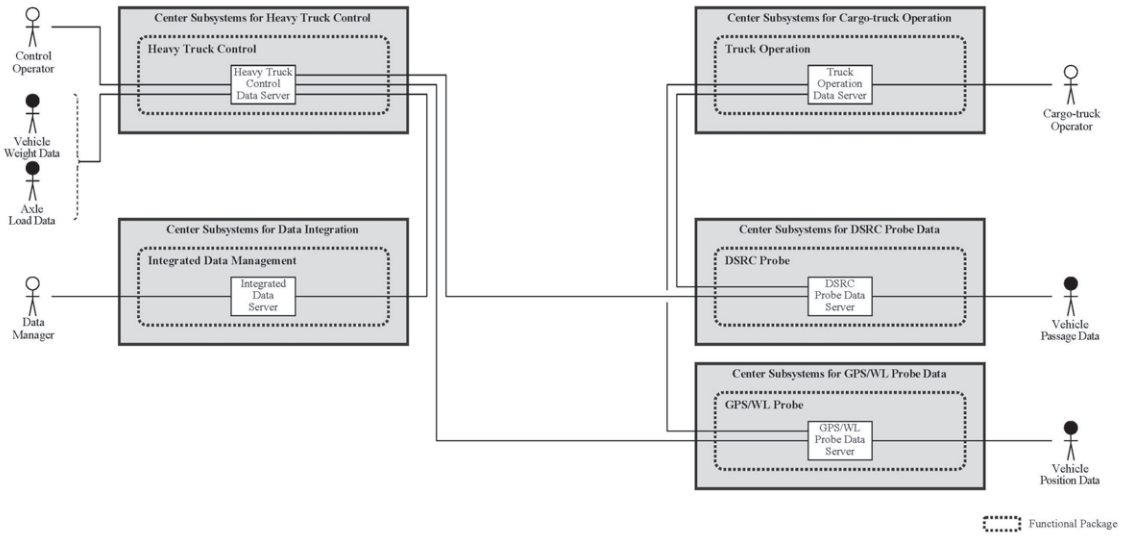
Figure 9.17 Vehicle Weighing – (1) by Axle Load Scale (For Reference)



Note: "Center Subsystems" are not to be installed in a single center. Functions for heavy truck control are to be installed in a toll office or a road management office.

Source: The Study Team

Figure 9.18 Center-to-Center Data Exchange – (1) for Heavy Traffic Control (For Reference)



Note: "Center Subsystems" are not to be installed in a single center. Functions for heavy truck control are to be installed in a toll office or a road management office.

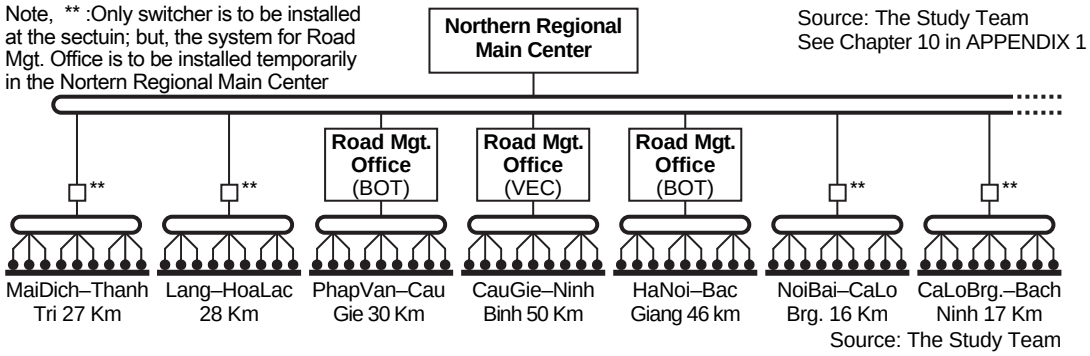
Source: The Study Team

9.6.3 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 of the Northern Regional Main Center is to be constructed in the Project as well. And the equipment and functions of the road management offices for the road sections of Phap Van – Cau Gie, Cau Gie – Ninh Binh and Ha Noi – Bac Giang are to be installed their own buildings; however, that of Mai Dich – Thanh Tri, Lang – Hoa Lac, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh are to be installed temporarily in the Northern Regional Main Center.

Figure 9.19 Northern Regional Main Center and Road Management Offices



The systems are to be installed in the respective toad sections in the Project and the respective systems include the Functional Packages as shown in the tables below.

Table 9.1 Systems for Each Section in the Project

Systems to be Installed	MaiDich–ThanhTri	Lang–HoaLac	PhapVan–CauGie	CauGie–NinhBinh	HaNoi–BachGiang	HaNoi–CaLoBrg.	CaLoBrg.–BacNinh
Traffic Information/Control	XX	XX	XX	XX	XX	XX	XX
Toll Collection/Management	**		***	***	***		**
Vehicle Weighing	**		***	***	***		**
Communication System	XX	XX	XX	XX	XX	XX	XX

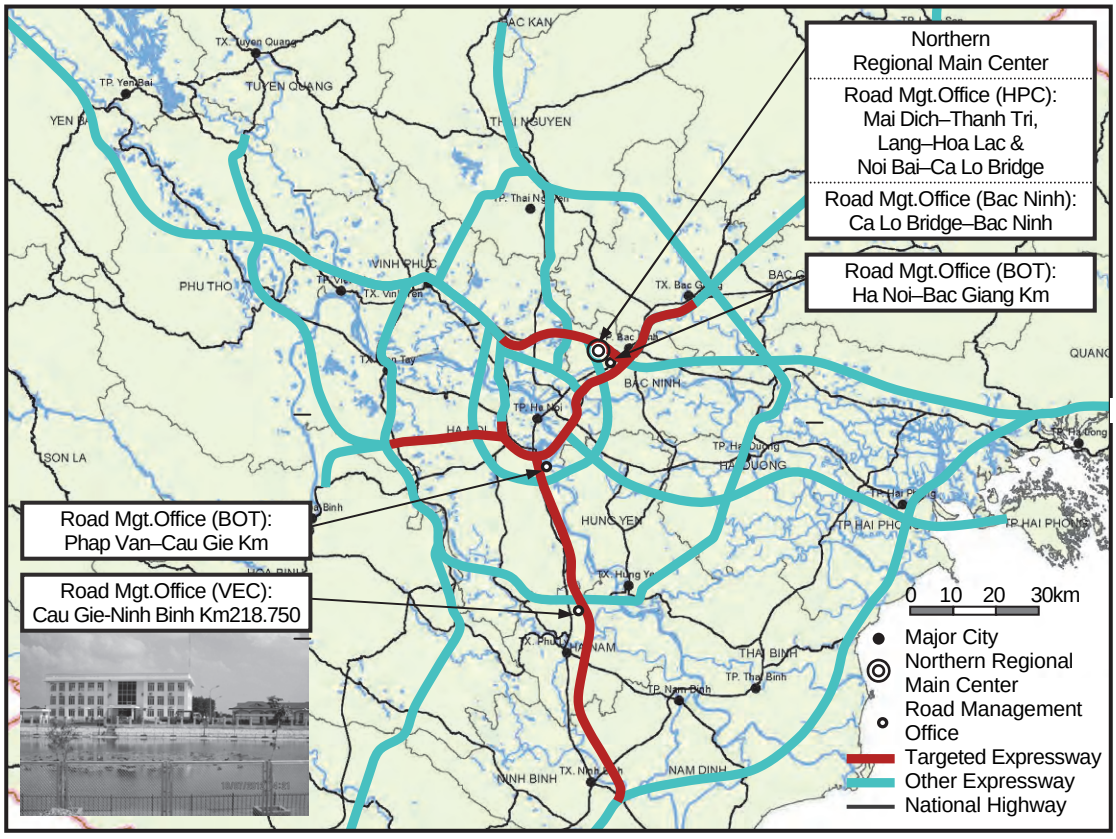
Note, ** : Road section where tollgates are removed responding to application of the road maintenance fund.
***: Road section where the system is implemented by other funds.
Source: The Study Team

Table 9.2 Functional Packages included in the System

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

Source: The Study Team

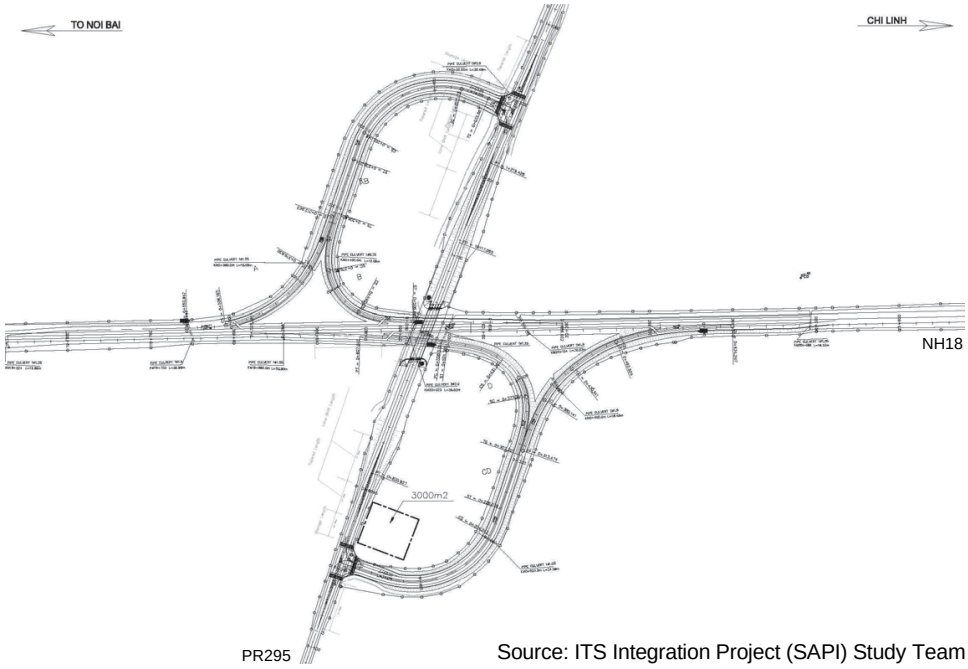
Figure 9.20 Location of Northern Regional Main Center and Road Management Offices



Source: The 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 9.21 Location of Northern regional Main Center



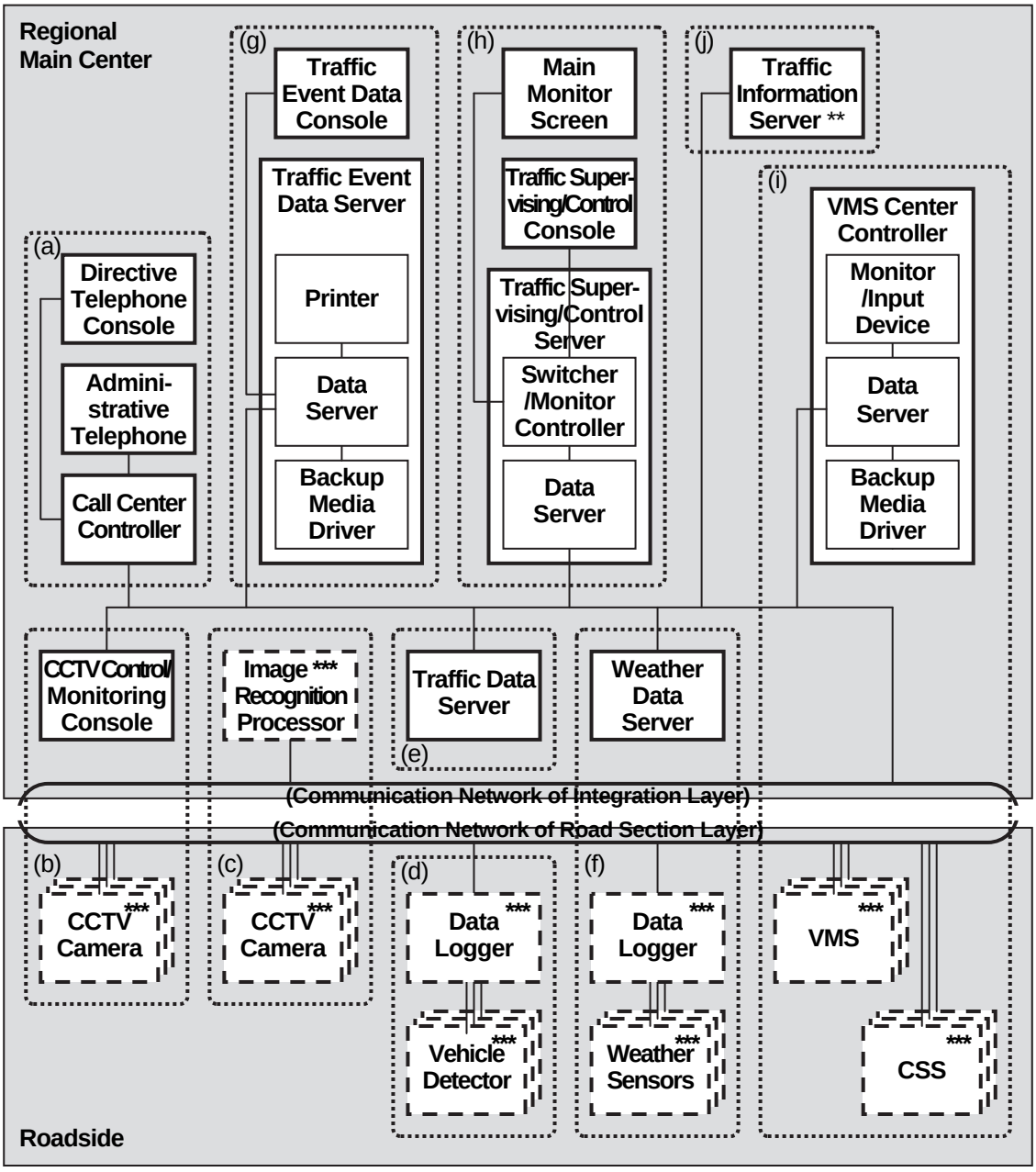
Source: ITS Integration Project (SAPI) Study Team

2) Northern Regional Main Center

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

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

Figure 9.22 System Architecture for Northern Regional Main Center

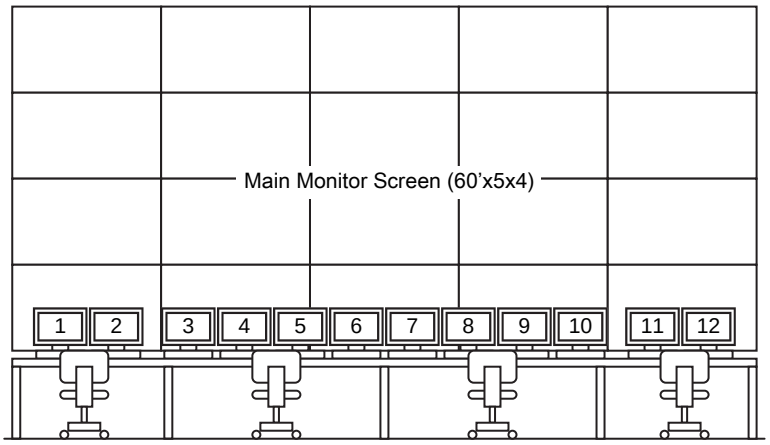


Note, ⬚ : Functional package, ** : To be connected to the Internet with protection by a firewall and stored data in it is to be copied from the traffic event data server, *** : To be installed at roadside or in the road management office.

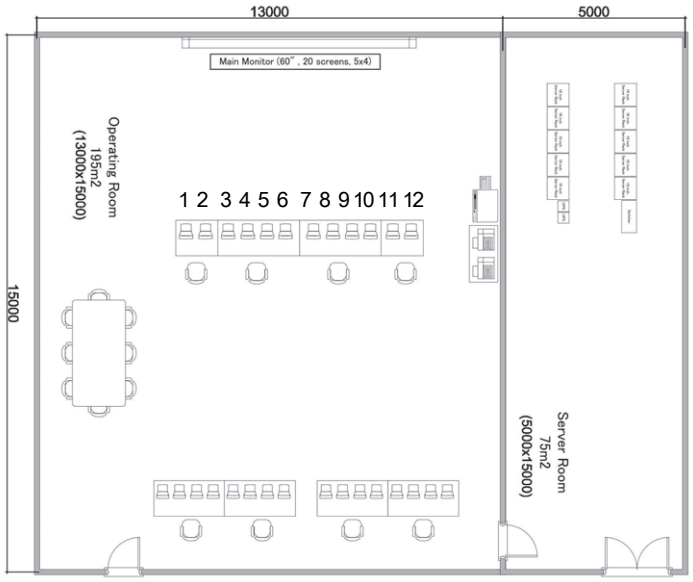
Source: The Study Team

For actualising the functions aforementioned, pieces of the center equipment are to be installed in the Regional Main Center as shown in the figure below. The data from detectors and sensors are to be processed in the Regional Main Center, and VMSs and CCTV cameras are to be controlled directly from the Regional Main Center, as well as the road management office, for taking appropriate action in the event of serious incident.

Figure 9.23 Equipment Overview in Regional Main Center



1. Traffic Data Monitor/Input Device
2. Weather Data Monitor/input Device
3. Directive Telephone Console
4. CCTV Control/Monitoring Console
5. Traffic Event Data Console
6. Traffic Supervising/Control Console
7. Directive Telephone Console
8. CCTV Control/Monitoring Console
9. Traffic Event Data Console
10. Traffic Supervising/Control Console
11. VMS Center Controller Monitor/Input Device
12. Traffic Information Monitor/Input Device



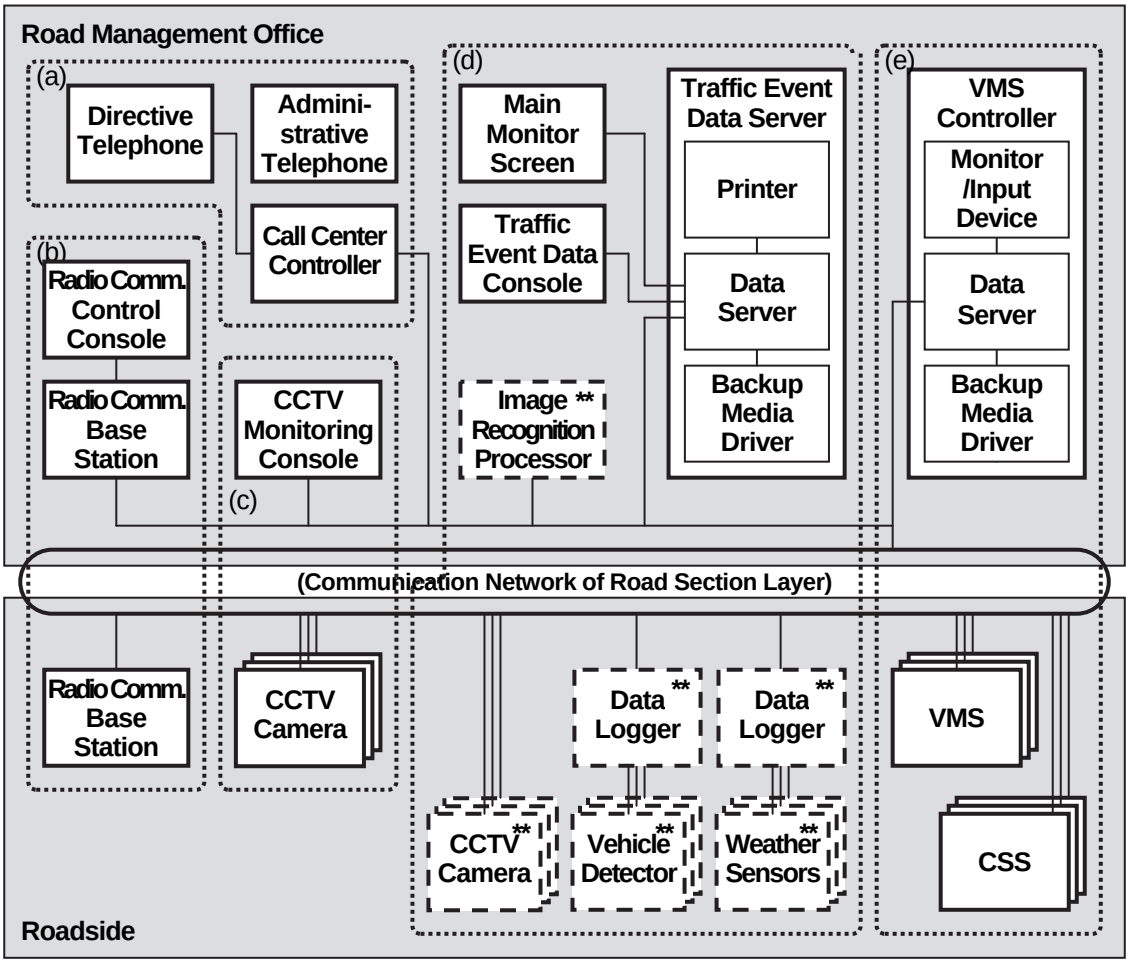
Source: The Study Team

3) Road Management Office

Center equipment necessary for expressway operation is to be installed in the road management office. CCTV cameras are to be controlled and the traffic event data are to be input in the office for handling/clearing incidents. Prioritisation of the data is to be done in the Regional Main Center and guidance based on it is to be sent to the operator in the road management office to input data for iVMS/CSS indication. Additionally, the direct VMS/CSS control from the Regional Main Center is to be accepted as well for responding to the serious incidents.

(a) Voice Communication
(b) Mobile Radio Communication
(c) CCTV Monitoring
(d) Traffic Event Data Management
(e) VMS Indication

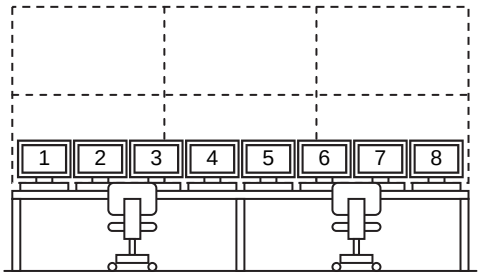
Figure 9.24 System Architecture for Road Management Office



Note, : Functional package, ** : Components of the functional packages to be coordinated with Traffic Event Data Management.

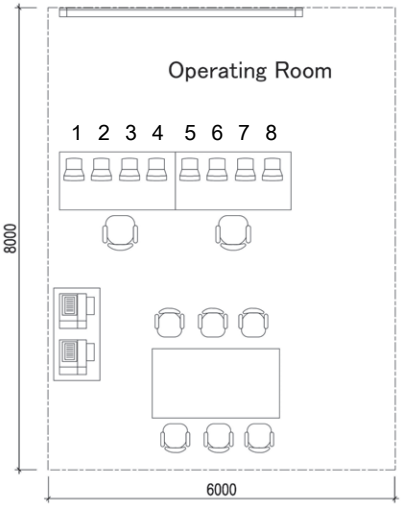
Source: The Study Team

Figure 9.25 Equipment Overview in Road Management Office



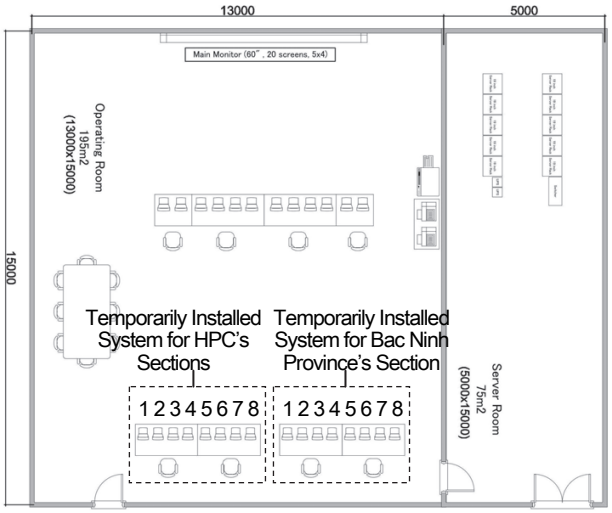
1. Mobile Communication Control Console
2. CCTV Control/Monitoring Console
3. Traffic Event Data Console
4. VMS Controller Monitor/Input Device
5. Mobile Communication Control Console
6. CCTV Control/Monitoring Console
7. Traffic Event Data Console
8. VMS Controller Monitor/Input Device

Note: Main monitor screen can be omitted if it is not necessary in the road management office.



Source: The Study Team

Figure 9.26 Equipment Overview Temporarily installed in Regional Main Center



Source:
The Study Team

4) Data Integration Center

The integrated data server is to be installed in the Data Integration Center for actualizing its function. The data are to be acquired from the data servers in the Regional Main Center and the toll offices, and to be managed by the operator.

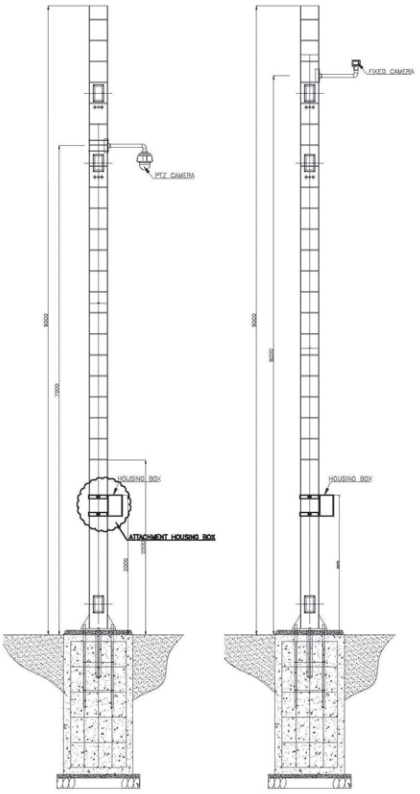
9.6.4 Roadside Equipment

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) (→For Referance)
- Touch&Go/manual (→For Referance)
- Axle load scale (→For Referance).

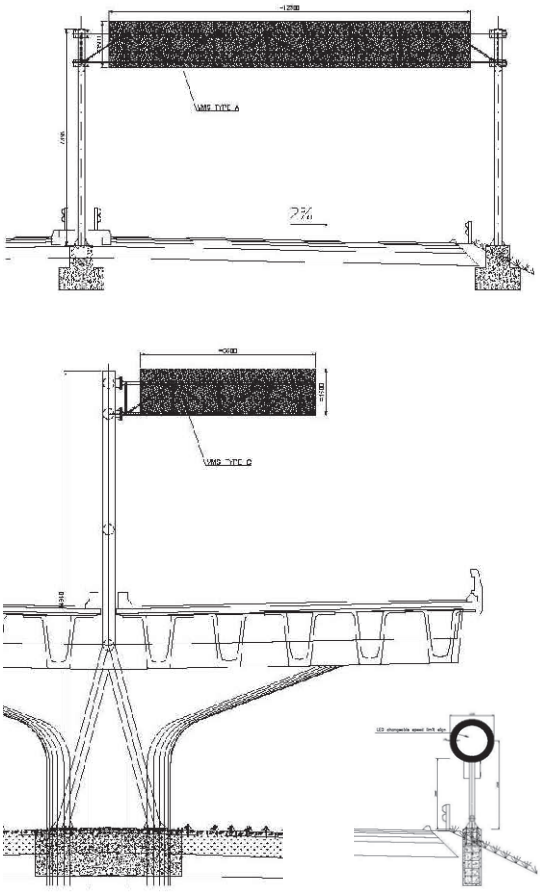
Typical installation of roadside equipment components are shown in the following figures and the arrangement on the road network is shown in the following tables.

Figure 9.27 Installation of CCTV Camera



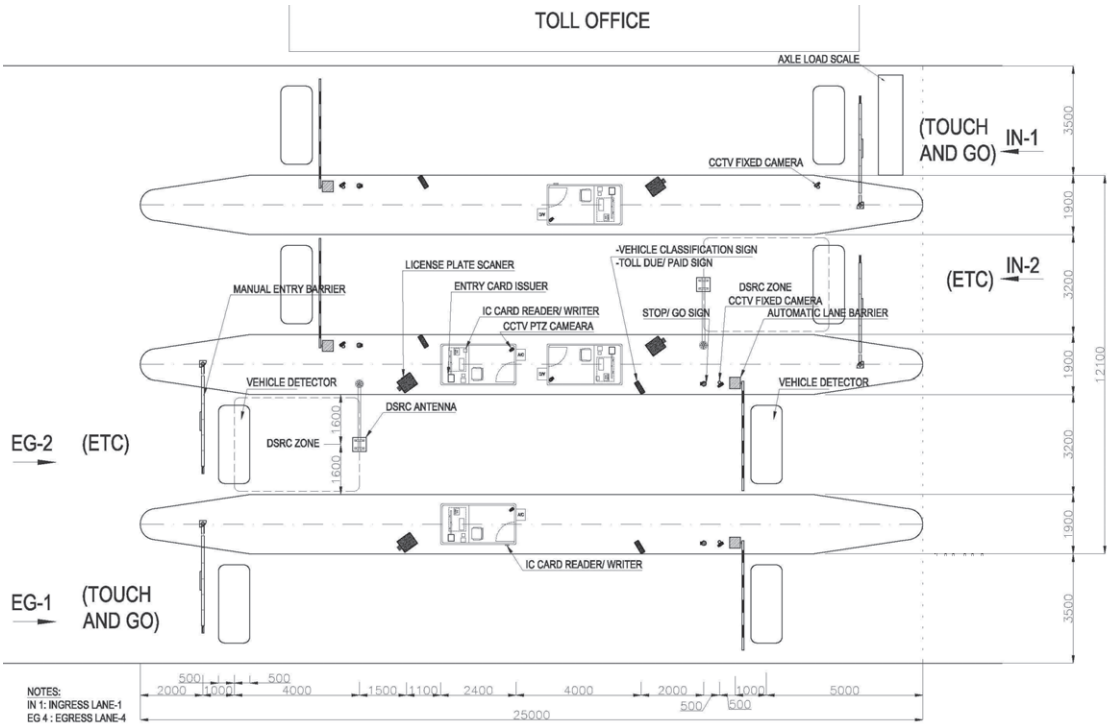
Source: ITS Integration Project (SAPI) Study Team

Figure 9.28 Installation of VMS/CSS



Source: ITS Integration Project (SAPI) Study Team

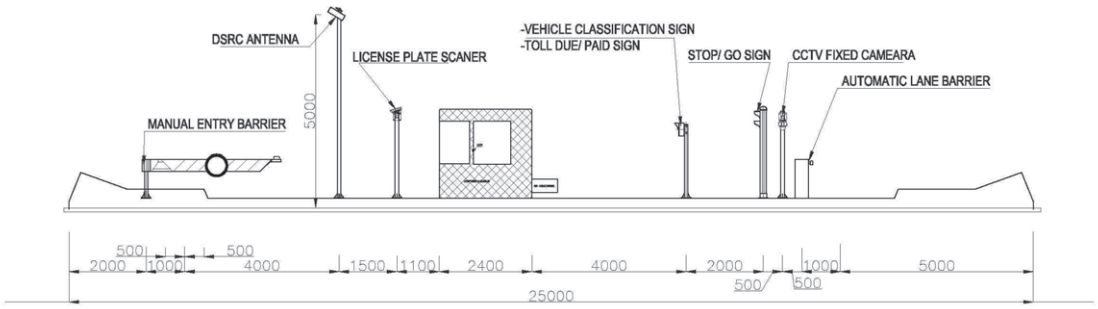
Figure 11.29 Installation of Roadside Equipment for Toll Collection (For Reference)



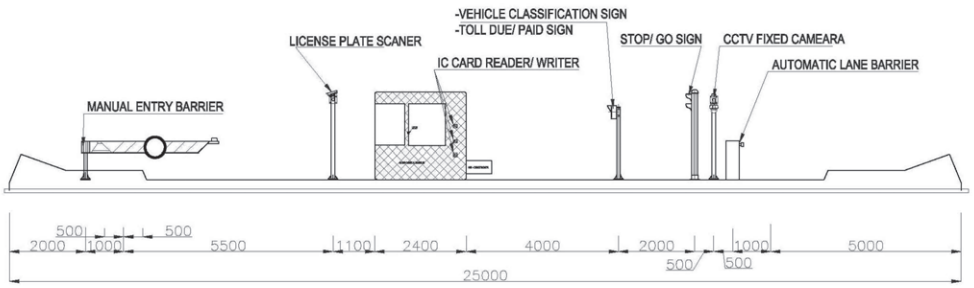
Source: ITS Integration Project (SAPI) Study Team

Figure 11.30 Installation of Roadside Equipment (For Reference)

(ETC)

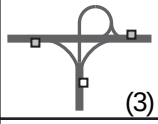
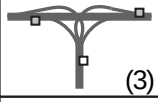
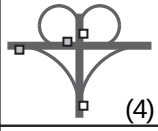
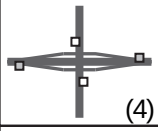
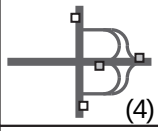
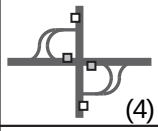
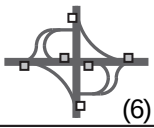
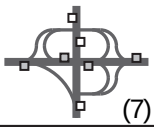
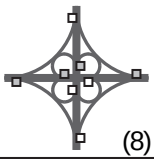
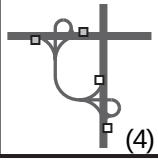


(Touch&Go/Manual)



Source: ITS Integration Project (SAPI) Study Team

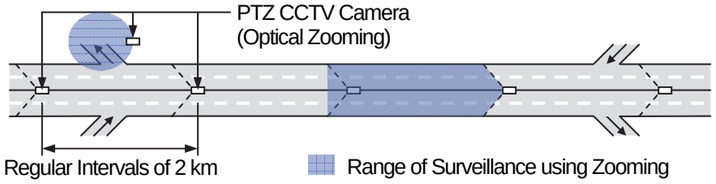
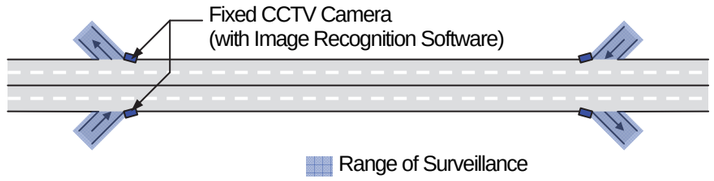
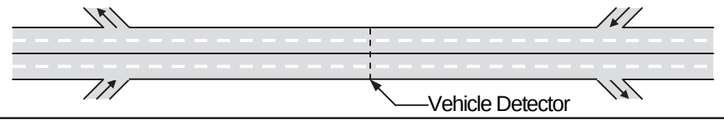
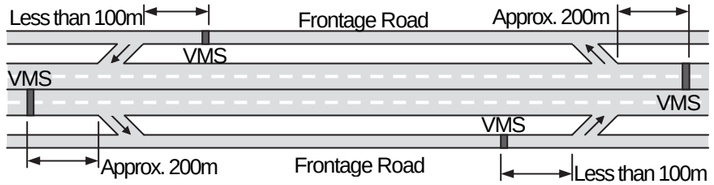
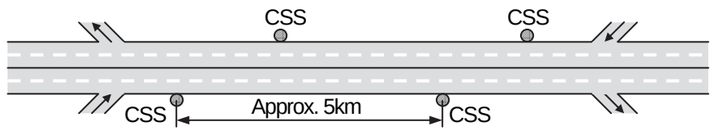
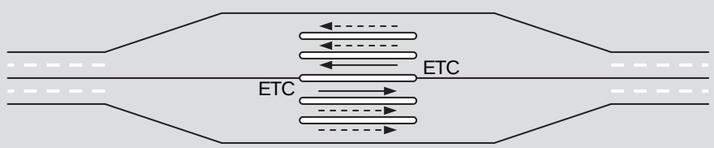
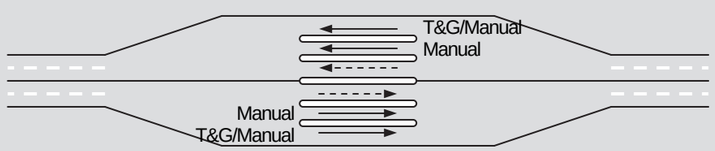
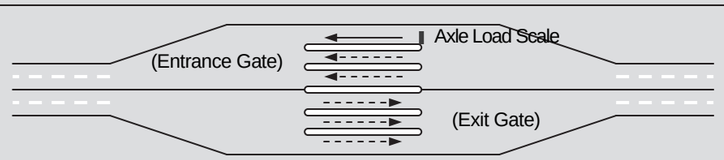
Table 9.3 Interchanges and VMS Arrangement

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 9.4 Total Arrangement of Roadside Equipment Components by the Project

System	Arrangement of Roadside Equipment		Mai Dich –Thanh Tri	Lang –Hoa Lac	Phap Van –Cau Gie	Cau Gie –Ninh Binh	Ha Noi –Bac Giang	Noi Bai –Ca Lo Bridge	Ca Lo Bridge –Bac Ninh
Traffic Information/ Control System	1. PTZ Camera: for Monitoring At regular intervals of 2 km (in practical use)		22 sets Excluding 12 sets installed by JICA Grant	40 sets	-- Excluding 14 sets to be installed by BOT, 22 sets by JICA Grant, and others by CadPro	-- Excluding items installed by Cadpro	13 sets Excluding 32 sets to be installed by BOT	22 sets	20 sets
	2. Fixed Camera: for Event Detection At all the ramps (in trial use)		21 sets Excluding 5 sets installed by JICA Grant	20 sets	-- Excluding 6 sets to be installed by BOT, 6 sets by JICA Grant, and others by CadPro	-- Excluding items installed by Cadpro	27 sets Excluding 18 sets to be installed by BOT	8 sets	4 sets
	3. Vehicle Detector: At the middle point between a pair of interchanges (in practical use)		14 sets	6 sets	-- Excluding 6 sets to be installed by BOT	--	6 sets Excluding 10 sets to be installed by BOT	4 sets	2 sets
	4. VMS: for Traffic Information At 100 m back from the diverge to the entrance gate and at 200 m back from the diverge to exit gate (in practical use)		21 sets Excluding 5 sets installed by JICA Grant	16 sets	-- Excluding 7 sets to be installed by BOT, and 2 sets by JICA Grant	10 sets Excluding items installed by CadPro	18 sets Excluding 18 sets to be installed by BOT	8 sets	4 sets
	5. CSS: for Speed Limitation At regular intervals of 5 km (in practical use)		15 sets	9 sets	-- Excluding 15 sets to be installed by BOT	--	16 sets Excluding 9 sets to be installed by BOT	6 sets	11 sets
Toll Collection/ Management System (For Reference)	6. ETC: for Toll Collection At a median-side lane of the tollgate which has the lanes more than two (in practical use)		--	--	8 sets	--	2 sets	--	--
	7. Touch&Go/Manual: for Toll Collection At a roadside lane of all the tollgates (in practical use)		--	--	40 sets	9 sets	8 sets	--	--
Vehicle Weighing System (For Reference)	8. Axle Load Scale: Overloading Regulation At a roadside lane of the entrance tollgate (in practical use)		--	--	6 sets	--	2 sets	--	--

Source: The Study Team

Table 9.5 Arrangement of Roadside Equipment Components on Mai Dich – Thanh Tri Section

System	Roadside Equipment	Trung Hoa / Thanh Xuan / Phap Van / Tam Trinh / Linh Nam / Thanh Tri / NH5–S.Dong Mai Dich — Thanh Tri													
Traffic Information/ Control System	1. PTZ Camera: for Monitoring (in Practical Use)	6 sets	2 sets	8 sets	2 sets	1 set (+3 sets ***)	1 set (+2 sets ***)	1 set (+1 set ***)	2 sets						
			--		--		(+2 sets ***)		--		--		(+2 sets ***)		(+2 sets ***)
	2. Fixed Camera: for Event Detection (in Trial Use)		4 sets		4 sets		2 sets		1 set (+1 set ***)		2 sets (+2 sets ***)		1 set (+1 set ***)		3 sets (+1 set ***)
	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		1 set (+3 sets ***)		1 set (+1 set ***)		4 sets		4 sets		2 sets (+1 set ***)
	5. CSS: for Speed Limitation (in Practical Use)	1 set	2 sets	2 sets	4 sets	2 sets	3 sets	1 set							
Toll Collection/ Management System (For Reference)	6. ETC: for Toll Collection (in Practical Use)														
	7. Touch&Go/ Manual: for Toll Collection (in Practical Use)														
Vehicle Weighing System (For Reference)	8. Axle Load Scale: for Overloading Regulation (in Practical Use)														

Note, *** : Installed by JICA Grant as the preceding part of the ITS Interation Project.

Source: The Study Team

Table 9.6 Arrangement of Roadside Equipment Components on Lang – Hoa Lac Section

System	Roadside Equipment	Hoa Lac (Hoa Lac)	Phu Cat	Dong Mo	Dai Mo	Trung Hoa (Lang)
Traffic Information/ Control System	1. PTZ Camera: for Monitoring (in Practical Use)	2 sets	14 sets	16 sets	4 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)	2 sets	3 sets	2 sets	2 sets	--
Toll Collection/ Management System (For Reference)	6. ETC: for Toll Collection (in Practical Use)					
	7. Touch&Go/ Manual: for Toll Collection (in Practical Use)					
Vehicle Weighing System (For Reference)	8. Axle Load Scale: for Overloading Regulation (in Practical Use)					

Source: The Study Team

Table 9.7 Arrangement of Roadside Equipment Components on Phap Van – Cau Gie Section & Cau Gie – Ninh Binh Section

System	Roadside Equipment	Phap Van – Phuong Nhi	Phuong Nhi – Khe Hoi	Khe Hoi – Van Diem	Van Diem – Dai Xuyen	Dai Xuyen – Cau Gie	Cau Gie – Vuc Vong	Vuc Vong – Liem Tuyen	Liem Tuyen – Cao Bo	Cao Bo – Ninh Binh
Traffic Information/ Control System	1. PTZ Camera: for Monitoring (in Practical Use)	-- (+4 sets *) (+4 sets ***)	-- (+1 set *) (+3 sets ***)	-- (+6 sets *) (+5 sets ***)	-- (+3 sets *) (+3 sets ***)	**	**	**	**	
		(+1 sets ***)	(+2 sets ***)	(+2 sets ***)	(+2 sets ***)		**	**	**	**
	2. Fixed Camera: for Event Detection (in Trial Use)	--	-- (+2 sets *) (+2 sets ***)	-- (+2 sets *) (+2 sets ***)	-- (+2 sets *) (+2 sets ***)		**	**	**	**
	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 *) (+1 set ***)	-- (+4 sets *)	-- (+1 set *) (+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		
Toll Collection/ Management System (For Reference)	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)	18 sets	8 sets	8 sets	9 sets	6 sets	4 sets	4 sets	4 sets	4 sets
Vehicle Weighing System (For Reference)	8. Axle Load Scale: for Overloading Regulation (in Practical Use)	1 set	2 sets	2sets	1 set	1 set	**	**	**	**

Note, * : To be onstalled by BOT, ** : Installed by Cadpro as the 1st stage of ITS, *** : Installed by JICA Grant as the preceding part of the ITS Interation Project.

Source: The Study Team

Table 9.8 Arrangement of Roadside Equipment Components on Ha Noi – Bac Giang Section

System	Roadside Equipment	Phuc Loi / Den Do / Tu Son / Tien Son / Lien Bao / Nam Bac Ninh Ha Noi — Bac Giang										
Traffic Information/ Control System	1. PTZ Camera: for Monitoring (in Practical Use)	--	2 sets	--	2 sets	4 sets	-- (+2 sets *)	-- (+2 sets *)	-- (+10 sets *)	-- (+8 sets *)	-- (+4 sets *)	
		--	--	--	--	--	5 sets	-- (+2 sets *)	-- (+2 sets *)	--	-- (+2 sets *)	
	2. Fixed Camera: for Event Detection (in Trial Use)	--	7 sets	4 sets	4 sets	8 sets	4 sets	-- (+6 sets *)	-- (+4 sets *)	-- (+4 sets *)	-- (+4 sets *)	
	3. Vehicle Detector (in Practical Use)	--	2 sets	2 sets	2 sets	2 sets +2 sets :Loop-coil	--	--	-- (+2 sets *)	-- (+2 sets *)	-- (+2 sets *)	
	4. VMS: for Traffic Information (in Practical Use)	--	4 sets	4 sets	3 sets	4 sets	3 sets	-- (+4 sets *)	-- (+4 sets *)	-- (+4 sets *)	-- (+4 sets*)	
	5. CSS: for Speed Limitation (in Practical Use)	1 set	2 sets	2 sets	2 sets	2 sets	--	-- (+3 sets *)	-- (+4 sets *)	-- (+4 sets *)	-- (+2 sets *)	
Toll Collection/ Management System (For Reference)	6. ETC: for Toll Collection (in Practical Use)	2 sets										
	7. Touch&Go/ Manual: for Toll Collection (in Practical Use)	8 sets										
Vehicle Weighing System (For Reference)	8. Axle Load Scale: for Overloading Regulation (in Practical Use)	2 sets										

Note, * : To be onstalled by BOT.

Source: the Study Team

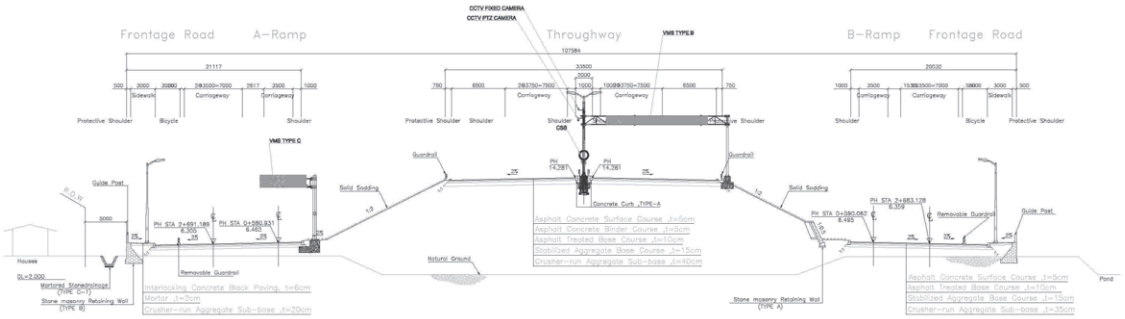
Table 9.9 Arrangement of Roadside Equipment Components on Noi Bai – Ca Lo Bridge Section & Ca Lo Bridge – Bac Ninh Section

System	Roadside Equipment	ThanhLong–Noi Bai / NH3–Phu Lo (Noi Bai – Ca Lo Bridge)	PR295–Cho (Ca Lo Bridge – Bac Ninh)
Traffic Information/ Control System	1. PTZ Camera: for Monitoring (in Practical Use)	4 sets / 10 sets / 8 sets 4 sets / 2 sets	8 sets / 12 sets 2 sets / 2 sets
	2. Fixed Camera: for Event Detection (in Trial Use)	4 sets / 4 sets	4 sets / 4 sets
	3. Vehicle Detector (in Practical Use)	-- / 2 sets / 2 sets +2 sets :Loop-coil	2 sets / 2 sets +2 sets :Loop-coil
	4. VMS: for Traffic Information (in Practical Use)	4 sets / 4 sets	3 sets / 4 sets
	5. CSS: for Speed Limitation (in Practical Use)	-- / 3 sets / 3 sets	1 sets / 2 sets / 8 sets
Toll Collection/ Management System (For Reference)	6. ETC: for Toll Collection (in Practical Use)		
	7. Touch&Go/ Manual: for Toll Collection (in Practical Use)		
Vehicle Weighing System (For Reference)	8. Axle Load Scale: for Overloading Regulation (in Practical Use)		

Source: The Study Team

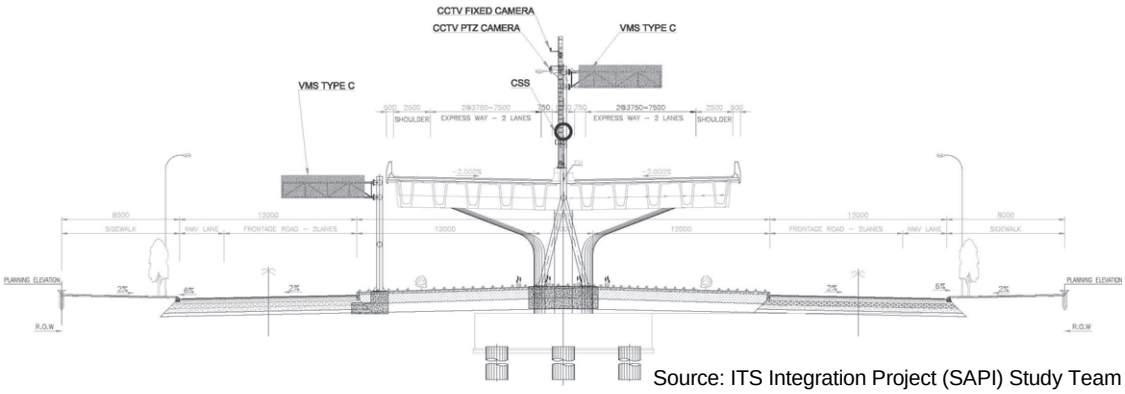
Typical cross sections of the installation of VMS, CSS and CCTV camera respectively at earthwork section, viaduct section and bridge section are shown in the following figures.

Figure 9.31 Typical Cross Section of Roadside Equipment Installation at Earthwork Section



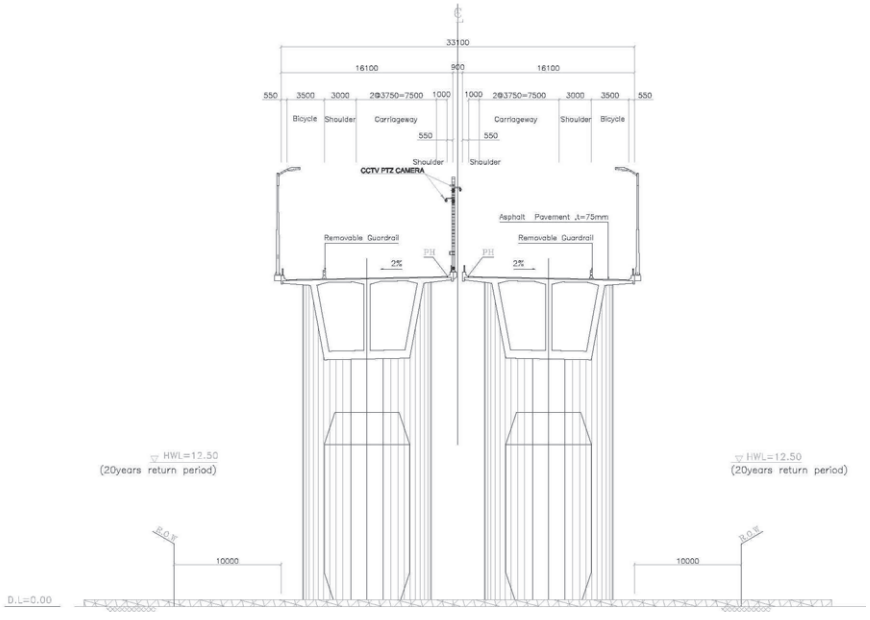
Source: ITS Integration Project (SAPI) Study Team

Figure 9.32 Typical Cross Section of Roadside Equipment Installation at Viaduct Section



Source: ITS Integration Project (SAPI) Study Team

Figure 9.33 Typical Cross Section of Roadside Equipment Installation at Bridge Section



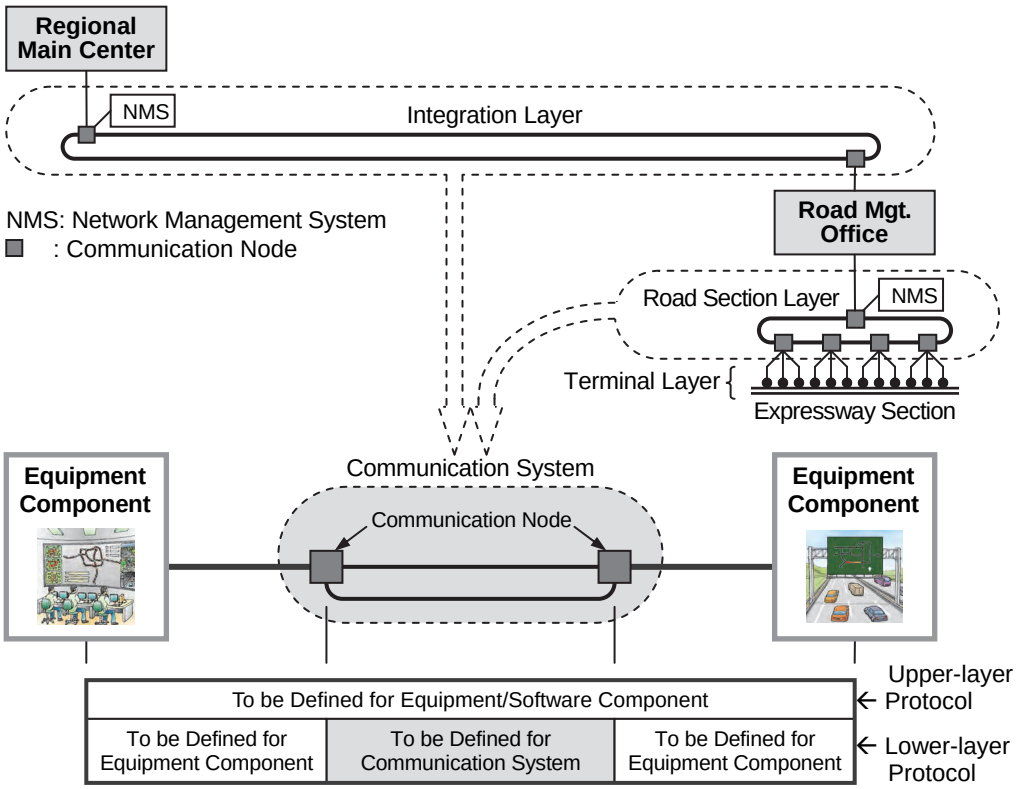
Source: ITS Integration Project (SAPI) Study Team

9.6.5 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 9.34 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:

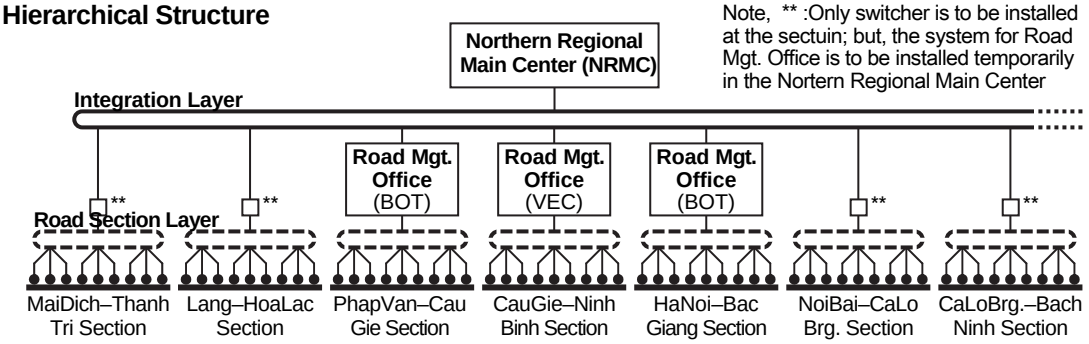
- Communication network layers
- Appropriate transmission system for ITS
- Applicable protocol
- IP version
- Network configuration overview for ITS integration project
- Equipment component of voice communication
- Numbering plan
- Directive telephone set
- Administrative telephone set

- 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.

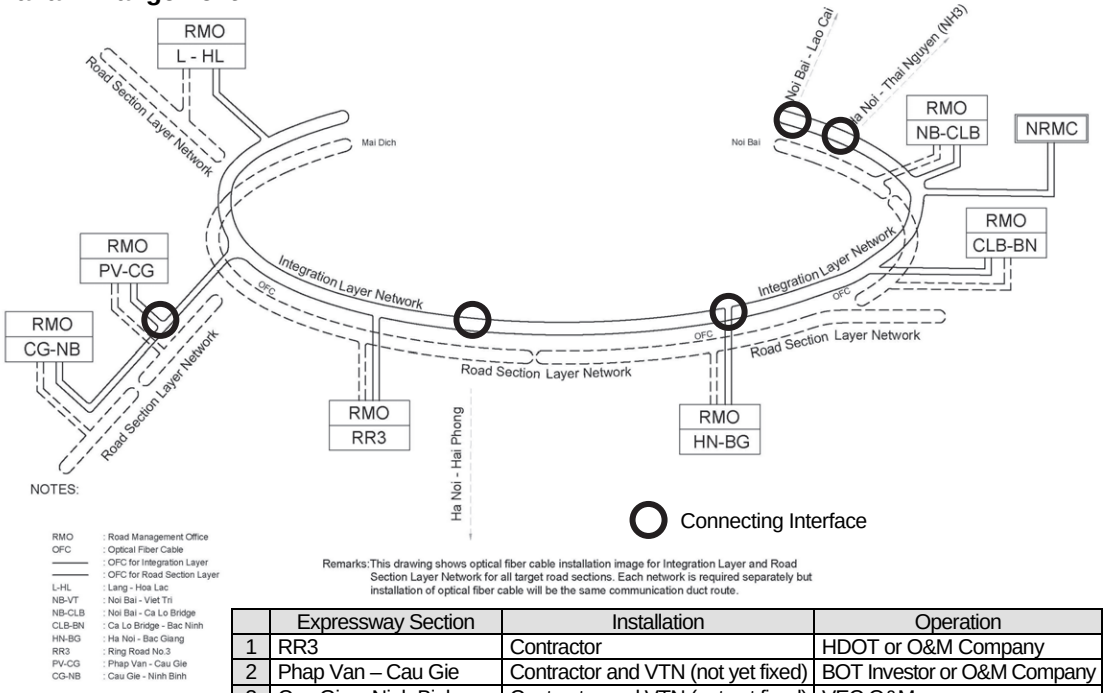
Communication network is to be implemented in ring shape along the expressway network as shown in the figure below.

Figure 9.35 Outline of Communication Network

Hierarchical Structure



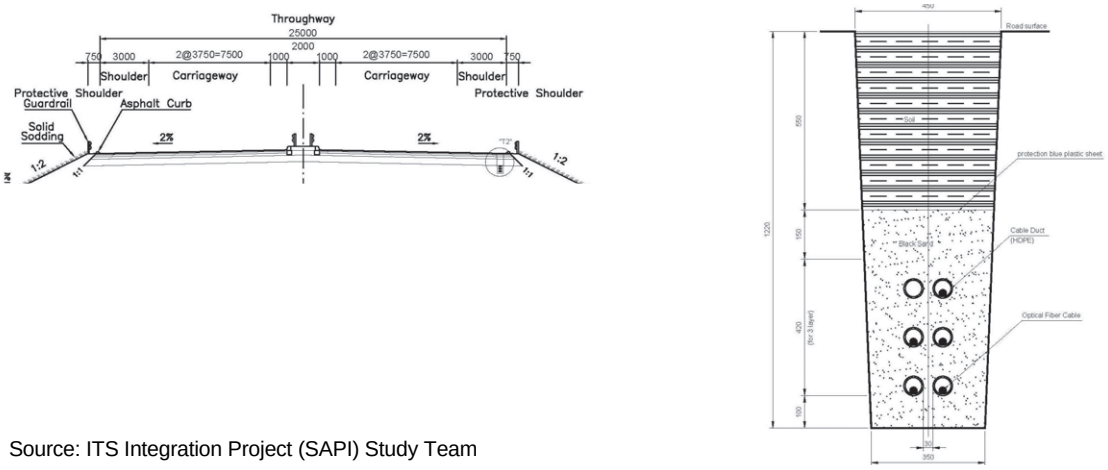
Planar Arrangement



	Expressway Section	Installation	Operation
1	RR3	Contractor	HDOT or O&M Company
2	Phap Van – Cau Gie	Contractor and VTN (not yet fixed)	BOT Investor or O&M Company
3	Cau Gie – Ninh Binh	Contractor and VTN (not yet fixed)	VEC O&M
4	Ha Noi – Bac Giang	Contractor and VTN	BOT Investor or O&M Company
5	Noi Bai – Ca Lo Bridge	Contractor	HDOT or O&M Company
6	Ca Lo Bridge – Bac Ninh	Contractor	BNDOT or O&M Company
7	Lang – Hoa Lac	Contractor	HDOT or O&M Company
8	Integration Layer Network	Contractor	O&M Company

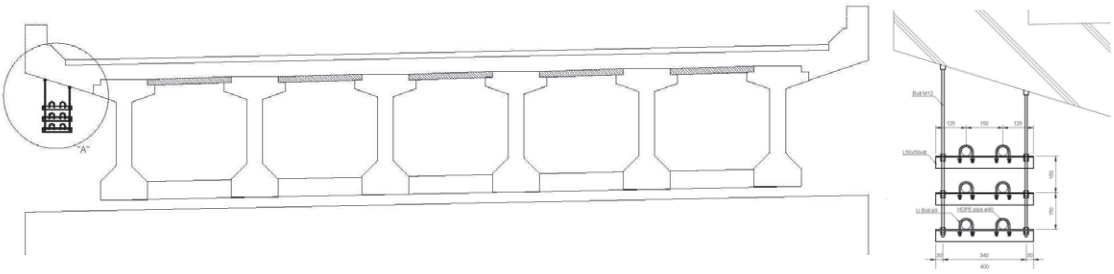
Source: The Study Team

Figure 9.36 Installation of Communication Duct at Earth Section



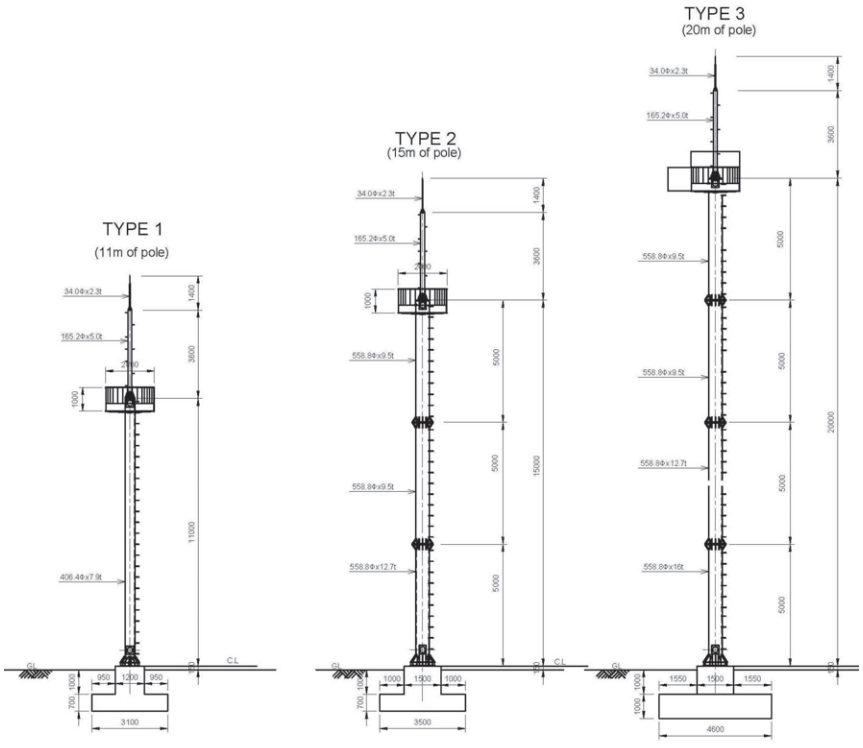
Source: ITS Integration Project (SAPI) Study Team

Figure 9.37 Installation of Communication Duct at Bridge Section



Source: ITS Integration Project (SAPI) Study Team

Figure 9.38 Installation of Radio Communication Antenna



Source: ITS Integration Project (SAPI) Study Team

9.7 Structures and Others

9.7.1 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.

9.7.2 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.

9.7.3 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.

The following values are "For Reference" in the case constructing a building of the Road Management Offce:

- 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 (For Reference)

Space of 20 m^2 is to be secured in all existing toll offices for ITS.

9.7.4 Electric Power Supply Plan/Design

The following discussion results are to be shown for the plan/design of power supply.

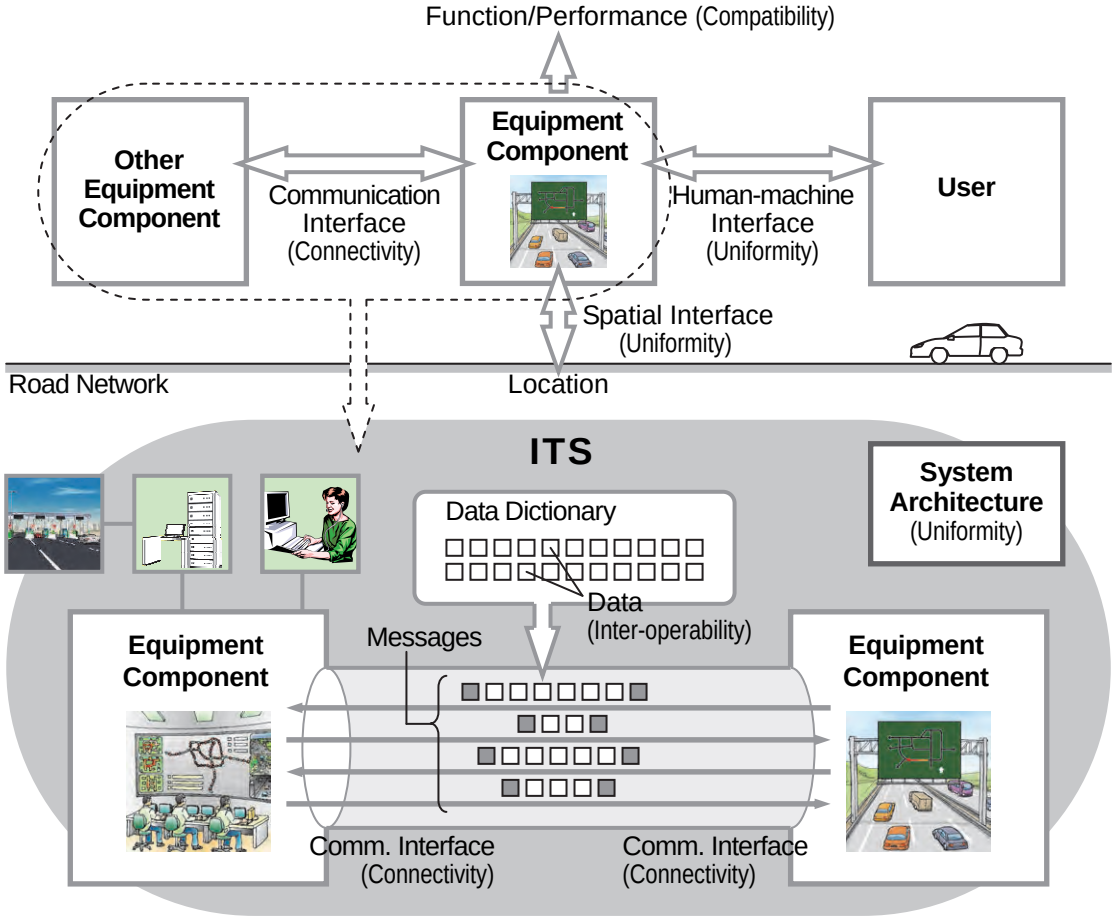
- Basic principle for design
- The survey on power supply status
- Responsibility demarcation point
- Power receiving capacity
- Voltage drop
- Northern Regional Main Center
- Road management office
- Toll office
- Roadside equipment

9.8 Summary 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 9.39 Performance Specifications on Equipment Component



Source: ITS Integration Project (SAPI) Study Team

Table 9.10 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	Connectivity	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. The equipment components defined in the system architecture are to be installed respectively in the centers, offices and other places, based on the Functional Packages, as shown in the figure and table below.

Table 9.11 Location of Equipment Components based on Functional Packages

Functional Packages		Center Subsystem						Roadside Subsystem	On-board Subsystem	Mobile Subsystem	In-door Subsystem
		Regional Main Center	Data Integration Center	Road Management Office	Toll Office	Road Owner's Head Office	OBU Registration Office				
1	Voice Communication	XX		XX	XX			XX			
2	CCTV Monitoring	XX		XX				XX			
3	Event Detection (by Image)							XX			
4	Vehicle Detection							XX			
5	Traffic Analysis	XX									
6	Weather Monitoring	XX						XX			
7	Traffic Event Management	XX		XX							
8	Traffic Supervision	XX									
9	VMS Indication	XX						XX			
10	Mobile Radio Communication			XX				XX		XX	
11	Traffic Information	XX									XX
12	Integrated Data Management	XX	XX		XX	XX					
13	Tollgate Lane Monitoring				XX			XX			
14	Vehicle/Class Identification							XX			
15	Lane Control							XX			
16	Road-to-Vehicle Communication							XX	XX		
17	IC-card Recording							XX		XX	XX
18	Toll Data Management				XX	XX					
19	OBU Management			XX			XX				XX
20	Axle Load Measurement							XX			
21	Measurement Lane Monitoring				XX						
Communication System		XX	XX	XX	XX			XX			
Communication Ducts		XX		XX	XX			XX			
Base Structures		XX		XX	XX			XX			
Electric Power Supply		XX	XX	XX	XX			XX			

Greyed out area is "For Reference". Source: The Study Team

The system for traffic information/control is composed of the twelve Functional Packages as shown below and the system architecture of each Functional Package is shown in the following figures.

Figure 9.40 Function Configuration for Traffic Information/Control

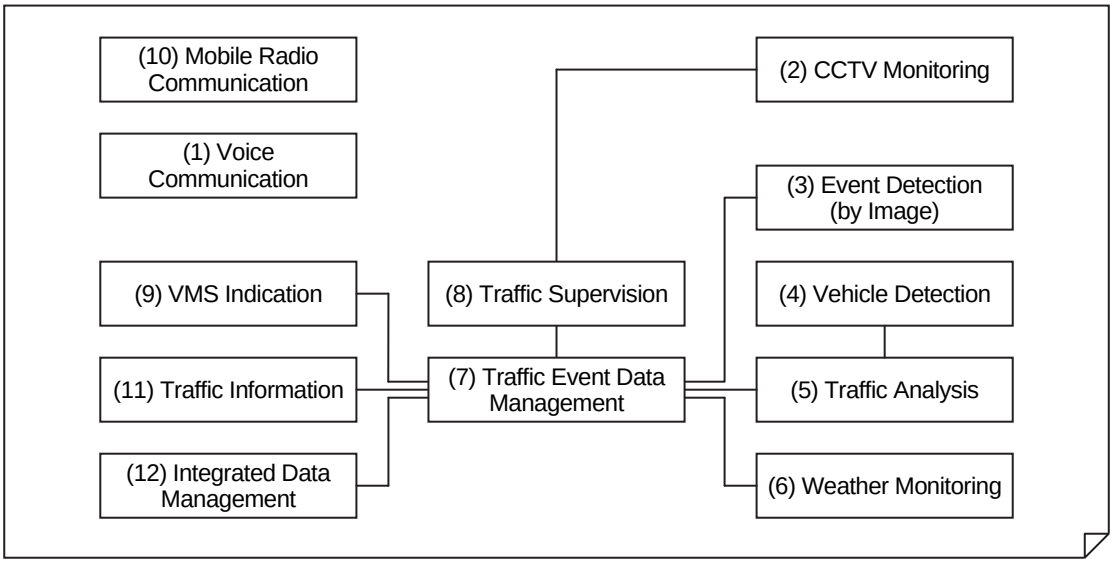
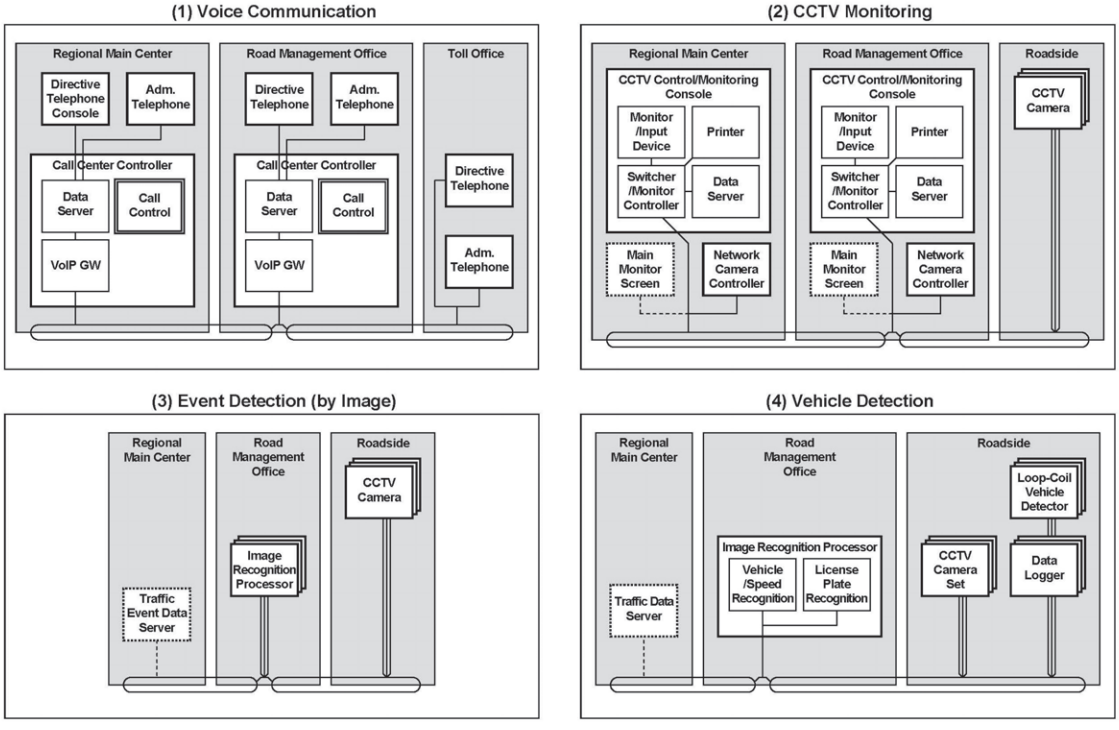
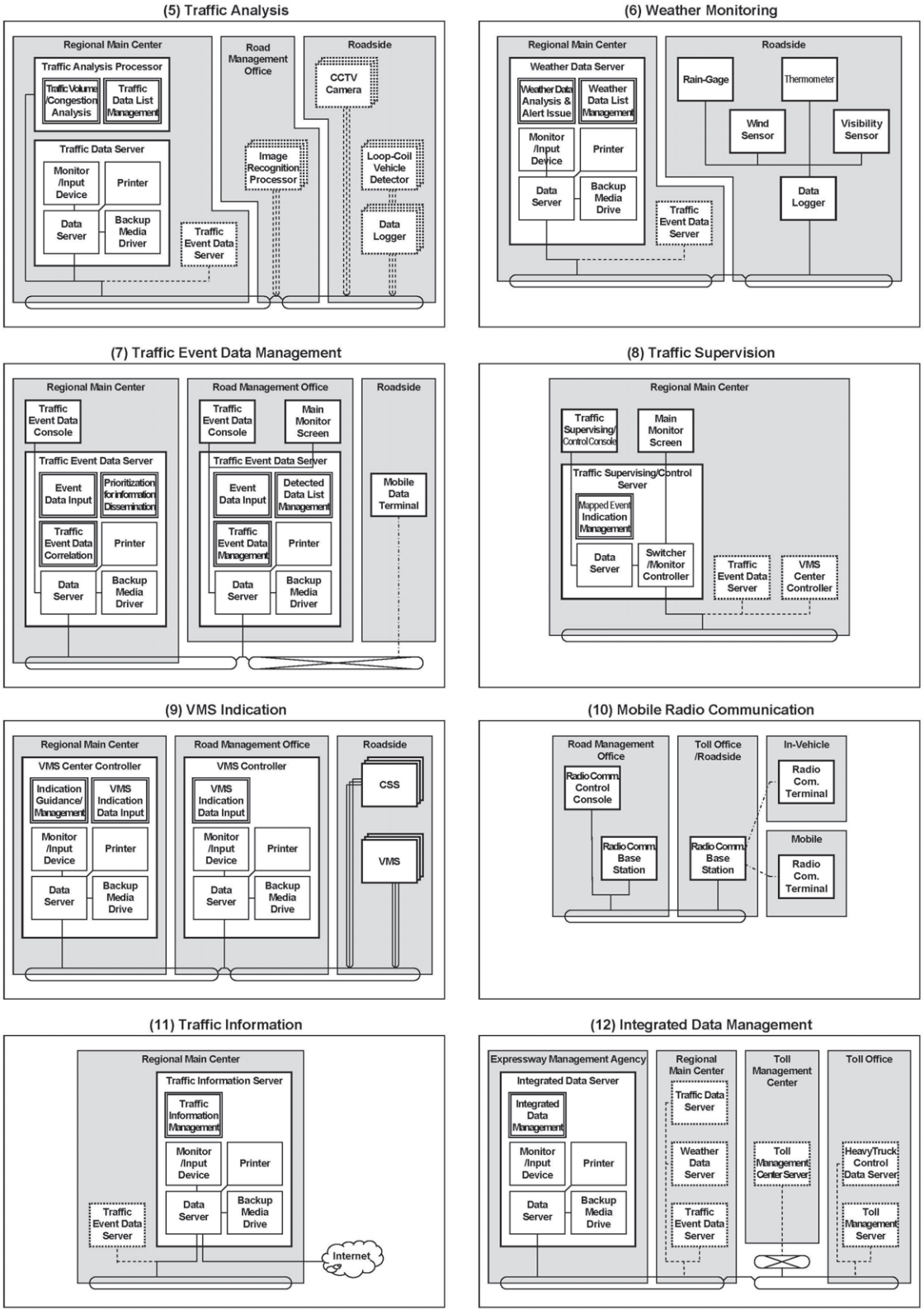


Figure 9.41 Detailed System Architectures of Functional Packages (1)-(4)



Source: The Study Team

Figure 9.42 Detailed System Architectures of Functional Packages (5)-(12)



: Location
: Equipment component
: Detailed Device
Broken Lines: Outside of This Functional Package
: Wireless communication
: Software

Source: The Study Team

The system for toll collection/management is composed of the seven Functional Packages as shown below and the system architecture of each Functional Package is shown in the following figures.

Figure 9.43 Function Configuration for Toll Collection/Management (For Reference)

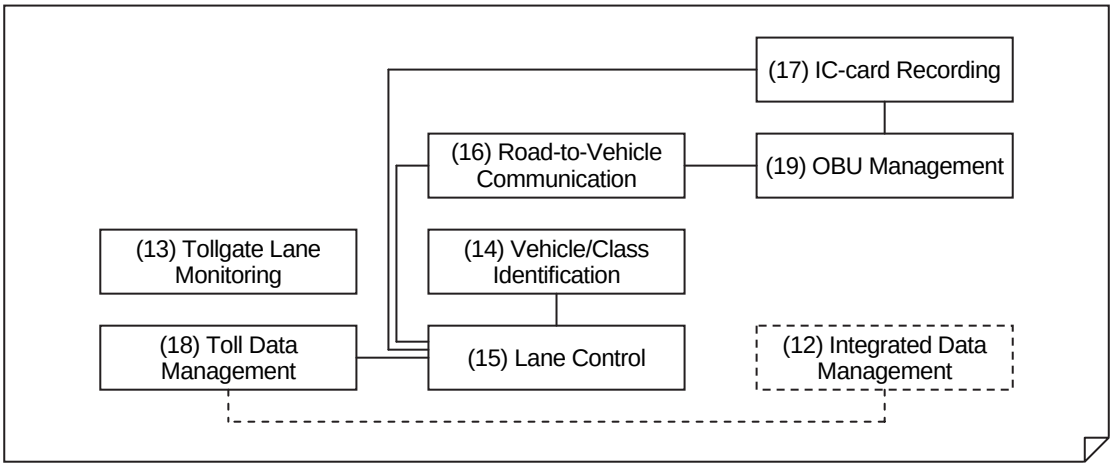
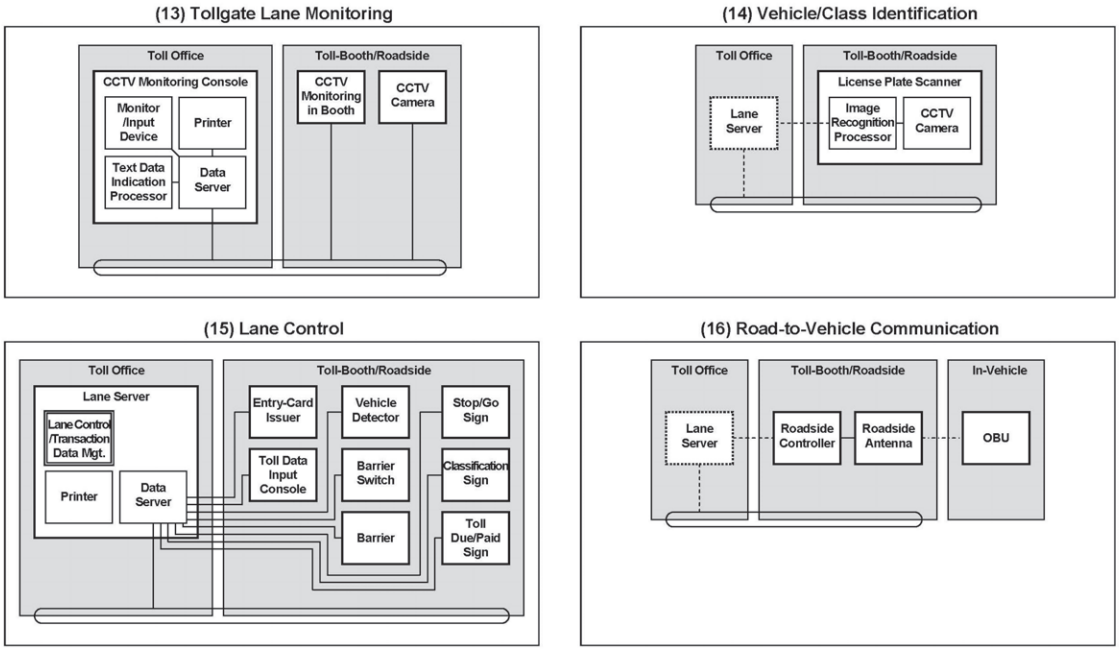


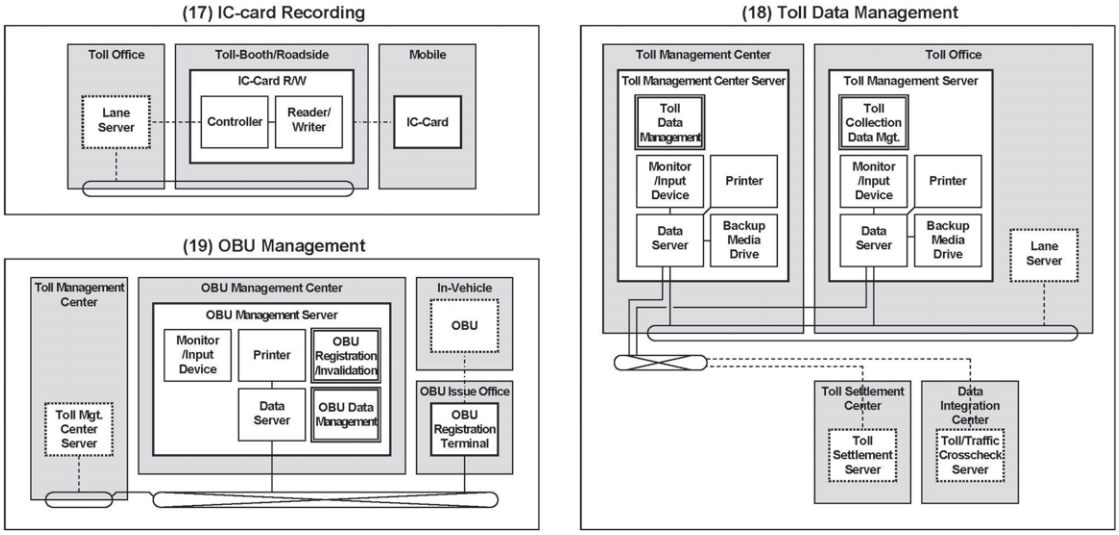
Figure 9.44 Detailed System Architectures of Functional Packages (13)-(16) (For Reference)



: Location
: Equipment component
: Detailed Device
Broken Lines: Outside of This Functional Package
: Wireless communication
: Software

Source: The Study Team

Figure 9.45 Detailed System Architectures of Functional Packages (17)-(19) (For Reference)



: Location
: Equipment component
: Detailed Device
Broken Lines: Outside of This Functional Package
: Wireless communication
: Software

Source: The Study Team

The system for vehicle weighing is composed of the two Functional Packages as shown below and the system architecture of each Functional Package is shown in the following figures.

Figure 9.46 Function Configuration for Vehicle Weighing (For Reference)

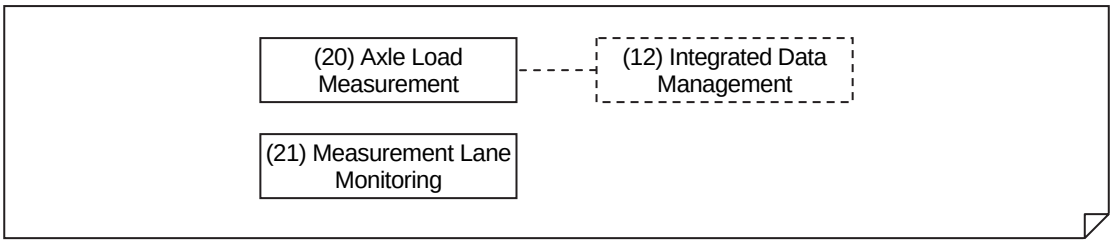
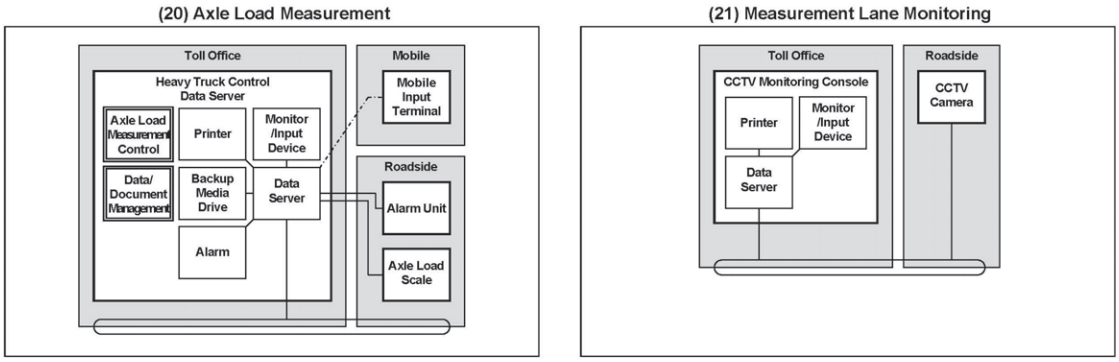


Figure 9.47 Detailed System Architectures of Functional Packages (20)-(21) (For Reference)



: Location
: Equipment component
: Detailed Device
Broken Lines: Outside of This Functional Package
: Wireless communication
: Software

Source: The Study Team

The requirements for the specification of functional packages and other items are listed in the following tables.

Table 9.12 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 the Regional Main Center, the Road Management Offices and the 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. • In case, part or whole of procurement and operation and maintenance related to the voice communication is to be outsourced to another organization such as telecommunications carrier or operator.	Regional Main Center Directive Telephone Console Administrative Telephone Call Center Controller Road Management Office Directive Telephone Administrative Telephone Call Center Controller 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, reverse driving, vandalism, flood, road damage, and natural disaster, by remote monitoring at the Regional Main Center and the Road Management Office. • To recognize the severity of incidents through identifying types of vehicles involved (such as trucks, buses and sedans) and identifying smoke or fire by appearance. • To identifying the place of incident occurrence at the Regional Main Center and the Road Management Office. • To control roadside equipment remotely from the Regional Main Center in real time and from the Road Management Office at an occurrence of incident. • To store the needed video images, such as the video image of traffic accident occurrence.	Roadside CCTV Camera Road Management Office CCTV Control/Monitoring Console Network Camera Controller Regional Main Center CCTV Control/Monitoring Console Network Camera Controller
(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 image analysis. • To notify the detected results automatically and promptly to the Regional Main Center and the Road Management Office. • To monitor original video image remotely at the Regional Main Center and the Road Management Office. • To identify the time and place of incident occurrence at the Regional Main Center and the Road Management Office.	Roadside CCTV Camera Road Management Office Image Recognition Processor
(4) Vehicle Detection	
Requirements	Major Equipment Component
• To measure number of vehicles and vehicle speed at a specific point on the road. • To notify the measured results automatically and promptly to the Regional Main Center and the Road Management Office. • To identify the time and place of measured values at the Regional Main Center road and management office.	Roadside Loop Coil Vehicle Detector Data-Logger CCTV Camera Road Management Office Image Recognition Processor

Source: The Study Team

Table 9.13 Requirements for Specification of Functional Packages and Other Items (2)

(5) Traffic Analysis	
Requirements	Major Equipment Component
• To calculate the traffic volume of each vehicle size (large vehicle and normal 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 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.	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 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 place/ seriousness. • To indicate the categorized events in Vietnamese and English. • To store the categorized events as the data for every 1 minutes in a database.	Roadside Mobile Data Terminal Road Management Office Traffic Event Data Console Traffic Event Data Server Main Monitor Screen Regional Main Center Traffic Event Data Console Traffic Event Data Server
(8) Traffic Supervision	
Requirements	Major Equipment Component
• To allow inputting the necessary data for generating/managing information for traffic control. • To indicate the road network that is object of operation and management by the road traffic operator. • To indicate the information categorized as traffic events with specific time and ~~/~~ place of their occurrences for the operators in the Regional Main Center and the Road Management Office.	Regional Main Center Traffic Supervising/Control Console Traffic Supervising/Control Server Main Monitor Screen

Source: The Study Team

Table 9.14 Requirements for Specification of Functional Packages and Other Items (3)

(9) VMS Indication	
Requirements	Major Equipment Component
• To disseminate information in the form of traffic events which includes traffic accidents, reverse driving, breakdown vehicles, left obstacle, natural disaster, vandalism, construction work, bad weather, flood, fire, traffic congestion and traffic restriction. • To indicate information in Vietnamese and English. • To indicate textual information to the drivers to read in their vehicles at the maximum speed 120 km/h. • To indicate the image such as pictographs in full-color. • To disseminate the textual information which is directly input from the Regional Main Center and the Road Management Office, irrespective of traffic event.	Roadside VMS CSS Road Management Office VMS Controller ** 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 or patrol crew to the Road Management Office. • To send directives to the units concerned simultaneously for clearing incidents and enforcing traffic regulations from the Road Management Office even though the receiving side using the terminal as normal communication. • To apply a full duplex communication method for interactive voice communication. • To obtain necessary license from Radio Frequency Directorate of Ministry of Information and Communication.	Toll Office/Roadside Radio Communication Base Station Road Management Office Radio Communication Control Console Radio Communication Base Station In-Vehicle Radio Communication Terminal 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 work 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 and vehicle weighing. • To integrate the data sets of incident, traffic volume, traffic congestion, bad weather, construction work, traffic restriction, hourly toll collection and axle load management into a form of historical data records. • To sort/display/output the historical data records in the form of list, table and graph as electronic data. • To search/calculate values required for checking validity of toll revenue in comparison with traffic data.	Regional Main Center Integrated Data Server **

Source: The Study Team

Table 9.15 Requirements for Specification of Functional Packages and Other Items (4)

Automated Toll Collection/Management System (For Reference)	
(13) Tollgate Lane Monitoring	
Requirements	Major Equipment Component
• To monitor vehicles passing through a tollgate lane, at the tollbooths and the Toll Office, and to identify their type of vehicle such as trailer, semi-trailer, bus and passenger car by visual observation. • To monitor toll payment/receipt transaction between a driver and a toll collector at the Toll Office. • To control the roadside equipment remotely at the Toll Office. • To store the needed video images such as the video image of violation/ vandalisation occurrence.	Toll Booth/Roadside CCTV Monitoring in Booth CCTV Camera Toll Office CCTV Monitoring Console
(14) Vehicle Identification	
Requirements	Major Equipment Component
• To monitor vehicles passing through a tollgate lane at the Toll Booth and the Toll Office, and identifying their type of vehicle such as trailer, semi-trailer, bus and passenger car by visual ovservation. • To measure the number of vehicles and the vehicle speed at a specific point on the road. • To recognize vehicle number plate, to convert textural information. • To display the image and the textural number plate of the vehicle on the monitor console in the Toll Booth, when the vehicle enter a tollgate lane. • To store the image and textural information of vehicle number plate. • To measure number of vehicles by trailers, semi-trailers and another type of vehicle by using number plate information. • To control the roadside equipment remotely at the Toll Office.	Toll-Booth/Roadside License Plate Scanner
(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 based on the regulated toll rate system. • To generate/process the data appropriate for collecting tolls based on the data from Entry-Card with 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 process the data for collecting tolls and giving the vehicle class by OBU/IC-card, in case of electric toll collection. • To process the data for collecting tolls and giving the vehicle class recognized by toll collector a higher priority, in case of manual toll collection. • To accept the settlement method such as by cash, prepaid and post-paid. • To check the prepaid balance of IC-card at Toll Booth. • To notify a driver, in case of prepaid balance shortage for required toll amount, the necessity to recharge prepaid balance before the next passage at the tollgate lane, indicating the amount due. • To control Barrier automatically according to the processing result of toll collection. • To block the vehicles without normal completion of toll collection by using Barrier and Barrier Switch. • 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 checking by toll collector.	Toll-Booth/Roadside Entry-Card Issuer Toll Data Input Console Vehicle Detector Barrier Switch Barrier Stop/Go Sign Classification Sign Toll Due/Paid Sign Toll Office Lane Server

Source: The Study Team

Table 9.16 Requirements for Specification of Functional Packages and Other Items (5)

(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%. • To accept the settlement method such as by prepaid and post-paid IC-card.	In-Vehicle OBU Toll-Booth/Roadside Roadside Antenna Roadside 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 securing 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.	Toll-Booth/Roadside IC-Card Reader/Writer Mobile IC-Card
(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.	Toll Office Toll Management Server Toll Management Center Toll Management Center 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
Vehicle Weighing System (For Reference)	
(20) Axle Load Measurement	
Requirements	Major Equipment Component
• To measure the number of axles and axle loads of vehicles in the high speed range, 10 -100 km/h. • To notify the detection of overloaded vehicle by using Alarm unit, Monitor and Mobile Input Terminal to the operator who monitors the measurement results in the Toll Office and other staff who monitors the measurement result at the roadside. • To generate/store identification data of overloaded vehicles. • To synchronize the measurement result and the image which is the front side of the vehicle include number plate. • To show the measurement result and the image to the driver for, the evidence of overload at the roadside by using Mobile Input Terminal. • To store the image which is the front side of the vehicle include number plate, and the measurement result of axle load, in case the overloaded vehicle.	Mobile Mobile Input Terminal Roadside Alarm Unit 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 at the Toll Office, and identifying their type such as trailer, semi-trailer, bus and passenger car by visual observation. • To control the roadside equipment remotely at the Toll Office. • To store the needed image which is the front side of the vehicle include number plate, and the measurement result of axle load, in case the overloaded vehicle.	Roadside CCTV Camera Toll Office CCTV Monitoring Console

Source: The Study Team

Table 9.17 Requirements for Specification of Functional Packages and Other Items (6)

Communication System	
Requirements	Major Equipment Component
• To exchange data among roadside equipment on the expressways, the Regional Main Center and the Road Management Offices. • To transmit video images from roadside equipment to the Road Management Office and the Regional Main Center. • To transmit interactive voice communications among the Regional Main Center, Road Management Offices and the Toll 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 fault that occur on communication network.	Regional Main Center L3SW Road Management Office L3SW Toll Office L2SW
Communication Ducts	
Requirements	Major Materials
• To secure the space/route for installing optical fiber cable for building communication network continuously through the earthwork sections and the bridge sections • To protect installed optical fiber cable and its joint from external factor such as traffic accident • To provide easy addition of optical fiber cable or replacement of the installed cable	Roadside HDPE Pipe Cement Fine Aggregate Coarse Aggregate Reinforcing Bar Spacer for Ducts
Base Structures	
Requirements	Major Materials
• 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 and on embankment slope. • To keep the roadside equipment in the original/proper position keeping the structure clearance from the road surface and in the original/proper direction for radio communication.	Roadside Structural Steel Cement Fine Aggregate Coarse Aggregate Reinforcing Bar

Source: The 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.

9.9 Quantities

Quantities of the project are shown in the table below categorized by equipment components.

Table 9.18 Quantity Table of Project

1. Traffic Information/Control System

Item No.	Equipment Component	Unit	Q'ty (a)
(1)	**Voice Communication**		
	Regional Main Center		
	Directive Communication Console	set	1
	Administrative Telephone	set	20
	Call Center Controller	set	1
	Call Control (Software)	set	1
	Road Management Office		
	Directive Telephone and Console	set	4.5
	Administrative Telephone	set	90
	Call Center Controller	set	4.5
	Call Control (Software)	set	4.5
	Toll Office		
	Directive Telephone	set	25
	Administrative Telephone	set	5
(2)	**CCTV Monitoring**		
	Roadside		
	CCTV Camera (PTZ type for Outside)	set	119
	Streamer	set	17
	Road Management Office		
	Network Camera Controller	set	1
	CCTV Control/Monitoring Console	set	1
	Regional Main Center		
	Network Camera Controller	set	4.1
	CCTV Control/Monitoring Console	set	4.1
(3)	**Event Detection (by Image)**		
	Roadside		
	CCTV Camera (Network Camera (Fix type for Image Recognition)	set	84
	Image Recognition Processor	set	84
(4)	**Vehicle Detection**		
	Roadside		
	Loop Coil Vehicle Detector	set	11
	Data Logger		11
	CCTV Camera	set	114
	Image Recognition Processor	set	114
(5)	**Traffic Analysis**		
	Regional Main Center		
	Traffic Analysis Processor	set	1
	Traffic Volume/Congestion Analysis (Software)	set	1
	Traffic Data List Management (Software)	set	1
	Traffic Data Server	set	1
(6)	**Weather Monitoring**		
	Regional Main Center		
	Weather Data Server	set	1
	Weather Data Analysis & Alert Issue (Software)	set	1
	Weather Data List Management	set	1

(7)	**Traffic Event Data Management**		
	Roadside		
	Mobile Input Terminal	set	25
	Road Management Office		
	Traffic Event Data Console	set	5.1
	Traffic Event Data Server	set	5.1
	Event Data Input (Software)	set	5.1
	Prioritization for Information Dissemination (Software)	set	5.1
	Traffic event Data Correlation (Software)	set	5.1
	Regional Main Center		
	Main Monitor Screen	set	1
	Traffic Event Data Console	set	1
	Traffic Event Data Server	set	1
	Event Data Input (Software)	set	1
	Prioritization for Information Dissemination (Software)	set	1
	Traffic event Data Correlation (Software)	set	1
(8)	**Traffic Supervision**		
	Regional Main Center		
	Main Monitor Screen	set	1
	Traffic Supervising/Control Console	set	1
	Traffic Supervising/Control Server	set	1
	Mapped Event Indication Management (Software)	set	1
(9)	**VMS Indication**		
	Roadside		
	VMS-type A	set	27
	VMS-type B	set	36
	VMS-type C	set	17
	CSS	set	50
	Road Management Office		
	VMS Center Controller	set	5.1
	VMS Indication Data Input (Software)	set	5.1
	Regional Main Center		
	VMS Center Controller	set	1
	Indication Guidance/Management (Software)	set	1
	VMS Indication Data Input (Software)	set	1
(10)	**Mobile Radio Communication**		
	Road Management Office		
	Radio Communication Base Station	set	2
	Radio Communication Control Console	set	2
	Toll Office		
	Radio Communication Base Station	set	5
	Mobile		
	Radio Communication Terminal	set	20
(11)	**Traffic Information**		
	Regional Main Center		
	Traffic Information Server	set	1
	Traffic Information Management (Software)	set	1
(12)	**Integrated Data Management**		
	Regional Main Center		
	Integrated Data Server	set	1
	Integrated Data Management (Software)	set	1

2. Automated Toll Collection/Management System (For Reference)

Item No.	Equipment Component	Unit	Q'ty (a)
(13)	**Tollgate Lane Monitoring**		
	Roadside		
	CCTV Camera (Fix Type)	set	48
	Toll Booth		
	CCTV Monitoring in Booth	set	48
	Toll Office		
	CCTV Monitoring Console	set	5
(14)	**Vehicle Identification**		
	Roadside		
	License Plate Scanner	set	57
(15)	**Lane Control**		
	Roadside		
	Vehicle Detector	set	57
	Entry-Card Issuer	set	57
	Toll Due/Paid Sign	set	57
	Stop/Go Sign	set	57
	Classification Sign	set	57
	Barrier	set	57
	Toll Booth		
	Toll Data Input Console	set	57
	Toll Office		
	Lane Server	set	5
	Lane Control/Transaction Data Management (Software)	set	5
(16)	**Road to Vehicle Communication**		
	In-Vehicle		
	OBU	set	5000
	Roadside		
	Roadside Antenna	set	10
	Roadside Controller	set	10
(17)	**IC-Card Recording**		
	Roadside		
	IC-Card Reader/Writer	set	10
	Mobile		
	IC-card	set	5000
(18)	**Toll Management**		
	Toll Office		
	Toll Management Server	set	5
	Toll Collection Data Management (Software)	set	5
	Toll Management Center		
	Toll Management Center Server	set	2
	Toll Data Management (Software)	set	2
(19)	**OBU Management**		
	OBU Issue Office		
	OBU Registration Terminal	set	1
	OBU Management Center		
	OBU Management Server	set	1
	OBU registration/Invalidation (Software)	set	1
	OBU Data Management (Software)	set	1

3. Vehicle Weighing System (For Reference)

Item No.	Equipment Component	Unit	Q'ty (a)
(20)	**Axle Load Measurement**		
	Roadside		
	Axle Load Scale	set	8
	Alarm Unit	set	8
	Toll Office		
	Heavy Truck Control Data Server	set	5
	Axle Load Measurement Control	set	5
	Data/Document Management	set	5
(21)	**Measurement Lane Monitoring**		
	Mobile		
	Mobile Input Terminal	set	10
	Roadside		
	CCTV Camera	set	8
	Toll Office		
	CCTV Monitoring Console	set	5

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	327.84
	Cable Termination	set	18
	Regional Main Center		
	L3SW	set	3
	L2SW	set	7
	Network Management System	set	1
	Road Management Office		
	L3SW	set	20
	L2SW	set	40
	Network Management System	set	6.6

5. Communication Ducts

Item No.	Equipment Component	Unit	Q'ty (a)
	Communication Ducts		
	Duct for Earthwork section	km	111.40
	Duct for Bridge Attachment	km	68.00
	Cable Chamber	Each	825

6. Base Structure

Item No.	Equipment Component	Unit	Q'ty (a)
	Pole		
	Pole for CCTV	each	97
	Pole for CSS	each	41
	Gantry Type G1	each	71
	Gantry Type G2	each	5
	Gantry Type G3	each	17
	Tower	each	13

7. 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

8. Electric Power Supply (Back-up)

Item No.	Equipment Component	Unit	Q'ty (a)
	Electric Power Supply (Back-up)		
	Back-up Power Supply Facilities	Set	12

9. O&M Vehicle

Item No.	Equipment Component	Unit	Q'ty (a)
	O&M Vehicle		
	Patrol Vehicle	set	5
	Towing Car	set	5

Source: The Study Team

9.10 Needed Harmonization to Existing Conditions and Requests of MOT

1) Proposed Equipment Components to be substituted with Existing System

In the foregoing discussions up to the section of "9.9 Quantities", some of the equipment components which can be substituted by the components of the existing system installed in the sections as shown below have been excluded from the Scope of the Project, although they are located in the target road network of the Project:

- Mai Dich – Thanh Tri and Phap Van – Cau Gie Sections: System installed by JICA Grant
- Cau Gie – Ninh Binh Section: System installed by other project by CadPro.

2) Traffic Information/Control System of BOT Sections

In the foregoing discussions, all parts of the Traffic Information/Control System excluding the parts shown in 1) have been assumed as the system to be installed in the Project.

However, it has become clear through the Study that the BOT companies, which have been assigned to operate the sections included in the target road network of the Project, have decided to install their Traffic Information/Control Systems by their own investment without government financial assistance and MOT agreed it.

Accordingly, such parts of Traffic Information/Control System for the two BOT sections are to be excluded from the Project Scope and from the discussions in the following chapters in principle; however, the components necessary for securing connectivity, inter-operability and functional continuity among the systems of the BOT Sections and of the other parts of the target road sections need to be installed in the Project. It is concluded for the BOT sections that the following parts of Traffic Information/Control System are to be installed in the Project:

- Phap Van – Cau Gie Section: The components for connection/inter-operation

- Ha Noi – Bac Giang Section: The roadside equipment components, ducts and power supply between Ha Noi and Bac Ninh, and the components for connection/inter-operation including the components to be installed in a space 30 m^2 in the Road Management Office.

Whereby the system integration for the whole target road network can be established. And in addition, the components and systems installed in the BOT Sections need to be investigated just prior to the commencement of the Project and the results are to be described in the Contract as the preconditions of existing system for the Detailed Design of the Project.

3) Toll Collection/Management System

In the foregoing sections, the Toll Collection/Management System has been discussed as an item of the system to be installed in the Project.

However, it has become clear through the Study that installation of the toll collection is to be limited to the two sections operated by BOT companies and that these companies have decided to install their Toll Collection/Management Systems including ETC, which are to be provided by a domestic private company, by their own investment without government financial assistance. Additionally, MOT has agreed that a type of ETC system appropriate for this country is to be selected eventually through the market competition process.

For the reasons above, MOT is requesting to exclude the Toll Collection/Management System from the Project Scope and from the discussions in the following chapters. It is needed to secure harmonization to such conditions.

4) Vehicle Weighing System

In the foregoing sections, the Vehicle Weighing System has been discussed as an item of the system to be installed in the Project. However, it has become clear through the Study that this system is in the same condition as that of the Toll Collection/Management System.

For this reason, MOT is requesting to exclude the Vehicle Weighing System from the Project Scope and from the discussions in the following chapters. It is needed to secure harmonization to such conditions.

9.11 Project Cost

Project cost is to be estimated, based on the results of basic design foregoing, in consideration of the main points below.

- Unit prices of equipment and installation works adopted in this project were set based on the result of quotations by Vietnamese companies and Japanese companies.
- Regarding the Items for which quotations were received from two or more companies, the Study Team decided a unit price from the viewpoint of experience of the companies.
- The Study Team conducted assessments of prices according to the local conditions.
- 10% of equipment cost including the cost for installation, test and inspection was added to the original equipment cost as the cost for spare parts for two years.
- The result of cost estimation was summarized for each Functional Package and for each expressway/section.
- The common cost such as "design and construction management" were calculated

independently for each section.

- The costs of "Guideline and manual preparation" and "Initial operation training" were calculated as the common cost.
- Price Escalation for Foreign Currency 2.0%, Price Escalation for Local currency 4.9% and Physical Contingency: 5.0%. These values were applied in accordance with JICA's policy and instruction.

Required cost of the Project is estimated as shown in the table below in the following manner:

- The values of Toll Collection/Management and of Vehicle Weighing are shown only for reference.
- The Project Cost is divided into the part to be implemented directly by the Project and the part to be implemented by the budget of BOT in consideration of the requests by MOT.
- The values of "Cost for Reference" shows all results estimated in the Study.

Table 9.19 Project Cost

No.	Category	Project Cost (To be implemented directly by Project)		Project Cost (To be implemented by Budget of BOT)		Cost for Reference	
		Value in JPY (Million JPY)	Value in VND (Billion VND)	Value in JPY (Million JPY)	Value in VND (Billion VND)	Value in JPY (Million JPY)	Value in VND (Billion VND)
1	Traffic Information/Control	2,990.4	536.9	696.0	124.9	3,686.4	661.8
2	Toll Collection/Management	--	--	1,373.8	249.3	1,373.8	249.3
3	Vehicle Weighing	--	--	423.0	75.9	423.0	75.9
4	Communication System	279.5	50.2	26.5	4.7	306.0	54.9
5	Communication Ducts	832.4	149.4	72.1	13.0	904.5	162.4
6	Building (NRMC)	144.7	26.0	--	--	144.7	26.0
7	Building (RMO)	--	--	--	--	50.2	9.0
8	Back-up Power Supply	451.3	81.0	51.7	9.3	503.0	90.3
9	O&M Vehicle	56.4	10.1	22.6	4.1	79.0	14.2
10	Subtotal (1+2+3+4+5+6+7+8+9)	4,754.7	853.6	2665.7	481.2	7,470.6	1,343.8
11	Consulting Service	544.0	97.7	--	--	621.9	111.7
12	Subtotal (10+11)	5,298.7	951.3	2665.7	481.2	8,092.5	1,455.5
13	Price Escalation	658.9	118.3	--	--	--	--
14	Physical Contingency	297.9	53.5	--	--	--	--
15	Subtotal (12+13+14)	6,255.6	1,123.1	--	--	--	--
16	Tax (10%, to be paid by LC)	625.6	112.3	--	--	--	--
17	Grand Total (15+16)	6,881.1	1,235.4	--	--	--	--

Exchange Rate (June 2015): 1US$ = JPY 120.70, 1US$ = VND 21,673,
NRMC: Northern Regional Main Center, RMO: Road Management Office for Lang – Hoa Lac

Source: The Study Team

9.12 Evaluation of Estimated Project Cost

1) Propriety of Estimated Project Cost

The allocation of the Project cost only of traffic information/control system and communication system for each section of the target road network and its unit cost (per kilometer) is shown in the table below. Where the Project cost, that is to say ITS implementation cost, comprises the equipment/matrial cost and the installation cost including the procurement cost and the testing/inspection cost.

Table 9.20 Allocation of Project Cost to Each Section

Section	Total ITS Implementation Cost		Road Length (km)	Unit Cost (per km)	
	Million JPY	Billion VND		Million JPY	Billion VND
Northern Regional Main Center	942.2	169.2	--	--	--
Mai Dich–Thanh Tri (Ring Road 3)	814.7	146.3	27	30.2	5.4
Lang–Hoa Lac	750.4	134.7	28	26.8	4.8
Phap Van–Cau Gie	354.1	63.6	30	11.8	2.1
Cau Gie–Ninh Binh	363.6	65.3	50	7.3	1.3
Ha Noi–Bac Giang	522.1	93.7	46	11.3	2.0
Noi Bai–Ca Lo Bridge	497.5	89.3	16	31.1	5.6
Ca Lo Bridge–Bac Ninh	510.2	91.6	17	30.0	5.4

Source: The Study Team

Additionally in this section, a comparison is to be made, using the ITS implementation cost per unit road length, between the Project cost above and the costs of two other expressway sections: Da Nang – Quang Ngai and Ha Noi – Hai Phong. However, it should be noted the ITS implementation cost of the Project in the table below excludes the costs for constructing the buildings, the electronic toll collection system and vehicle weighing system.

Table 9.21 Comparison of ITS Implementation Cost per Unit Road Length

Name of Project/Section	Total ITS Implementation Cost		Road Length (km)	Unit Cost (per km)	
	Million JPY	Billion VND		Million JPY	Billion VND
The Project	4,553.64	817.53	214.00	21.28	3.82
Da Nang – Quang Ngai	3,331.30	598.08	139.00	23.97	4.30
Hanoi - Hai Phong	3,678.12	660.35	105.84	34.75	6.24

Source: The Study Team

From the comparison results above, it is confirmed that the estimated unit cost of the Project is lower than or in the same level as that of the two sections. Accordingly, the ITS proposed for the Project and the estimated Project cost above are to be considered reasonable.

2) Major Factors of Difference from Project Cost Estimated in SAPI

The items below are the major factors of the difference between the Project Cost (Eligible Part): 5,349 million JPY estimated in the Study (at Exchange Rate 1US$ = JPY 120.70 in June 2015) and 5,731 million JPY estimated in SAPI (at Exchange Rate 1US$ = JPY 81.68 in February 2012).

Major Factors increasing Project Cost:

- Change in exchanging rate: 2,738 million JPY
- Addition of license plate recognition system for speed trap: 126 million JPY
- Addition of O&M vehicles: 56 million JPY.

Major Factors decreasing Project Cost:

- Exclusion of Toll Collection/Management (to be implemented by BOT company): -1,374 million JPY
- Exclusion of Vehicle Weighing (to be implemented by BOT company): -423 million JPY
- Execution of equipment components of Traffic Information/Control in BOT sections (to be implemented by BOT company): -869 million JPY
- Cost reduction by reviewing: -636 million JPY.

3) Required Cost for Technology of "Integrated/Prioritized Information Dissemination"

For the implementation of ITS Integration Project, the technology of "integrated/prioritized information dissemination", which is the core part of the traffic information/control, has been established only in Japan. Accordingly this part of the Project needs to be provided by the supplier which has the track records of this technology in Japan.

However, as shown in the table below, the implementation cost of this technology has amounted to 852.6 million JPY, which has taken account for only 17.9% of the Total Project cost at 4,754.7 million JPY. The advantages of this technology aforementioned, which are extremely useful for the traffic control of expressway network, can be realized by such limited amount of implementation cost.

In addition, other large parts of the Project can be provided by any suppliers in the world including the local companies in Vietnam.

Table 9.22 Breakdown of Project Cost

Item	Project Cost	
	Value in JPY (Million JPY)	Value in VND (Billion VND)
Part of System for "Integrated/Prioritized Information Dissemination"	852.6	153.1
Other Part of System including all Roadside Equipment Components	2,417.4	434.0
Communication Duct, Building and Others	1,484.8	266.6
Total	4,754.7	853.6

Source: The Study Team

10. Feasibility Study of Project

10.1 General

The discussion results of the following items are presented in this chapter:

- Economic Analysis
- Financial Analysis
- Conclusion
- Target to be Set-up for Post-evaluation
- Financial Schedule.

10.2 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 Quantifiable Separately from That of Road

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 10.1 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.

10.3 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 (For reference)
- Vehicle weighing (For reference)

10.3.1 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 10.2 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 10.3 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 10.4 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 10.5 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 10.6 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 10.7 Traffic Accident Rate in Expressway in Japan

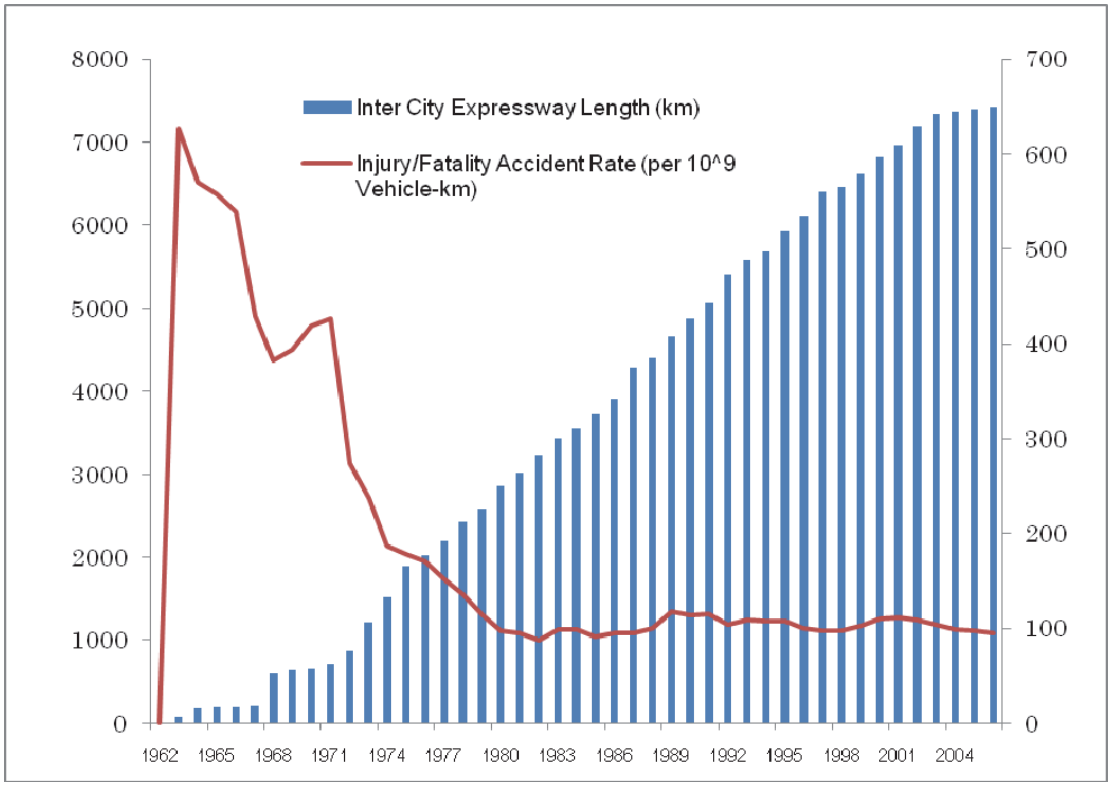
Year	Number of Accidents (Injury/Fatality Accident)	Total Length on Operation (km) of Expressway	Estimated Rate of Accident per km of Expressway Operation Length
1965	301	189.7	1.59
1970	2,671	649.3	4.11
1975	2,271	1,888.3	1.20
1980	2,152	2,859.8	0.75
1985	2,802	3,720.9	0.75
1990	5,541	4,869.4	1.14
1995	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). 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 10.1 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 10.8 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 Intersection 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 10.9 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 arrive 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. 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 10.10 Estimated Number of Accidents in Expressway to be Identified by CCTV Camera (PTZ Camera)

	Without CCTV Camera	With CCTV Camera
		Targeted Expressways
Total Number of CCTV Camera (PTZ Camera) to be Equipped	Zero	167
Coverage Length of Surveillance Range by CCTV Camera (km in length)	Zero km	214 km
Estimated Number of Accidents to be Identified by CCTV Camera (PTZ Camera) (= Effect by CCTV Camera)	Zero	214

Source: Estimated by the Study Team
Note: The objective expressway sections are:
Targeted Expressways including Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.

10.3.2 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.)

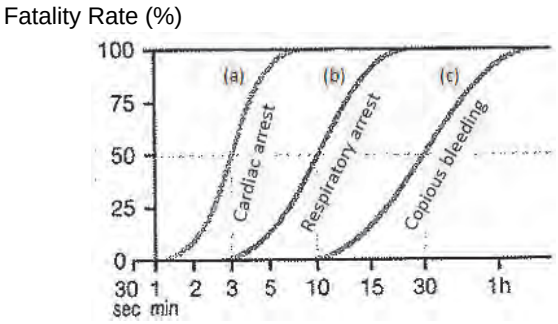
(b) That is, this enable to shorten the required time taken for emergency vehicles (ambulance, police car, tow truck, etc.) to arrive at scene of incidents.
(The reduction of required time for emergency services can be also obtained through mitigation of traffic congestion by detour selection of some 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 10.2 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 equipment 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 10.11 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 (shown in the figure foregoing), 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 (shown in the figure foregoing), 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)

Based 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 the table foregoing, 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 10.12 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
Targeted Expressways (214 km)	2020	328	230	115	0.54	1,968	1,378	689	3.22
	2030	508	356	178	0.83	3,051	2,136	1,068	4.99

Source: Estimated by the 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:
Targeted Expressways including Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.

(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.

10.3.3 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.

10.3.4 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.

10.3.5 Non-Stop Toll Collection (ETC) (For Reference)

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 10.13 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
Targeted Expressways	2020	5,096	3,066	2,030(40%)
	2030	7,899	4,752	3,147 (40%)

Source: Estimated by the Study Team
Note: i) The objective expressway sections are:
Targeted Expressways including Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.
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 10.14 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
Targeted Expressways	2020	3,977.9	3,966.3	11.6(0.3%)
	2030	5,820.8	5,803.8	17.0(0.3%)

Source: Estimated by the 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:
Targeted Expressways including Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.
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".

(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 of ETC is shown in terms of the reduced rate of approximately 0.3% in “With ETC” compared to “Without ETC”.

Table 10.15 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
Targeted	2020	1,405.7	1,401.4	4.3 (0.3%)
Expressways	2030	2,062.9	2,056.6	6.3(0.3%)

Source: Estimated by the 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:
Targeted Expressways including Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.
iii) (%) in the column of reduction stands for the reduced rate compared to “Without ETC”.

10.3.6 Vehicle Weighing (For Reference)

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.

10.4 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 to be 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.

In addition, according to the engineering study results, the cost of ITS implementation will be different regarding the cost related to the methods of system integration. In this study, the cost reduction by integrated system implementation is to be estimated by making comparison between the cases of integration by “stepwise method” and by “immediate method”.

10.5 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 of the Targeted Expressways are shown as follows:

Table 10.16 Estimated Cost for ITS Implementation

	Estimated ITS Implementation Cost (Million Yen)	Distance km	Estimated ITS Implementation Cost per Kilometer (Million Yen)
Targeted Expressways	6,881	214	32.2

Source: Estimated by the Study Team

Note: ITS Cost includes construction cost, consulting services, price contingency, physical contingency, project administration cost, and tax (VAT), excluding financial costs of IDC, commitment charge
The objective expressway sections are:
Targeted Expressways including Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.

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 10.17 Estimated Cost of Road Construction by Objective Expressway

Expressway	Estimated Cost Adjusted Yen Basis (Million Yen at Year 2015 Price)	Total Length (km)	Adjusted Cost per km (Million Yen per km)
Mai Dich – Thanh Tri (Ring Road 3)	109,666	27	4,062
Lang – Hoa Lac	63,606	28	2,272
Phap Van – Cau Gie	30,448	30	1,015
Cau Gie – Ninh Binh	59,516	50	1,190
Ha Noi – Bac Giang	43,988	46	956
Noi Bai – Ca Lo Bridge	19,854	33	602
Ca Lo Bridge – Bac Ninh			
(Total)	327,078	214	1,528

Source: Estimated by the 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 the case of Targeted Expressways are estimated as follows:

Table 10.18 Estimated Weighted Average Road Construction Cost per Kilometer

	Estimated Road construction Cost (Adjusted Yen Basis Million Yen at Year 2015 Price)	Distance Km	Estimated Weighted Average Road Construction Cost per Kilometer (Million Yen)
Targeted Expressways	327,078	214	1,528

Source: Estimated by the Study Team
Note: The objective expressway sections are:
Targeted Expressways including Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.

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 the case of Targeted Expressways shows 3%. This ratio is 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 are considered financially reasonable.

Table 10.19 Cost Ratio of ITS Implementation to Road Construction

	Estimated ITS Implementation Cost per Kilometer (Million Yen) (a)	Estimated Weighted Average Road Construction Cost per Kilometer (Million Yen) (b)	Estimated Ratio (a) / (b)
Targeted Expressways	32.2	1,528	2.11%

Source: Estimated by the Study Team
Note: The objective expressway sections are:
Targeted Expressways including Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge, Ca Lo Bridge - Bac Ninh, Phap Van – Cau Gie, Cau Gie – Ninh Binh, and Lang – Hoa Lac.

10.6 Cost Reduction by Integrated System Implementation

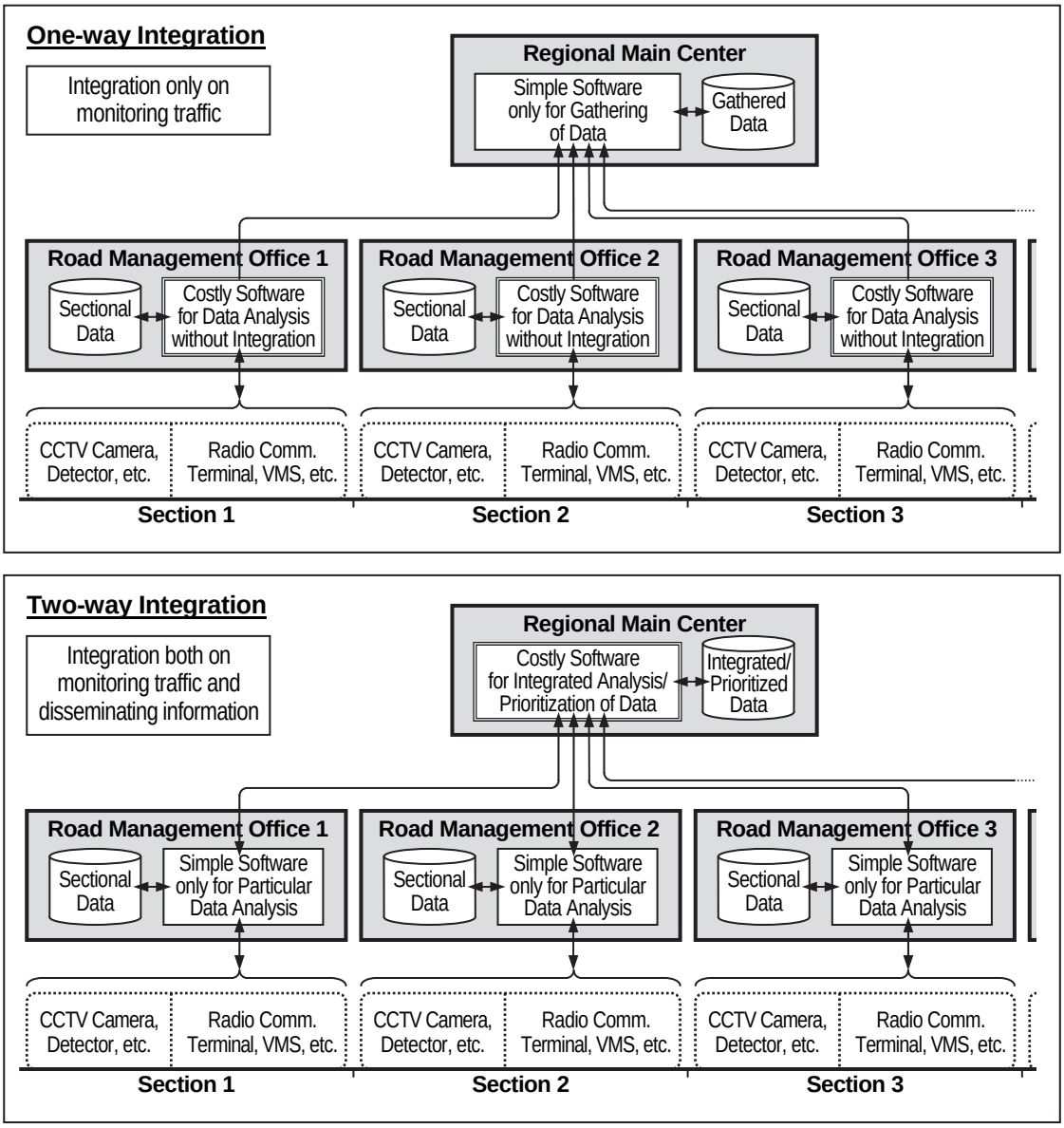
There can be the two methods for the integrated system implementation of ITS.

- Stepwise Method:
  - One-way Integration in the stage of the ITS Integration Project
  - Two-way Integration in the later stage.
- Immediate Method:
  - Two-way Integration in the stage of the ITS Integration Project immediately.

The definitions of the One-way Integration and the Two-way Integration are as shown below and their images are shown in the next page.

- One-way Integration: integration only on monitoring but on information dissemination.
- Two-way Integration: integration both on monitoring and on information dissemination.

Figure 10.3 Images of One-way Integration and Two-way Integration



Source: The Study Team

However, the Stepwise Method requires the following losses (i.e. unnecessary costs):

- Losses due to duplication of hardware/software (by implementing them separately in the expressway sections)
- Losses due to modification/replacement of hardware/software (for retrofitting connection/ inter-operation with the system separately implemented in the expressway sections)
- Losses due to the payment of technical disclosure fee (for retrofitting connection/ inter-operation with the system separately implemented in the expressway sections).

A comparison on the system implementation cost is to be made, based on the estimated cost shown in Section 9.10, between the Stepwise Method and the Immediate Method for the following 10 expressways, with a total length of 673 km, to which ITS will be installed in the same time frame:

- Mai Dich – Thanh Tri (Ring Road 3)
- Lang – Hoa Lac
- Phap Van – Cau Gie
- Cau Gie – Ninh Binh
- Ha Noi – Bac Giang
- Noi Bai – Ca Lo Bridge
- Ca Lo Bridge – Bac Ninh

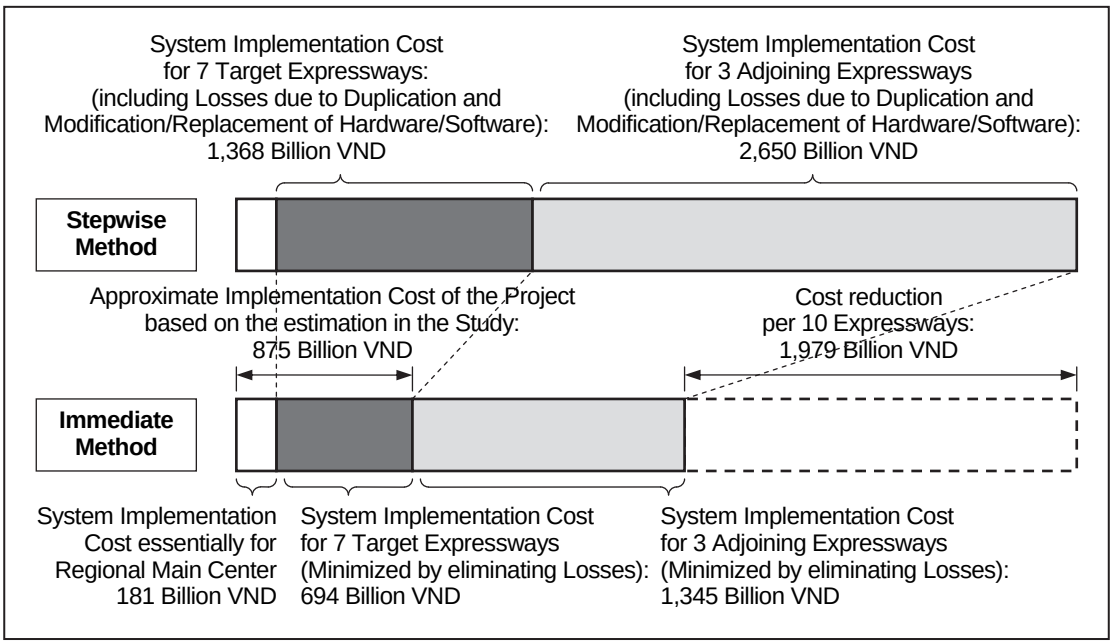
} 7 target expressways of the Project

- Ha Noi – Hai Phong
- Ha Noi – Thai Nguyen
- Noi Bai – Lao Cai.

} 3 adjoining expressways around the Project

The result is illustrated in the figure below in consideration of the losses due to the duplication and the modification/replacement of hardware/software, which are caused by the separate system implementation.

Figure 10.4 Comparison of System Implementation Costs considering Losses



Source: The Study Team

The effect of cost reduction by system integration for the 10 expressways with a total length of 673 km is estimated as 1,979 billion VND, which is equivalent to the difference in system implementation cost between the cases of integration by “stepwise method” and by “immediate method”.

The reduced cost, approximately estimated based on the values calculated in the Study, reaches an amount far larger than the implementation cost of the ITS Integration Project. And in addition to this amount, the cost due to the payment of technical disclosure fee is possibly be reduced.

Hence, the Immediate Method (i.e. immediate implementation of the Two-way Integration in the ITS Integration Project) is recommended to eliminate the unnecessary costs and to minimize the ITS implementation cost.

Additionally, it should be noted that most part of the effects by system integration is provided by the technology of “Two-way Integrated Traffic Information/Control actualized by Integrated/ Prioritized Information Dissemination (using traffic event data)”, which is highly advanced through actual application to traffic information/control over the expressway network more than 8,000 km in Japan.

10.7 Study Results

Quantified Effect:

The quantified ITS implementation effects, the cost ratio of ITS implementation to road construction and the costreduction effects by system integration are shown using the indicators -1 to -7 in the table.

Table 10.20 Quantified Effect for Targeted Expressways

	Without ITS	With ITS (by integrated system implementation by immediate method)
Operation Length km	Zero	214
Indicator-1: Estimated Number of Accidents to be Identified by CCTV Camera for Operation Length in km	Zero	214
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 2020)	1,378	689
(Number of Fatalities in 2030)	2,136	1,068
Reduction per Unit Length in Year 2020	--	3.22
Reduction per Unit Length in Year 2030	--	4.99
Indicator-3: Effect of Reduction of Passing Time at Tollgates for Operation Length in km (Unit : hours/day)		
(in 2020)	5,096	3,066
(in 2030)	7,899	4,752
Reduction in Year 2020	--	2,030
Reduction in Year 2030	--	3,147
Indicator-4: Effect of CO2 Emission Reduction for Operation Length in km (Unit : ton-CO2 per day)		
(in 2020)	3,977.9	3,966.3
(in 2030)	5,820.8	5,803.8
Reduction in Year 2020	--	11.6
(For reference) Reduction in Year 2030	--	17.0
Indicator-5: Effect of Fuel Consumption Reduction for Operation Length in km (Unit : Kilo Litter per day)		
(in 2020)	1,405.7	1,401.4
(in 2030)	2,062.9	2,056.6
Reduction in Year 2020	--	4.3
(For reference) Reduction in Year 2030	--	6.3
Indicator-6: Cost Ratio of ITS Implementation to Road Construction	--	2.11%
Indicator-7: Cost reduction by Integrated System Implementation (Unit : billion VND)	--	1,979

Source: Estimated by the 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.
The objective expressway sections are:
Targeted Expressways including Seven (7) Sections of Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.

Examined Appropriateness of the Project

From the results of the typical effects of ITS introduction from economic and financial aspects foregoing, it is examined that the ITS integration is to be achieved covering the 7 sections

as the Project Scope: Mai Dich – Thanh Tri (Ring Road 3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge, Ca Lo Bridge – Bac Ninh.

10.8 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: DRVN in 2023; after two (2) years from the completion of Project.

(1) Time taken for providing traffic information to road users:

- Base : Approx. 30 to 40 minutes in 2016 (by updated information in radio broadcasting)
- Target : Approx. 5 minutes in 2023 (using VMS)

Note: Objective of expressway sections (Target Expressway) are:
Mai Dich – Thanh Tri (Ring Road No.3), Lang – Hoa Lac, Phap Van – Cau Gie, Cau Gie – Ninh Binh, Ha Noi – Bac Giang, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.

(2) Time taken for dispatching emergency vehicle onto the through lanes of expressway:

- Base : Approx. 30 minutes in 2016
- Target : Approx. 5 minutes in 2023 (using ITS).

Note: Number of fatalities in accidents is determined by vehicle kilometers, 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 includes 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.

10.9 Preliminary Estimation of EIRR

1) Expected Implementation Effects

The effects of ITS implementation shown in section 10.2 are included originally in the effects of road construction and these two kinds of effects are inseparable. However, in this chapter, a preliminary estimation of EIRR is to be carried out focusing on the saving in vehicle time cost.

- **Benefit of Saving in Vehicle Time Cost:** Effect of saving in vehicle time cost by the promotion such as the detour or the adjustment of the departure time by the grasp of a quick event in the traffic congestion occurrence and the provision of information with a variety of media.

However, about the implementation effect of the ITS, generally the border with the road implementation effect is not clear, and it is thought that it is difficult to estimate only a implementation effect of the ITS strictly. And there is not the precedent which measured a implementation effect of the ITS as the actual situation, and in case of Vietnam, does the estimation by many assumptions.

2) Preliminary Estimation of Traffic Accident

The occurrence of the traffic congestion due to a traffic accident estimates saving of the congestion time by the avoidance behaviour of those estimated traffic congestion.

The occurrence number of events that needed the number of traffic accident occurrence (and fatalities) and rescue in operation started HCMC – Trung Luong Expressway in February, 2010 is as follows in 18 months.

Table 10.21 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 10.22 Incidents that need rescue on HCMC – Trung Luong Expressway during 18 Months since February 2010

Items	Bus	Truck	Total
One-car accident	946	1,805	2,751
Breakdown	2,386	2,071	4,457
(Total)	3,332	3,876	7,208

Source: Traffic Control Center, HCMC - Trung Luong Expressway

The number of traffic accidents is 113 per 18 month, and as for the breakdown, number of fatal accidents, 8 per 18 month and other accidents are 105 per 18 month. When HCMC – Trung Luong Expressway is extension 39.8km, when exchanging this toa unit in 1km/year, it is fatal accident: 0.13 per km-year, other accidents: 1.76 per km-year.

Because the total extension for this project is 214km, as for the number of annual occurrence, it is estimated a fatal accident: 27.82 per year, other accidents: 376.64 per year.

Table 10.23 The length of Expressway section

Road Name/Section	Length (km)
Mai Dich - Thanh Tri	27
Lang - Hoa Lac	28
Hanoi - Bac Giang	46
Noi Bai - Ca Lo bridge	16
Ca Lo bridge-Bac Ninh	17
Phap Van - Cau Gie	30
Cau Gie - Ninh Binh	50
(Total)	214

Source: Study Team

3) Preliminary Estimation of Traffic Volume

The traffic volume per day in 2020 and 2030 in a section targeted for a project is estimated to be follows. When take the average of all sections; 2020 is Passenger Car: 17,115, Bus: 10,613, Truck: 12,821, 2030 is Passenger Car: 28,108, Bus: 16,834, Truck: 16,634.

The estimate result of the traffic volume per time in the daytime, night and peak hour is shown as follows.

Table 10.24 Estimation of Traffic Volume (based on Table 10.30)

Section (vehicles per day)	2020			2030		
	PC	Bus	Truck	PC	Bus	Truck
Mai Dich - Tanh Tri (Ring Road 3)	24,311	6,419	13,678	37,678	8,152	17,004
Lang - Hoa Lac	19,650	2,443	12,932	19,761	2,461	13,004
Hanoi - Bac Giang (NH No.1)	13,100	3,300	10,300	14,000	3,500	10,900
Noi Bai - Bac Ninh (NH No.18)	8,215	1,391	8,827	21,200	3,664	19,579
Phap Van - Cau Gie	15,253	20,080	11,953	28,083	30,137	13,923
Cau Gie - Ninh Binh	22,160	30,048	19,236	47,928	53,094	25,396
(Average)	17,115	10,613	12,821	28,108	16,834	16,634

Source: Compiled by the Study Team

Table 10.25 Estimation of Traffic Volume on each Time Zone 2020

Type of Vehicle (vehicles per day)	Day-night ratio	Peak Ratio	2020	Time Zone		
			Average	Day Time	Night Time	Peak Time
Passenger Car	1.2	10%	17.115	14,263	2,853	1,712
Bus	1.2	10%	10,613	8,844	1,769	1,061
Truck	1.2	10%	12,821	10,684	2,137	1,282
(vehicles per hour)						
Passenger Car				1,084	238	1,712
Bus				672	147	1,061
Truck				812	178	1,282
(vehicles per hour-direction)						
Passenger Car				542	119	856
Bus				336	74	531
Truck				406	89	641

Source: Compiled by the Study Team

Table 10.26 Estimation of Traffic Volume on each Time Zone 2030

Type of Vehicle (vehicles per day)	Day-night ratio	Peak Ratio	2030 Average	Time Zone		
				Day Time	Night Time	Peak Time
Passenger Car	1.2	10%	28,108	23,423	4,685	2,811
Bus	1.2	10%	16,834	14,028	2,806	1,683
Truck	1.2	10%	16,634	13,862	2,772	1,663
(vehicles per hour)						
Passenger Car				1,780	390	2,811
Bus				1,066	234	1,683
Truck				1,053	231	1,663
(vehicles per hour-direction)						
Passenger Car				890	195	1,405
Bus				533	117	842
Truck				527	116	832

Source: Compiled by the Study Team

4) Preconditions for Preliminary Estimation

In estimation of the cost benefit by the implementation of the traffic control system, the following effects are assumed.

(1) Envisioned Development Effect

By provision of the traffic information to depend on patrol by the traffic operator using the CCTV camera and SNS such as variable message signboard, internet or Twitter, it promote the traffic congestion avoidance behavior (detour, departure time adjustment) of the user by to recognize an accident and the occurrence of the traffic congestion with it early and to provide information to a user using a variety of media and express a saving effect at traffic congestion time.

(2) Assumption Preconditions

- The number of occurrence of the fatal accident is 27.82 per year, other accident 376.64 per year.
- In the case of a fatal accident, assumes that the closure of traffic of all lanes is done starting from an occurrence place and, in the case of a collision, assumes that lane restriction is done starting from an occurrence place.
- In the case of the closure of all lanes, assumes that all of inflow traffic volume stays between to elimination of road obstacles and, in the case of lane restriction, assumes that 70% of inflow traffic volume stays between to elimination of road obstacles.
- Among traffic accident, assume that 20% occur in peak time, 60% occur in day time to exclude between peak hours and 20% occur in night time.
- After an accident inspection or vehicle evacuation, it is assumed the accident occurrence to be 120 minutes at time required for to elimination of road obstacles.
- After elimination of road obstacles, assume that there is not the inflow of the succeeding vehicle until the traffic volume that stayed drains all.
- （Without）In case of the undevelopment of traffic control system, assumes that the

provision of the traffic information to depend on SNS such as variable message signboard, Internet, Twitter is not done at all and assumes that there is not the traffic congestion avoidance behavior of the user.

- （Without）Because the advance grasp of site conditions by CCTV is not done, the dispatch of a towing vehicle according to the scale of the accident is late and needs great time in elimination of road obstacles.
- （With）Because a towing vehicle which provision of the traffic information to depend on SNS such as variable message signboard, Internet, Twitter is started after 30 minutes of the accident occurrence, and the traffic congestion avoidance behavior of the user is performed in the case of the preparation of the traffic control system and accepted the scale of the accident are dispatched since first action, assume that elimination of road obstacles is done quickly.
- About the traffic capacity, Nttmax = 2,000 PCU/hour.lane prescribed in TCVN5729 was adopted.
- Decided that the PCU corresponding value of each vehicle used the value of a table below prescribed in TCVN4054; Bus: 2.5pcu, Truck: 2.5pcu.

Table 10.27 Passenger Car Equivalent factors

Terrain	Type of vehicles					
	Bicycle	Motor bike	Car	Trucks of 2 axles and mini bus with less than 25 seats	Truck of more than 3 axles and large bus	Trailer and bus with trailer
Flat and rolling	0.2	0.3	1.0	2.0	2.5	4.0
Mountainous	0.2	0.3	1.0	2.5	3.0	5.0

Source: TCVN4054

- The unit price of the time according to types of vehicles in the cost estimation used the following value.

Table 10.28 Unit Value of Time in Each Transport Mode

Mode / Year	Bicycle	Motorcycle	Passenger Car	Bus	Truck
2014 ($/h) *1	1.3	1.9	2.8	1.5	2.8
2020 ($/h) *2	1.7	2.5	3.8	1.9	3.8
2030 ($/h) *1	2.5	3.5	5.3	2.8	5.3
2040 ($/h)*2	3.3	4.5	7.0	3.5	7.0
2050 ($/h)*2	4.0	5.5	8.5	4.3	8.5

*1) Source : JICA report
*2) Estimated by the trend of 2014's and 2030's

Source: the Study Team

5) Preliminary Estimation of Lost Cost

(1) Without

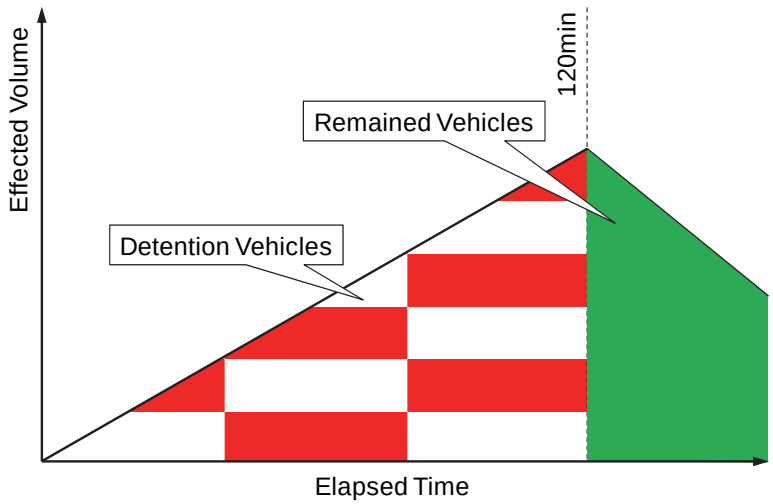
- All lane closure of traffic or lane closure of traffic is done including until leaving of an accident inspection and the accident vehicle from the traffic accident occurrence for 120 minutes.
- The occurrence of the traffic accident and the closed provision information are not performed, but the inflow restriction of the succeeding vehicle is done after elimination of road obstacles.
- It is as follows about the traffic volume (one-way) in the traffic accident occurrence point;

  [At year 2020] Day Time (per hour): Passenger Car 542, Bus 336, Truck 406
  Night Time (per hour): Passenger Car 119, Bus 74, Truck 89
  Peak Time (per hour): Passenger Car 856, Bus 531, Truck 641

  [At year 2030] Day Time (per hour): Passenger Car 890, Bus 533, Truck 527
  Night Time (per hour): Passenger Car 195, Bus 117, Truck 116
  Peak Time (per hour): Passenger Car 1,405, Bus 842, Truck 832

- An elapsed time from the traffic accident occurrence and relations of the traffic volume to be affected are shown in the chart below, the traffic volume x losses of the waiting time increase the traffic volume to be affected with an elapsed time increase, and to increase in waiting time.
- In addition, loss time occurs about those vehicles remaining in to need time according to traffic capacity so that the traffic volume that stayed disposes all in elimination of road obstacles.

Table 10.3 The relation between Elapsed Time and Effected Volume



Source: the Study Team

- From the traffic accident occurrence to elimination of road obstacles for 120 minutes, moreover the loss cost was estimated from the traffic accident occurrence as 120 minutes by provision information until the detour of the succeeding vehicle was done. The result of the estimation is shown in the table below.

Table 10.29 [Without] The lost cost during Road Closed / Lane Closed

	Road Closed			Lane Closed			Total (Thousand US$)	Total (Million JPY)	Total (Million VND)
	Value of Time in a year (US$)			Value of Time in a year (US$)					
	Day (60%)	Night (20%)	Peak (20%)	Day (60%)	Night (20%)	Peak (20%)			
2020	142,536	10,419	75,019	1,350,805	98,743	710,950	2,388	288	51,765
2021	155,935	11,399	82,071	1,477,784	108,025	777,781	2,613	315	56,631
2022	169,930	12,422	89,437	1,610,413	117,720	847,586	2,848	344	61,714
2023	184,521	13,488	97,116	1,748,690	127,828	920,363	3,092	373	67,013
2024	199,708	14,599	105,109	1,892,617	138,349	996,114	3,346	404	72,529
2025	215,491	15,752	113,416	2,042,193	149,283	1,074,838	3,611	436	78,261
2026	231,870	16,950	122,037	2,197,418	160,630	1,156,536	3,885	469	84,209
2027	248,846	18,190	130,971	2,358,292	172,390	1,241,206	4,170	503	90,374
2028	266,417	19,475	140,220	2,524,815	184,563	1,328,850	4,464	539	96,756
2029	284,585	20,803	149,781	2,696,988	197,148	1,419,467	4,769	576	103,354
2030	300,517	21,968	158,167	2,847,972	208,185	1,498,933	5,036	608	109,140
2031	322,708	23,590	169,846	3,058,280	223,558	1,609,621	5,408	653	117,199
2032	342,664	25,049	180,349	3,247,400	237,383	1,709,158	5,742	693	124,446
2033	363,216	26,551	191,166	3,442,169	251,621	1,811,668	6,086	735	131,910
2034	384,364	28,097	202,297	3,642,587	266,271	1,917,151	6,441	777	139,591
2035	406,108	29,686	213,741	3,848,655	281,334	2,025,608	6,805	821	147,488
2036	428,448	31,319	225,499	4,060,371	296,811	2,137,037	7,179	867	155,601
2037	451,385	32,996	237,571	4,277,737	312,700	2,251,440	7,564	913	163,931
2038	474,917	34,716	249,956	4,500,751	329,002	2,368,817	7,958	961	172,477
2039	499,045	36,480	262,656	4,729,415	345,717	2,489,166	8,362	1,009	181,240
2040	523,770	38,287	275,668	4,963,728	362,846	2,612,489	8,777	1,059	190,219
2041	549,091	40,138	288,995	5,203,691	380,387	2,738,785	9,201	1,111	199,415
2042	575,008	42,033	302,636	5,449,302	398,341	2,868,054	9,635	1,163	208,827
2043	601,520	43,971	316,590	5,700,563	416,708	3,000,296	10,080	1,217	218,456
2044	628,629	45,952	330,858	5,957,472	435,488	3,135,512	10,534	1,271	228,301
2045	656,334	47,978	345,439	6,220,031	454,681	3,273,701	10,998	1,327	238,363
2046	684,636	50,046	360,335	6,488,239	474,286	3,414,863	11,472	1,385	248,641
2047	713,533	52,159	375,544	6,762,096	494,305	3,558,998	11,957	1,443	259,136
2048	743,026	54,315	391,066	7,041,602	514,737	3,706,106	12,451	1,503	269,847
2049	773,116	56,514	406,903	7,326,758	535,582	3,856,188	12,955	1,564	280,775
2050	803,801	58,757	423,053	7,617,562	556,839	4,009,243	13,469	1,626	291,919
2051	835,083	61,044	439,517	7,914,016	578,510	4,165,272	13,993	1,689	303,280
2052	866,961	63,374	456,295	8,216,119	600,593	4,324,273	14,528	1,753	314,857
2053	899,434	65,748	473,387	8,523,871	623,090	4,486,248	15,072	1,819	326,651
2054	932,504	68,166	490,792	8,837,272	645,999	4,651,196	15,626	1,886	338,661
2055	966,170	70,626	508,511	9,156,322	669,322	4,819,117	16,190	1,954	350,887
2056	1,000,432	73,131	526,543	9,481,022	693,057	4,990,011	16,764	2,023	363,330
2057	1,035,291	75,679	544,890	9,811,370	717,205	5,163,879	17,348	2,094	375,990
2058	1,070,745	78,271	563,550	10,147,368	741,767	5,340,720	17,942	2,166	388,866
2059	1,106,795	80,906	582,524	10,489,015	766,741	5,520,534	18,547	2,239	401,959
2060	1,143,442	83,585	601,812	10,836,311	792,128	5,703,322	19,161	2,313	415,268

- US$1=JPY120.7 and VND21,673

Source: the Study Team

Table 10.30 [Without] The lost cost during congestion after Road Closed / Lane Closed

	Value of Time (Road Closed)			Value of Time (Lane Closed)			Total (Thousand US$)	Total (Million JPY)	Total (Million VND)
	Per Year			Per Year					
	Day (60%)	Night (20%)	Peak (20%)	Day (60%)	Night (20%)	Peak (20%)			
2020	85,421	1,369	70,987	809,526	12,977	672,736	1,653	200	35,826
2021	97,904	1,569	81,361	927,832	14,874	771,051	1,895	229	41,061
2022	111,545	1,788	92,696	1,057,099	16,946	878,476	2,159	261	46,782
2023	126,393	2,026	105,035	1,197,812	19,202	995,412	2,446	295	53,010
2024	142,499	2,284	118,421	1,350,455	21,649	1,122,262	2,758	333	59,765
2025	159,916	2,564	132,894	1,515,512	24,295	1,259,428	3,095	374	67,069
2026	178,694	2,865	148,499	1,693,467	27,147	1,407,313	3,458	417	74,945
2027	198,883	3,188	165,277	1,884,803	30,214	1,566,319	3,849	465	83,413
2028	220,536	3,535	183,271	2,090,006	33,504	1,736,847	4,268	515	92,494
2029	243,703	3,907	202,524	2,309,558	37,024	1,919,301	4,716	569	102,210
2030	265,930	4,263	220,994	1,800,141	28,857	1,495,962	3,816	461	82,707
2031	294,784	4,726	244,973	1,995,464	31,988	1,658,281	4,230	511	91,681
2032	322,801	5,175	268,255	2,185,112	35,029	1,815,883	4,632	559	100,395
2033	352,535	5,651	292,966	2,386,393	38,255	1,983,152	5,059	611	109,643
2034	384,040	6,156	319,146	2,599,652	41,674	2,160,376	5,511	665	119,441
2035	417,364	6,691	346,840	2,825,237	45,290	2,347,842	5,989	723	129,805
2036	452,561	7,255	376,090	3,063,491	49,110	2,545,837	6,494	784	140,752
2037	489,681	7,850	406,937	3,314,761	53,138	2,754,649	7,027	848	152,297
2038	528,774	8,477	439,424	3,579,393	57,380	2,974,565	7,588	916	164,455
2039	569,892	9,136	473,595	3,857,733	61,842	3,205,872	8,178	987	177,243
2040	613,087	9,828	509,490	4,150,126	66,529	3,448,858	8,798	1,062	190,677
2041	658,408	10,555	547,154	4,456,918	71,447	3,703,810	9,448	1,140	204,773
2042	705,908	11,316	586,627	4,778,455	76,601	3,971,015	10,130	1,223	219,546
2043	755,637	12,113	627,953	5,115,082	81,998	4,250,761	10,844	1,309	235,012
2044	807,646	12,947	671,174	5,467,145	87,641	4,543,334	11,590	1,399	251,188
2045	861,987	13,818	716,333	5,834,991	93,538	4,849,023	12,370	1,493	268,088
2046	918,711	14,727	763,471	6,218,964	99,694	5,168,114	13,184	1,591	285,730
2047	977,867	15,676	812,632	6,619,411	106,113	5,500,895	14,033	1,694	304,128
2048	1,039,509	16,664	863,858	7,036,677	112,802	5,847,654	14,917	1,801	323,300
2049	1,103,686	17,693	917,191	7,471,108	119,766	6,208,677	15,838	1,912	343,260
2050	1,170,450	18,763	972,674	7,923,049	127,011	6,584,251	16,796	2,027	364,024
2051	1,239,852	19,876	1,030,348	8,392,847	134,542	6,974,665	17,792	2,148	385,609
2052	1,311,943	21,031	1,090,258	8,880,848	142,365	7,380,206	18,827	2,272	408,030
2053	1,386,774	22,231	1,152,444	9,387,396	150,485	7,801,160	19,900	2,402	431,303
2054	1,464,397	23,475	1,216,950	9,912,838	158,908	8,237,816	21,014	2,536	455,445
2055	1,544,861	24,765	1,283,818	10,457,520	167,640	8,690,460	22,169	2,676	480,470
2056	1,628,219	26,101	1,353,090	11,021,787	176,686	9,159,380	23,365	2,820	506,395
2057	1,714,520	27,485	1,424,809	11,605,985	186,051	9,644,863	24,604	2,970	533,236
2058	1,803,818	28,916	1,499,018	12,210,460	195,741	10,147,196	25,885	3,124	561,009
2059	1,896,162	30,397	1,575,758	12,835,557	205,761	10,666,668	27,210	3,284	589,729
2060	1,991,603	31,927	1,655,072	13,481,622	216,118	11,203,564	28,580	3,450	619,412

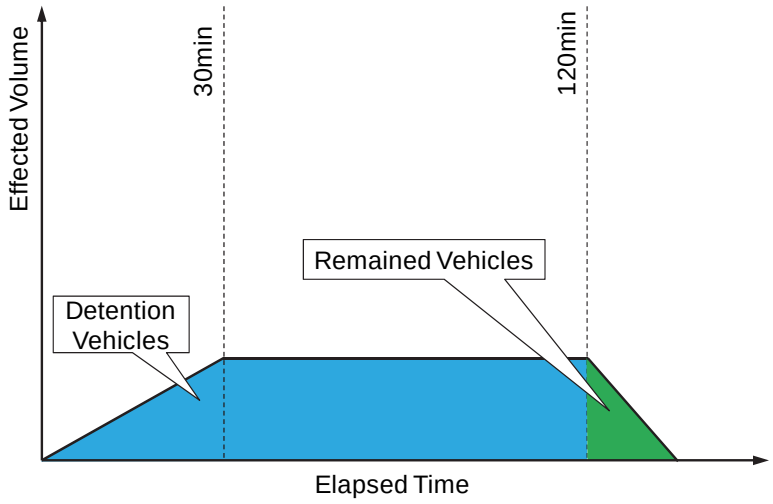
- US$1=JPY120.7 and VND21,673

Source: the Study Team

(2) With

- All lane closure of traffic or lane closure of traffic is done including until leaving of an accident inspection and the accident vehicle from the traffic accident occurrence for 120 minutes.
- The information of a traffic accident and the traffic congestion is provided 30 minutes after the occurrence of the traffic accident by the various kinds of media such as SNS such as variable message signboard, Internet, Twitter, and the detour of the road user is performed. And the outflow instruction with the IC just before the accident site of occurrence is done by a road operator.
- An elapsed time from the traffic accident occurrence and relations of the traffic volume to be affected are shown in the chart below, the traffic volume to be affected with an elapsed time increases, but the increase of the traffic volume becomes the fixed quantity because detour is promoted 30 minutes later by provision information.
- Loss time occurs about those vehicles remaining in to need time according to traffic capacity so that the traffic volume that stayed disposes all in elimination of road obstacles.

Table 10.4 The relation between Elapsed Time and Effected Volume



Source: the Study Team

- From the traffic accident occurrence to elimination of road obstacles for 120 minutes, and the loss cost was estimated from the traffic accident occurrence as 30 minutes by provision information until the detour of the succeeding vehicle was done. The result of the estimation is shown in the table below.

Table 10.31 [Without] The lost cost during Road Closed / Lane Closed

	Road Closed			Lane Closed			Total (Thousand US$)	Total (Million JPY)	Total (Million VND)
	Value of Time in a year (US$)			Value of Time in a year (US$)					
	Day (60%)	Night (20%)	Peak (20%)	Day (60%)	Night (20%)	Peak (20%)			
2020	62,360	4,558	32,821	590,977	43,200	311,041	1,045	126	22,647
2021	68,222	4,987	35,906	646,531	47,261	340,279	1,143	138	24,776
2022	74,344	5,435	39,129	704,556	51,503	370,819	1,246	150	27,000
2023	80,728	5,901	42,488	765,052	55,925	402,659	1,353	163	29,318
2024	87,372	6,387	45,985	828,020	60,528	435,800	1,464	177	31,731
2025	94,277	6,892	49,620	893,459	65,311	470,242	1,580	191	34,239
2026	101,443	7,415	53,391	961,370	70,276	505,984	1,700	205	36,842
2027	108,870	7,958	57,300	1,031,753	75,421	543,028	1,824	220	39,539
2028	116,558	8,520	61,346	1,104,607	80,746	581,372	1,953	236	42,331
2029	124,506	9,101	65,529	1,179,932	86,252	621,017	2,086	252	45,217
2030	131,476	9,611	69,198	1,245,988	91,081	655,783	2,203	266	47,749
2031	141,185	10,321	74,308	1,337,998	97,807	704,209	2,366	286	51,275
2032	149,915	10,959	78,903	1,420,737	103,855	747,757	2,512	303	54,445
2033	158,907	11,616	83,635	1,505,949	110,084	792,605	2,663	321	57,711
2034	168,159	12,292	88,505	1,593,632	116,494	838,754	2,818	340	61,071
2035	177,672	12,988	93,512	1,683,786	123,084	886,203	2,977	359	64,526
2036	187,446	13,702	98,656	1,776,412	129,855	934,954	3,141	379	68,075
2037	197,481	14,436	103,937	1,871,510	136,806	985,005	3,309	399	71,720
2038	207,776	15,188	109,356	1,969,079	143,939	1,036,357	3,482	420	75,459
2039	218,332	15,960	114,912	2,069,119	151,251	1,089,010	3,659	442	79,293
2040	229,149	16,751	120,605	2,171,631	158,745	1,142,964	3,840	463	83,221
2041	240,227	17,560	126,435	2,276,615	166,419	1,198,218	4,025	486	87,244
2042	251,566	18,389	132,403	2,384,070	174,274	1,254,773	4,215	509	91,362
2043	263,165	19,237	138,508	2,493,996	182,310	1,312,630	4,410	532	95,575
2044	275,025	20,104	144,750	2,606,394	190,526	1,371,786	4,609	556	99,882
2045	287,146	20,990	151,130	2,721,264	198,923	1,432,244	4,812	581	104,284
2046	299,528	21,895	157,646	2,838,605	207,500	1,494,002	5,019	606	108,781
2047	312,171	22,819	164,300	2,958,417	216,259	1,557,062	5,231	631	113,372
2048	325,074	23,763	171,092	3,080,701	225,197	1,621,422	5,447	657	118,058
2049	338,238	24,725	178,020	3,205,457	234,317	1,687,082	5,668	684	122,839
2050	351,663	25,706	185,086	3,332,683	243,617	1,754,044	5,893	711	127,715
2051	365,349	26,707	192,289	3,462,382	253,098	1,822,306	6,122	739	132,685
2052	379,295	27,726	199,629	3,594,552	262,760	1,891,869	6,356	767	137,750
2053	393,503	28,765	207,107	3,729,193	272,602	1,962,733	6,594	796	142,910
2054	407,971	29,822	214,721	3,866,306	282,625	2,034,898	6,836	825	148,164
2055	422,700	30,899	222,473	4,005,891	292,828	2,108,364	7,083	855	153,513
2056	437,689	31,995	230,363	4,147,947	303,212	2,183,130	7,334	885	158,957
2057	452,940	33,110	238,389	4,292,474	313,777	2,259,197	7,590	916	164,496
2058	468,451	34,243	246,553	4,439,473	324,523	2,336,565	7,850	947	170,129
2059	484,223	35,396	254,854	4,588,944	335,449	2,415,234	8,114	979	175,857
2060	500,256	36,568	263,293	4,740,886	346,556	2,495,203	8,383	1,012	181,680

- US$1=JPY120.7 and VND21,673

Source: the Study Team

Table 10.32 [With] The lost cost during congestion after Road Closed / Lane Closed

	Value of Time (Road Closed)			Value of Time (Lane Closed)			Total	Total	Total
	Per Year			Per Year			(Thousand US$)	(Million JPY)	(Million VND)
	Day (60%)	Night (20%)	Peak (20%)	Day (60%)	Night (20%)	Peak (20%)			
2020	21,355	342	17,747	202,382	3,244	168,184	413	50	8,956
2021	24,476	392	20,340	231,958	3,718	192,763	474	57	10,265
2022	27,886	447	23,174	264,275	4,236	219,619	540	65	11,696
2023	31,598	507	26,259	299,453	4,800	248,853	611	74	13,252
2024	35,625	571	29,605	337,614	5,412	280,566	689	83	14,941
2025	39,979	641	33,224	378,878	6,074	314,857	774	93	16,767
2026	44,673	716	37,125	423,367	6,787	351,828	864	104	18,736
2027	49,721	797	41,319	471,201	7,554	391,580	962	116	20,853
2028	55,134	884	45,818	522,501	8,376	434,212	1,067	129	23,123
2029	60,926	977	50,631	577,390	9,256	479,825	1,179	142	25,553
2030	66,482	1,066	55,249	450,035	7,214	373,990	954	115	20,677
2031	73,696	1,181	61,243	498,866	7,997	414,570	1,058	128	22,920
2032	80,700	1,294	67,064	546,278	8,757	453,971	1,158	140	25,099
2033	88,134	1,413	73,241	596,598	9,564	495,788	1,265	153	27,411
2034	96,010	1,539	79,787	649,913	10,418	540,094	1,378	166	29,860
2035	104,341	1,673	86,710	706,309	11,323	586,961	1,497	181	32,451
2036	113,140	1,814	94,022	765,873	12,277	636,459	1,624	196	35,188
2037	122,420	1,962	101,734	828,690	13,284	688,662	1,757	212	38,074
2038	132,194	2,119	109,856	894,848	14,345	743,641	1,897	229	41,114
2039	142,473	2,284	118,399	964,433	15,460	801,468	2,045	247	44,311
2040	153,272	2,457	127,373	1,037,532	16,632	862,215	2,199	265	47,669
2041	164,602	2,639	136,788	1,114,229	17,862	925,952	2,362	285	51,193
2042	176,477	2,829	146,657	1,194,614	19,150	992,754	2,532	306	54,886
2043	188,909	3,028	156,988	1,278,770	20,499	1,062,690	2,711	327	58,753
2044	201,912	3,237	167,794	1,366,786	21,910	1,135,834	2,897	350	62,797
2045	215,497	3,455	179,083	1,458,748	23,385	1,212,256	3,092	373	67,022
2046	229,678	3,682	190,868	1,554,741	24,923	1,292,029	3,296	398	71,432
2047	244,467	3,919	203,158	1,654,853	26,528	1,375,224	3,508	423	76,032
2048	259,877	4,166	215,964	1,759,169	28,200	1,461,913	3,729	450	80,825
2049	275,922	4,423	229,298	1,867,777	29,942	1,552,169	3,960	478	85,815
2050	292,613	4,691	243,168	1,980,762	31,753	1,646,063	4,199	507	91,006
2051	309,963	4,969	257,587	2,098,212	33,636	1,743,666	4,448	537	96,402
2052	327,986	5,258	272,564	2,220,212	35,591	1,845,051	4,707	568	102,008
2053	346,694	5,558	288,111	2,346,849	37,621	1,950,290	4,975	600	107,826
2054	366,099	5,869	304,238	2,478,210	39,727	2,059,454	5,254	634	113,861
2055	386,215	6,191	320,954	2,614,380	41,910	2,172,615	5,542	669	120,118
2056	407,055	6,525	338,273	2,755,447	44,171	2,289,845	5,841	705	126,599
2057	428,630	6,871	356,202	2,901,496	46,513	2,411,216	6,151	742	133,309
2058	450,954	7,229	374,754	3,052,615	48,935	2,536,799	6,471	781	140,252
2059	474,040	7,599	393,939	3,208,889	51,440	2,666,667	6,803	821	147,432
2060	497,901	7,982	413,768	3,370,406	54,030	2,800,891	7,145	862	154,853

- US$1=JPY120.7 and VND21,673

Source: the Study Team

6) Preliminary Estimation of Benefit

- By the implementation of the traffic control system, recognition and the correspondence of a quick traffic accident are done and become able to provide the information to a road user.
- Therefore, the difference of loss cost estimated with [With] case and [Without] case is arrested with “Benefit of Saving in Vehicle Time Cost” to express by the implementation of the traffic control system.
- The estimation result every 10 years from 2020 form a differences of the loss cost between [With] case and [Without] case is shown in the table below.
- In benefit of 312 million yen in 2020 become 678 million yen more than double in 2030 from increase of successive traffic volume and increase of the hourly rate according to types of vehicles, and it is to 2435 million yen in 2050.
- By the cost estimation, it becomes 5819 million yen in 2030, 16,342 million yen in 2040, and 35,689 million yen in 2050.

Table 10.33 Preliminary Estimation of Benefit by ITS implementation

	Benefit in a year		Accumulated Benefit Total	
	(Million JPY)	(Billion VND)	(Million JPY)	(Billion VND)
2020	312	56	312	56
2030	687	123	5,819	1,045
2040	1,392	250	16,342	2,934
2050	2,435	437	35,689	6,408
2060	3,888	698	67,664	12,150

Source: the Study Team

Table 10.34 [Without - With] Preliminary Estimation of Benefit by ITS implementation

	Road Closed - Value of Time (US$)						Lane Closed - Value of Time (US$)						Benefit in a Year			Accumulated Total Benefit		
	Detention Vehicles			Remained Vehicles			Detention Vehicles			Remained Vehicles								
	Day (60%)	Night (20%)	Peak (20%)	Day (60%)	Night (20%)	Peak (20%)	Day (60%)	Night (20%)	Peak (20%)	Day (60%)	Night (20%)	Peak (20%)	(Thousand US$)	(Million JPY)	(Billion VND)	(Thousand US$)	(Million JPY)	(Billion VND)
2020	80,177	5,861	42,198	64,066	1,027	53,240	759,828	55,543	399,909	607,145	9,733	504,552	2,583	312	56	2,583	312	56
2021	87,713	6,412	46,165	73,428	1,177	61,021	831,254	60,764	437,502	695,874	11,155	578,289	2,891	349	63	5,474	661	119
2022	95,586	6,987	50,308	83,658	1,341	69,522	905,857	66,218	476,767	792,824	12,709	658,857	3,221	389	70	8,695	1,049	188
2023	103,793	7,587	54,628	94,794	1,520	78,777	983,638	71,903	517,704	898,359	14,401	746,559	3,574	431	77	12,268	1,481	266
2024	112,336	8,212	59,124	106,875	1,713	88,815	1,064,597	77,821	560,314	1,012,842	16,236	841,697	3,951	477	86	16,219	1,958	352
2025	121,214	8,861	63,797	119,937	1,923	99,671	1,148,733	83,972	604,597	1,136,634	18,221	944,571	4,352	525	94	20,571	2,483	446
2026	130,427	9,534	68,646	134,020	2,148	111,374	1,236,048	90,354	650,551	1,270,100	20,360	1,055,485	4,779	577	104	25,350	3,060	549
2027	139,976	10,232	73,671	149,163	2,391	123,958	1,326,539	96,969	698,179	1,413,602	22,661	1,174,739	5,232	632	113	30,582	3,691	663
2028	149,860	10,955	78,874	165,402	2,651	137,453	1,420,209	103,816	747,478	1,567,504	25,128	1,302,635	5,712	689	124	36,294	4,381	787
2029	160,079	11,702	84,252	182,778	2,930	151,893	1,517,056	110,896	798,450	1,732,169	27,768	1,439,475	6,219	751	135	42,514	5,131	921
2030	169,041	12,357	88,969	199,447	3,197	165,746	1,601,984	117,104	843,150	1,350,105	21,643	1,121,971	5,695	687	123	48,208	5,819	1,045
2031	181,523	13,269	95,539	221,088	3,544	183,730	1,720,283	125,752	905,412	1,496,598	23,991	1,243,710	6,214	750	135	54,423	6,569	1,180
2032	192,748	14,090	101,447	242,100	3,881	201,192	1,826,662	133,528	961,401	1,638,834	26,271	1,361,912	6,704	809	145	61,127	7,378	1,325
2033	204,309	14,935	107,531	264,401	4,239	219,724	1,936,220	141,537	1,019,063	1,789,795	28,691	1,487,364	7,218	871	156	68,345	8,249	1,481
2034	216,205	15,804	113,792	288,030	4,617	239,360	2,048,955	149,777	1,078,398	1,949,739	31,255	1,620,282	7,756	936	168	76,101	9,185	1,649
2035	228,436	16,699	120,229	313,023	5,018	260,130	2,164,868	158,251	1,139,404	2,118,927	33,968	1,760,882	8,320	1,004	180	84,421	10,190	1,830
2036	241,002	17,617	126,843	339,421	5,441	282,067	2,283,959	166,956	1,202,084	2,297,618	36,832	1,909,378	8,909	1,075	193	93,330	11,265	2,023
2037	253,904	18,560	133,634	367,260	5,887	305,203	2,406,227	175,894	1,266,435	2,486,071	39,853	2,065,987	9,525	1,150	206	102,855	12,415	2,229
2038	267,141	19,528	140,600	396,581	6,357	329,568	2,531,673	185,064	1,332,459	2,684,545	43,035	2,230,924	10,167	1,227	220	113,022	13,642	2,450
2039	280,713	20,520	147,744	427,419	6,852	355,196	2,660,296	194,466	1,400,156	2,893,300	46,381	2,404,404	10,837	1,308	235	123,860	14,950	2,684
2040	294,621	21,537	155,064	459,815	7,371	382,118	2,792,097	204,101	1,469,525	3,112,595	49,897	2,586,644	11,535	1,392	250	135,395	16,342	2,934
2041	308,864	22,578	162,560	493,806	7,916	410,365	2,927,076	213,968	1,540,566	3,342,688	53,585	2,777,857	12,262	1,480	266	147,657	17,822	3,200
2042	323,442	23,643	170,232	529,431	8,487	439,970	3,065,232	224,067	1,613,280	3,583,841	57,451	2,978,261	13,017	1,571	282	160,674	19,393	3,482
2043	338,355	24,734	178,082	566,728	9,085	470,965	3,206,566	234,398	1,687,667	3,836,311	61,498	3,188,070	13,802	1,666	299	174,477	21,059	3,781
2044	353,604	25,848	186,107	605,735	9,710	503,381	3,351,078	244,962	1,763,725	4,100,359	65,731	3,407,501	14,618	1,764	317	189,094	22,824	4,098
2045	369,188	26,987	194,310	646,490	10,364	537,250	3,498,767	255,758	1,841,457	4,376,243	70,154	3,636,767	15,464	1,866	335	204,558	24,690	4,433
2046	385,108	28,151	202,688	689,033	11,046	572,604	3,649,634	266,786	1,920,860	4,664,223	74,770	3,876,086	16,341	1,972	354	220,899	26,663	4,788
2047	401,362	29,339	211,243	733,401	11,757	609,474	3,803,679	278,047	2,001,936	4,964,558	79,585	4,125,671	17,250	2,082	374	238,149	28,745	5,161
2048	417,952	30,552	219,975	779,632	12,498	647,893	3,960,901	289,540	2,084,685	5,277,507	84,601	4,385,740	18,191	2,196	394	256,341	30,940	5,556
2049	434,878	31,789	228,883	827,765	13,270	687,893	4,121,301	301,265	2,169,106	5,603,331	89,825	4,656,507	19,166	2,313	415	275,507	33,254	5,971
2050	452,138	33,051	237,967	877,838	14,072	729,505	4,284,879	313,222	2,255,199	5,942,287	95,258	4,938,189	20,174	2,435	437	295,680	35,689	6,408
2051	469,734	34,337	247,228	929,889	14,907	772,761	4,451,634	325,412	2,342,965	6,294,636	100,907	5,230,999	21,215	2,561	460	316,896	38,249	6,868
2052	487,665	35,648	256,666	983,958	15,773	817,693	4,621,567	337,834	2,432,404	6,660,636	106,774	5,535,154	22,292	2,691	483	339,187	40,940	7,351
2053	505,932	36,983	266,280	1,040,081	16,673	864,333	4,794,677	350,488	2,523,514	7,040,547	112,864	5,850,870	23,403	2,825	507	362,591	43,765	7,858
2054	524,534	38,343	276,070	1,098,297	17,606	912,713	4,970,965	363,375	2,616,298	7,434,629	119,181	6,178,362	24,550	2,963	532	387,141	46,728	8,391
2055	543,471	39,727	286,037	1,158,646	18,574	962,863	5,150,431	376,494	2,710,753	7,843,140	125,730	6,517,845	25,734	3,106	558	412,875	49,834	8,948
2056	562,743	41,136	296,181	1,221,164	19,576	1,014,818	5,333,075	389,845	2,806,881	8,266,340	132,514	6,869,535	26,954	3,253	584	439,828	53,087	9,532
2057	582,351	42,570	306,501	1,285,890	20,614	1,068,607	5,518,896	403,428	2,904,682	8,704,489	139,538	7,233,647	28,211	3,405	611	468,040	56,492	10,144
2058	602,294	44,027	316,997	1,352,863	21,687	1,124,263	5,707,894	417,244	3,004,155	9,157,845	146,806	7,610,397	29,506	3,561	639	497,546	60,054	10,783
2059	622,572	45,510	327,670	1,422,121	22,797	1,181,818	5,900,071	431,292	3,105,300	9,626,668	154,321	8,000,001	30,840	3,722	668	528,386	63,776	11,452
2060	643,186	47,017	338,519	1,493,702	23,945	1,241,304	6,095,425	445,572	3,208,118	10,111,217	162,089	8,402,673	32,213	3,888	698	560,599	67,664	12,150

7) Preliminary Cost Benefit Analysis

For the benefit of each year estimated in a preceding clause, EIRR (Economic Internal Rate of Return) was estimated including ITS implementation cost. It is assumed for the estimation that the pieces of roadside equipment are to be updated every five years and that the whole system is to be replaced every 20 years. Under these conditions, the preliminary estimation of EIRR is calculated at 12.33% for the period from 2017 to 2060.

However, the effects of road construction originally include the part which cannot be realized without traffic information; that is the effects of ITS implementation. Accordingly, it can be said that the value 12.33% is corresponding to the part, in the effects of road construction, which will be lost in the case ITS is not installed. In addition, it is difficult to quantify the functions of ITS and it is impossible to separate/estimate the effects of ITS implementation with higher accuracy.

Table 10.35 Preliminary Cost Benefit Analysis

	Cost (Billion VND)								Benefit Year (Billion VND)	Flow (Billion VND)
		Traffic Information /Control	Communication System	Communication Ducts	Building	Back-up Power Supply	O&M Vehicle	Consulting Service		
2017	0.0								0.0	0.0
2018	0.0								0.0	0.0
2019	▲ 800.4	385.9	50.2	149.5	26.0	81.0	10.1	97.7	0.0	▲ 800.4
2020	0.0								56.0	56.0
2021	0.0								62.7	62.7
2022	0.0								69.8	69.8
2023	0.0								77.5	77.5
2024	▲ 10.1						10.1		85.6	75.5
2025	▲ 161.8	161.8							94.3	▲ 67.5
2026	0.0								103.6	103.6
2027	0.0								113.4	113.4
2028	0.0								123.8	123.8
2029	▲ 10.1						10.1		134.8	124.7
2030	▲ 161.8	161.8							123.4	▲ 38.4
2031	0.0								134.7	134.7
2032	0.0								145.3	145.3
2033	0.0								156.4	156.4
2034	▲ 10.1						10.1		168.1	158.0
2035	▲ 161.8	161.8							180.3	18.5
2036	0.0								193.1	193.1
2037	0.0								206.4	206.4
2038	0.0								220.4	220.4
2039	▲ 10.1						10.1		234.9	224.7
2040	▲ 436.1	385.9	50.2						250.0	▲ 186.1
2041	0.0								265.8	265.8
2042	0.0								282.1	282.1
2043	0.0								299.1	299.1
2044	▲ 10.1						10.1		316.8	306.7
2045	▲ 161.8	161.8							335.1	173.3
2046	0.0								354.2	354.2
2047	0.0								373.9	373.9
2048	0.0								394.3	394.3
2049	▲ 10.1						10.1		415.4	405.3
2050	▲ 161.8	161.8							437.2	275.4
2051	0.0								459.8	459.8
2052	0.0								483.1	483.1
2053	0.0								507.2	507.2
2054	▲ 10.1						10.1		532.1	521.9
2055	▲ 161.8	161.8							557.7	395.9
2056	0.0								584.2	584.2
2057	0.0								611.4	611.4
2058	0.0								639.5	639.5
2059	▲ 10.1						10.1		668.4	658.3
2060	▲ 436.1	385.9	50.2						698.1	262.1
EIRR										12.33%

Source: the Study Team

10.10 Financial Schedule

(1) General

Based on the Project (Target Expressways) cost including operation and maintenance costs, the basic assumptions, and the assumed financing plan, the following financial examination is made:

- Estimation of project cost including contingencies (price and physical), and interest during construction (IDC) / commitment charge.
- Estimation of amount of principal repayment and interest payment of loans.
- Estimation of amount of required fund after operation start.

(2) Assumed Financing Plan

The assumed financing sources are JICA's Loans, and the government counterpart fund.
The financing plan by cost item and by funding sources is assumed as follows:

- JICA's Loans are assumed as follows:
  - Loan applied for the cost item of construction
  - Loan for Consulting Services applied for the cost item of consulting services
- Government counterpart fund is used for the cost items of project administration cost (assumed to be 3% of construction cost) and taxes.

(3) Project Cost including Contingencies

a) Basic Assumptions

The following assumptions are made:

Implementation Schedule

The implementation schedule is assumed from year 2017 to 2020 for consulting services, and from year 2018 to 2020 for construction. The share percentages of cost disbursement are 10%, 40%, 40% and 10% for consulting services, and 40%, 50% and 10% for construction, respectively for each year.

Price and Physical Contingencies

The price contingency rates are:

- Foreign currency portion: 2.0%
- Local currency portion 4.9%

The physical contingency rate is 5%.
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 (IDC) / commitment charge is estimated.

(4) Loan Scheme

Case-1: STEP

Regarding JICA's Loans, the loan schemes of STEP (Special Terms for Economic Partnership) is assumed. The assumed loan conditions are shown below.

Table 10.36 Assumed Loan Conditions for STEP

(Case of STEP)	(Without Re-Lending)
Construction	Interest Rate: 0.10% Total Repayment 40 Years (Grace period of 10 years and net repayment of 30 years) Front End Fee: 0.20% on Loan amount (paid by counterpart fund)
Consulting Service	Interest Rate: 0.01% Total Repayment 40 Years (Grace period of 10 years and net repayment 30 years) Front End Fee: 0.20% on Loan amount (paid by counterpart fund)

Source: Compiled by the Study Team

Case-2: General Terms

Regarding JICA's Loans, the loan schemes of General Terms is assumed. The assumed loan conditions are shown below.

Table 10.37 Assumed Loan Conditions for General Terms

(General Terms)	(Without Re-Lending)
Construction	Interest Rate: 1.40% Total Repayment 30 Years (Grace period of 10 years and net repayment of 20 years) Front End Fee: 0.20% on Loan amount (paid by counterpart fund)
Consulting Service	Interest Rate: 0.01% Total Repayment 30 Years (Grace period of 10 years and net repayment of 20 years) Front End Fee: 0.20% on Loan amount (paid by counterpart fund)

Source: Compiled by the Study Team

(5) 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:

Case-1: STEP

Table 10.38 Estimated Project Cost after Contingencies and IDC for STEP

(Million Yen)

	FC			LC			Total		
	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others
Construction	2,603	2,603	0	2,152	2,152	0	4,755	4,755	0
Price Escalation	198	198	0	418	418	0	616	616	0
Physical Contingency	140	140	0	128	128	0	269	269	0
(Subtotal)	2,941	2,941	0	2,698	2,698	0	5,639	5,639	0
Consulting Services	573	573	0	43	43	0	616	616	0
(Subtotal)	3,514	3,514	0	2,741	2,741	0	6,256	6,256	0
Land Acquisition	0	0	0	0	0	0	0	0	0
Project Administration	0	0	0	143	0	143	143	0	143
(Subtotal)	3,514	3,514	0	2,884	2,741	143	6,398	6,256	143
Tax (VAT, 10%)	0	0	0	626	0	626	626	0	626
(Subtotal)	3,514	3,514	0	3,510	2,741	768	7,024	6,256	768
IDC **	10	10	0	0	0	0	10	10	0
Commitment Charge **	13	0	13	0	0	0	13	0	13
(Grand Total)	3,537	3,524	13	3,510	2,741	768	7,047	6,266	781

Source: Estimated by the Study Team

Note: (1) Consulting Services includes the component of price escalation and physical contingency
(2) Tax, Project Administration and Front End Fee are to be paid by counterpart fund.

Case-2: General Terms

Table 10.39 Estimated Project Cost after Contingencies and IDC for General Terms

(Million Yen)

	FC			LC			Total		
	Total	JICA Portion	Others	Total	JICA Portion	Others	Total	JICA Portion	Others
Construction	2,603	2,603	0	2,152	2,152	0	4,755	4,755	0
Price Escalation	198	198	0	418	418	0	616	616	0
Physical Contingency	140	140	0	128	128	0	269	269	0
(Subtotal)	2,941	2,941	0	2,698	2,698	0	5,639	5,639	0
Consulting Services	573	573	0	43	43	0	616	616	0
(Subtotal)	3,514	3,514	0	2,741	2,741	0	6,256	6,256	0
Land Acquisition	0	0	0	0	0	0	0	0	0
Project Administration	0	0	0	143	0	143	143	0	143
(Subtotal)	3,514	3,514	0	2,884	2,741	143	6,398	6,256	143
Tax (VAT, 10%)	0	0	0	626	0	626	626	0	626
(Subtotal)	3,514	3,514	0	3,510	2,741	768	7,024	6,256	768
IDC **	142	142	0	0	0	0	142	142	0
Commitment Charge **	13	0	13	0	0	0	13	0	13
(Grand Total)	3,669	3,657	13	3,510	2,741	768	7,179	6,398	781

Source: Estimated by the Study Team

Note: (1) Consulting Services includes the component of price escalation and physical contingency
(2) Tax, Project Administration and Front End Fee are to be paid by counterpart fund.

(6) Tabulation of Cash Flow

a) Assumption on Operation and Maintenance Costs for ITS

The total distance kilometer of the target expressways is 214km, and based on the engineering study results, the value of annual total operation and maintenance (O&M) costs (except replacement cost of equipment) is estimated to be 327.59 million yen as below.

Table 10.40 Operation and Maintenance Cost for ITS

Items	Cost (Million Yen/year)	Remarks
Personnel Cost	49.78	For present condition: - Personnel for the Northern Regional Main Center - Personnel for 5 Road Management Offices - Personnel for 34 Toll Offices.
Spare Equipment Components & Software License	102.33	Spare Parts, Data Base Software, etc.
Maintenance Support by Supplier	55.64	10% of Software Cost
Telephone & Communication	10.70	Northern Regional Main Center and 3 Road Management Offices
Electric Power Supply	109.14	Northern Regional Main Center and 3 Road Management Offices
Total	327.59	

Note: 1 Yen is assumed at 180 VND

Source: The Study Team

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 1.53 million yen per annum, and the annual total costs are estimated to be 327 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 principal 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 start is examined. The following table shows the cash flow for the case of loan scheme of “STEP” and “General Terms”.

Table 10.41 Tabulation of Cash Flow in the Case of STEP

Year	In-Flow								Out-Flow							In-Flow minus Out-Flow
	Loan			Counter-part Fund			(Total)		Invest	Front End Fee	Loan Principal Repay	Interest Pay	O/M Costs for ITS	Replace Cost of Equipment	(Total)	
	(Disbursed)	(IDC)	(Total Disbursed)	Equity	Fund for Front End Fee	Required Fund after Operation	(Total)	(Million Yen)							(Million Yen)	
2016	0.00	0.00	0.00	0.00			0.00	0.00	0.00			0.00			0.00	0.00
2017	59.65	0.00	59.65	5.96	1.23		7.20	66.85	65.61	1.23		0.00			66.85	0.00
2018	2,447.20	1.12	2,448.32	301.78	11.30		313.08	2,761.39	2,750.10	11.30		0.00			2,761.39	0.00
2019	3,096.31	3.67	3,099.98	380.95			380.95	3,480.93	3,480.93			0.00			3,480.93	0.00
2020	652.42	5.41	657.83	79.51		699.07	778.58	1,436.40	737.33			0.00	372.08	326.99	1,436.40	0.00
2021						714.38	714.38	714.38				5.71	381.68	326.99	714.38	0.00
2022						724.23	724.23	724.23				5.71	391.53	326.99	724.23	0.00
2023						734.33	734.33	734.33				5.71	401.63	326.99	734.33	0.00
2024						744.69	744.69	744.69			0.00	5.71	411.99	326.99	744.69	0.00
2025						755.32	755.32	755.32			0.00	5.71	422.62	326.99	755.32	0.00
2026						766.23	766.23	766.23			0.00	5.71	433.53	326.99	766.23	0.00
2027						797.96	797.96	797.96			20.55	5.71	444.71	326.99	797.96	0.00
2028						997.65	997.65	997.65			208.86	5.61	456.18	326.99	997.65	0.00
2029						1,009.23	1,009.23	1,009.23			208.86	5.42	467.95	326.99	1,009.23	0.00
2030						1,021.11	1,021.11	1,021.11			208.86	5.23	480.03	326.99	1,021.11	0.00
2031						1,033.30	1,033.30	1,033.30			208.86	5.04	492.41	326.99	1,033.30	0.00
2032						1,045.82	1,045.82	1,045.82			208.86	4.85	505.12	326.99	1,045.82	0.00
2033						1,058.66	1,058.66	1,058.66			208.86	4.66	518.15	326.99	1,058.66	0.00
2034						1,071.84	1,071.84	1,071.84			208.86	4.47	531.52	326.99	1,071.84	0.00
2035						1,085.36	1,085.36	1,085.36			208.86	4.28	545.23	326.99	1,085.36	0.00
2036						1,099.24	1,099.24	1,099.24			208.86	4.09	559.30	326.99	1,099.24	0.00
2037						1,113.48	1,113.48	1,113.48			208.86	3.90	573.73	326.99	1,113.48	0.00
2038						1,128.09	1,128.09	1,128.09			208.86	3.71	588.53	326.99	1,128.09	0.00
2039						1,143.08	1,143.08	1,143.08			208.86	3.52	603.71	326.99	1,143.08	0.00
2040						1,158.47	1,158.47	1,158.47			208.86	3.33	619.29	326.99	1,158.47	0.00
2041						1,174.25	1,174.25	1,174.25			208.86	3.14	635.27	326.99	1,174.25	0.00
2042						1,190.45	1,190.45	1,190.45			208.86	2.95	651.66	326.99	1,190.45	0.00
2043						1,207.08	1,207.08	1,207.08			208.86	2.76	668.47	326.99	1,207.08	0.00
2044						1,224.13	1,224.13	1,224.13			208.86	2.57	685.71	326.99	1,224.13	0.00
2045						1,241.63	1,241.63	1,241.63			208.86	2.38	703.41	326.99	1,241.63	0.00
2046						1,259.59	1,259.59	1,259.59			208.86	2.19	721.55	326.99	1,259.59	0.00
2047						1,278.02	1,278.02	1,278.02			208.86	2.00	740.17	326.99	1,278.02	0.00
2048						1,296.92	1,296.92	1,296.92			208.86	1.81	759.27	326.99	1,296.92	0.00
2049						1,316.32	1,316.32	1,316.32			208.86	1.62	778.86	326.99	1,316.32	0.00
2050						1,336.22	1,336.22	1,336.22			208.86	1.43	798.95	326.99	1,336.22	0.00
2051						1,356.65	1,356.65	1,356.65			208.86	1.24	819.56	326.99	1,356.65	0.00
2052						1,377.60	1,377.60	1,377.60			208.86	1.04	840.71	326.99	1,377.60	0.00
2053						1,399.10	1,399.10	1,399.10			208.86	0.85	862.40	326.99	1,399.10	0.00
2054						1,421.16	1,421.16	1,421.16			208.86	0.66	884.65	326.99	1,421.16	0.00
2055						1,443.79	1,443.79	1,443.79			208.86	0.47	907.47	326.99	1,443.79	0.00
2056						1,467.02	1,467.02	1,467.02			208.86	0.28	930.88	326.99	1,467.02	0.00
2057						1,470.30	1,470.30	1,470.30			188.31	0.09	954.90	326.99	1,470.30	0.00
(Total)	6,255.57	10.20	6,265.77	768.20	12.53	42,361.77	43,142.50	49,408.27	7,033.97	12.53	6,265.77	125.58	23,544.79	12,425.62	49,408.27	

Source: Estimated by the Study Team

Table 10.42 Tabulation of Cash Flow in the Case of General Terms

Year	In-Flow								Out-Flow							In-Flow minus Out-Flow
	Loan			Counter-part Fund			(Total)		Invest	Front End Fee	Loan Principal Repay	Interest Pay	O/M Costs for ITS	Replace Cost of Equipment	(Total)	
	(Disbursed)	(IDC)	(Total Disbursed)	Equity	Fund for Front End Fee	Required Fund after Operation	(Total)	(Million Yen)							(Million Yen)	
2016	0.00	0.00	0.00	0.00			0.00	0.00	0.00			0.00			0.00	0.00
2017	59.65	0.00	59.65	5.96	1.23		7.20	66.85	65.61	1.23		0.00			66.85	0.00
2018	2,447.20	15.44	2,462.64	301.78	11.56		313.34	2,775.98	2,764.42	11.56		0.00			2,775.98	0.00
2019	3,096.31	51.04	3,147.34	380.95			380.95	3,528.30	3,528.30			0.00			3,528.30	0.00
2020	652.42	75.82	728.23	79.51		699.07	778.58	1,506.81	807.74			0.00	372.08	326.99	1,506.81	0.00
2021						789.67	789.67	789.67				81.00	381.68	326.99	789.67	0.00
2022						799.52	799.52	799.52				81.00	391.53	326.99	799.52	0.00
2023						809.62	809.62	809.62				81.00	401.63	326.99	809.62	0.00
2024						819.98	819.98	819.98			0.00	81.00	411.99	326.99	819.98	0.00
2025						830.61	830.61	830.61			0.00	81.00	422.62	326.99	830.61	0.00
2026						841.52	841.52	841.52			0.00	81.00	433.53	326.99	841.52	0.00
2027						883.52	883.52	883.52			30.82	81.00	444.71	326.99	883.52	0.00
2028						1,182.04	1,182.04	1,182.04			319.89	78.97	456.18	326.99	1,182.04	0.00
2029						1,189.76	1,189.76	1,189.76			319.89	74.92	467.95	326.99	1,189.76	0.00
2030						1,197.78	1,197.78	1,197.78			319.89	70.87	480.03	326.99	1,197.78	0.00
2031						1,206.12	1,206.12	1,206.12			319.89	66.82	492.41	326.99	1,206.12	0.00
2032						1,214.77	1,214.77	1,214.77			319.89	62.77	505.12	326.99	1,214.77	0.00
2033						1,223.75	1,223.75	1,223.75			319.89	58.72	518.15	326.99	1,223.75	0.00
2034						1,233.07	1,233.07	1,233.07			319.89	54.67	531.52	326.99	1,233.07	0.00
2035						1,242.74	1,242.74	1,242.74			319.89	50.62	545.23	326.99	1,242.74	0.00
2036						1,252.75	1,252.75	1,252.75			319.89	46.57	559.30	326.99	1,252.75	0.00
2037						1,263.13	1,263.13	1,263.13			319.89	42.52	573.73	326.99	1,263.13	0.00
2038						1,273.88	1,273.88	1,273.88			319.89	38.47	588.53	326.99	1,273.88	0.00
2039						1,285.02	1,285.02	1,285.02			319.89	34.42	603.71	326.99	1,285.02	0.00
2040						1,296.54	1,296.54	1,296.54			319.89	30.37	619.29	326.99	1,296.54	0.00
2041						1,308.47	1,308.47	1,308.47			319.89	26.32	635.27	326.99	1,308.47	0.00
2042						1,320.81	1,320.81	1,320.81			319.89	22.27	651.66	326.99	1,320.81	0.00
2043						1,333.57	1,333.57	1,333.57			319.89	18.22	668.47	326.99	1,333.57	0.00
2044						1,346.77	1,346.77	1,346.77			319.89	14.17	685.71	326.99	1,346.77	0.00
2045						1,360.41	1,360.41	1,360.41			319.89	10.12	703.41	326.99	1,360.41	0.00
2046						1,374.51	1,374.51	1,374.51			319.89	6.07	721.55	326.99	1,374.51	0.00
2047						1,358.25	1,358.25	1,358.25			289.07	2.02	740.17	326.99	1,358.25	0.00
2048						1,086.26	1,086.26	1,086.26			0.00	0.00	759.27	326.99	1,086.26	0.00
2049						1,105.85	1,105.85	1,105.85			0.00	0.00	778.86	326.99	1,105.85	0.00
2050						1,125.94	1,125.94	1,125.94			0.00	0.00	798.95	326.99	1,125.94	0.00
2051						1,146.55	1,146.55	1,146.55			0.00	0.00	819.56	326.99	1,146.55	0.00
2052						1,167.70	1,167.70	1,167.70			0.00	0.00	840.71	326.99	1,167.70	0.00
2053						1,189.39	1,189.39	1,189.39			0.00	0.00	862.40	326.99	1,189.39	0.00
2054						1,211.64	1,211.64	1,211.64			0.00	0.00	884.65	326.99	1,211.64	0.00
2055						1,234.46	1,234.46	1,234.46			0.00	0.00	907.47	326.99	1,234.46	0.00
2056						1,257.87	1,257.87	1,257.87			0.00	0.00	930.88	326.99	1,257.87	0.00
2057						1,281.89	1,281.89	1,281.89			0.00	0.00	954.90	326.99	1,281.89	0.00
(Total)	6,255.57	142.30	6,397.87	768.20	12.80	43,745.24	44,526.24	50,924.11	7,166.07	12.80	6,397.87	1,376.96	23,544.79	12,425.62	50,924.11	

Source: Estimated by the Study Team

(8) Summary of Cash Flow for Loan Schemes of STEP and General Terms

The following table shows the summary of results of cash flow for Base Case and Reference Case of loan scheme:

Table 10.43 Summary of Cash Flow for Loan Schemes of STEP and General Terms

(Million Yen)

	STEP	General Terms
Loan Conditions:		
Assumed Interest Rate: Loan for Construction Loan for Consultancy	 0.10% 0.01%	 1.40% 0.01%
Repayment (Years):	Grace: 10 Years and Net Repay: 30 Years	Grace 10 Years and Net Repay 20 Years
Results:		
Project Cost before IDC & Front End Fee	7,024	7,024
(Loan Amount) (Equity)	(6,256) (768)	(6,256) (768)
IDC	10	142
Front End Fee	13	13
Project Cost after IDC & Front End Fee	7,047	7,179
Loan Amount	6,256	6,256
IDC	10	142
Loan Amount including IDC (= Total Amount of Loan Repayment)	6,256	6,398
Total Amount of Interest to be Paid	126	1,377
Total Amount of Required Budget after Operation	42,362	43,745

Source: Estimated by the Study Team

(9) Balance of O&M Costs and Toll Revenue of Each Section

a) Assumption on Costs of O&M

The number of Toll Office is assumed based on a planned Interchange, and the number of the rest area is assumed to be one place every each section. The annual total personnel cost in each section are estimated as follows.

Table 10.44 Personnel Cost

	Basic Condition		Present Condition		Future Condition		Personnel Cost
	Length	RMO	TO	RA	TO	RA	
Mai Dich–Thanh Tri	27	0.5	0	0	7	1	2.88
Lang–Hoa Lac	28	0.5	0	0	5	1	2.88
Phap Van–Cau Gie	30	1	4	0	4	1	8.65
Cau Gie–Ninh Binh	50	1	4	0	4	1	8.65
Ha Noi–Bac Giang	46	1	1	0	10	1	8.65
Noi Bai–Ca Lo Bridge	16	0.5	0	0	2	0.5	2.88
Ca Lo Bridge–Bac Ninh	17	0.5	0	0	2	0.5	5.11

Note, RMO: Road Management Office, TO: Toll Office, RA: Rest area for sales

The unit value of O&M costs (except replacement cost of equipment) for ITS per kilometer is estimated to be 4.60 million yen per annum as below.

Table 10.45 Other Costs of O&M

Items	Cost (Million Yen/year/km)	Remarks
Personnel Cost	0.23	For present condition: - Personnel for the Northern Regional Main Center - Personnel for 5 Road Management Offices - Personnel for 34 Toll Offices.
Spare Equipment Components & Software License	0.48	Spare Parts, Data Base Software, etc.
Maintenance Support by Supplier	0.26	10% of Software Cost
Telephone & Communication	0.05	Northern Regional Main Center and 3 Road Management Offices
Electric Power Supply	0.51	Northern Regional Main Center and 3 Road Management Offices
Total	1.53	

Note: 1 Yen is assumed at 180 VND Source: Estimated by ITS Integration Project (SAPI) Study Team

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 1.53 million yen per annum, and the annual total costs are estimated to be 327 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) 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 1.5 million yen per annum.

The distance kilometer of the target road network is 214 km, and the annual total O&M costs for ITS are estimated to be 328 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).

d) Estimation of Traffic and Toll Revenue

Unit toll rates are defined by the Circular No.14/2012/TT-BTC of MOF.

Table 10.46 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 2020 and 2030 are shown in the table below. However, the HPC's section without the toll is excluded.

Table 10.47 Estimation of Traffic and Toll Revenue

Vehicle-km (Case 2) (1000 vehicles-km/day)	2020			2030		
	PC	Bus	Truck	PC	Bus	Truck
Mai Dich - Tanh Tri (Ring Road 3)	656.4	173.3	369.3	1,017.3	220.1	459.1
Lang - Hoa Lac	550.2	68.4	362.1	553.3	68.9	364.1
Hanoi - Bac Giang (NH No.1)	602.6	151.8	473.8	644.0	161.0	501.4
Noi Bai - Bac Ninh (NH No.18)	271.1	45.9	291.3	699.6	120.9	646.1
Phap Van - Cau Gie	457.6	602.4	358.6	842.5	904.1	417.7
Cau Gie - Ninh Binh	1,108.0	1,502.4	961.8	2,396.4	2,654.7	1,269.8
Total	3,645.8	2,544.2	2,816.8	6,153.1	4,129.7	3,658.2

Mai Dich - Tanh Tri (Ring Road 3)	0.0	0.0	0.0	0.0	0.0	0.0
Lang - Hoa Lac	0.0	0.0	0.0	0.0	0.0	0.0
Hanoi - Bac Giang (NH No.1)	219940.0	55407.0	380461.4	235060.0	58765.0	402624.2
Noi Bai - Bac Ninh (NH No.18)	0.0	0.0	0.0	0.0	0.0	0.0
Phap Van - Cau Gie	167005.8	219857.8	287955.8	307512.5	329996.5	335373.0
Cau Gie - Ninh Binh	404416.4	548390.6	772301.3	874700.6	968976.5	1019673.5
Toll Revenue for each class, mil.VND/year	791371.1	823655.4	1440718.5	1417273.1	1357738.0	1757670.6
Total, mil.VND/year			3055745.0			4532681.7
Total, mil.Yen/year			17020.5			25247.0

Note: 1 Yen is assumed at 180 VND, PC: Passenger car. Source: Compiled by the Study Team

e) Estimation of Commission fee for Sales at Rest Area

The sales of Rest Area became approximately 170 billion yen a year presently in Japan. The commission fee for sales at the Rest Area is estimated in consideration for the ratio of the expressway traffic volume as shown below. The commission fee for sales at Rest Area was estimated based on the number of future condition of Rest Area assumed in table 10.27 and Vehicle-km of table 10.30. The assumed values are:

- Number of passengers: 1.8 passenger/PC, 1.5 passenger/truck, 43 passenger/bus
- Number of visitors: 20%
- Per capita purchased price: 20,000VND.

As a result, the commission fee for sales at Rest Area became 22,439 million yen in 2030.

Table 10.48 Estimation of Commission Fee for Sales at Rest Area

Commission Fee for Sales	2020	2025	2030
Mai Dich - Tanh Tri (Ring Road 3)	69827.6	282166.5	494505.4
Lang - Hoa Lac	31000.5	103688.5	176376.5
Hanoi - Bac Giang (NH No.1)	36774.5	125476.1	214177.6
Noi Bai - Bac Ninh (NH No.18)	17198.5	132847.8	248497.0
Phap Van - Cau Gie	195703.6	875920.8	1556137.9
Cau Gie - Ninh Binh	293005.7	1516629.4	2740253.0
Total, mil. VND/year	643510.4	3036729.0	5429947.5
Total, mil. Yen/year	3584.35	16914.58	30244.81

Unit: million Yen/Year Source: Estimated by the Study Team

f) Balance of Toll Revenue and O&M Costs

Based on the afore-mentioned estimation results regarding cost items, the balance of revenue and O&M costs is made for years 2025 and 2030. Toll revenue in 2025 is estimated by the average increase ratio from 2020 to 2030, as shown in the following table:

Table 10.49 Balance of Revenue and O&M Cost (1)

	Year	Revenue		Road	ITS			Balance		Ratio
		Toll (a)	Commission Fee (x30%) (b)	O&M Cost (c)	O&M Cost (d)	Replace Cost (e)	Sub-total (f)= (d)+(e)	(a) -((c)+(f))	(a)+(b) -((c)+(f))	((c)+(f)) /((a)+(b))
MaiDich -TanhTri	2020	0								
	2021			116.69	46.94	41.26	88.20			
	2022			122.89	48.16	41.26	89.41			
	2023			129.41	49.40	41.26	90.65			
	2024			136.29	50.67	41.26	91.93			
	2025	0	471.50	143.52	51.98	41.26	93.24	-236.76	234.74	0.50
	2026			151.14	53.32	41.26	94.58			
	2027			159.17	54.70	41.26	95.95			
	2028			167.62	56.11	41.26	97.36			
	2029			176.52	57.56	41.26	98.81			
	2030	0	826.32	185.90	59.04	41.26	100.30	-286.19	540.13	0.35
Lang -HoaLac	2020	0								
	2021			121.01	48.68	42.78	91.47			
	2022			127.44	49.94	42.78	92.72			
	2023			134.21	51.23	42.78	94.01			
	2024			141.33	52.55	42.78	95.33			
	2025	0	173.26	148.84	53.91	42.78	96.69	-245.53	-72.27	1.42
	2026			156.74	55.30	42.78	98.08			
	2027			165.07	56.72	42.78	99.51			
	2028			173.83	58.19	42.78	100.97			
	2029			183.06	59.69	42.78	102.47			
	2030	0	294.73	192.78	61.23	42.78	104.01	-296.79	-2.06	1.01
PhapVan -CauGie	2020	3758.7								
	2021			129.66	52.16	45.84	98.00			
	2022			136.54	53.51	45.84	99.35			
	2023			143.79	54.89	45.84	100.73			
	2024			151.43	56.30	45.84	102.14			
	2025	4588.8	1463.66	159.47	57.76	45.84	103.60	4325.73	5789.39	0.04
	2026			167.94	59.25	45.84	105.09			
	2027			176.86	60.77	45.84	106.61			
	2028			186.25	62.34	45.84	108.18			
	2029			196.14	63.95	45.84	109.79			
	2030	5419.0	2600.31	206.55	65.60	45.84	111.44	5101.01	7701.32	0.04

Unit: million Yen/Year Source: Estimated by the Study Team

Table 10.50 Balance of Revenue and O&M Cost (2)

	Year	Revenue		Road	ITS			Balance		Ratio
		Toll (a)	Commission Fee (x30%) (b)	O&M Cost (c)	O&M Cost (d)	Replace Cost (e)	Sub-total (f)= (d)+(e)	(a) -((c)+(f))	(a)+(b) -((c)+(f))	((c)+(f)) /((a)+(b))
CauGiei-NinhBinh	2020	9608.9								
	2021			216.10	86.93	76.40	163.33			
	2022			227.57	89.18	76.40	165.58			
	2023			239.66	91.48	76.40	167.88			
	2024			252.38	93.84	76.40	170.24			
	2025	12778.9	2534.29	265.78	96.26	76.40	172.66	12340.46	14874.75	0.03
	2026			279.90	98.74	76.40	175.14			
	2027			294.76	101.29	76.40	177.69			
	2028			310.41	103.90	76.40	180.30			
	2029			326.89	106.58	76.40	182.98			
	2030	15948.9	4578.96	344.25	109.33	76.40	185.73	15418.91	19997.87	0.03
HaNoi-BacGiang	2020	3652.9								
	2021			198.81	79.98	70.29	150.27			
	2022			209.37	82.04	70.29	152.33			
	2023			220.48	84.16	70.29	154.45			
	2024			232.19	86.33	70.29	156.62			
	2025	3766.1	209.67	244.52	88.56	70.29	158.85	3362.73	3572.40	0.10
	2026			257.51	90.84	70.29	161.13			
	2027			271.18	93.19	70.29	163.47			
	2028			285.58	95.59	70.29	165.88			
	2029			300.74	98.06	70.29	168.35			
	2030	3879.2	357.89	316.71	100.59	70.29	170.88	3391.61	3749.50	0.12
NoiBai-CaLo Bridge	2020	0								
	2021			69.15	27.82	24.45	52.27			
	2022			72.82	28.54	24.45	52.98			
	2023			76.69	29.27	24.45	53.72			
	2024			80.76	30.03	24.45	54.48			
	2025	0	107.63	85.05	30.80	24.45	55.25	-140.30	-32.67	1.30
	2026			89.57	31.60	24.45	56.05			
	2027			94.32	32.41	24.45	56.86			
	2028			99.33	33.25	24.45	57.70			
	2029			104.61	34.11	24.45	58.55			
	2030	0	201.33	110.16	34.99	24.45	59.43	-169.60	31.73	0.84
CaLo Bridge-BacNinh	2020	0								
	2021			73.47	29.56	25.98	55.53			
	2022			77.37	30.32	25.98	56.30			
	2023			81.48	31.10	25.98	57.08			
	2024			85.81	31.91	25.98	57.88			
	2025	0	114.36	90.37	32.73	25.98	58.70	-149.07	-34.71	1.30
	2026			95.17	33.57	25.98	59.55			
	2027			100.22	34.44	25.98	60.41			
	2028			105.54	35.33	25.98	61.30			
	2029			111.14	36.24	25.98	62.21			
	2030	0	213.91	117.05	37.17	25.98	63.15	-180.20	33.72	0.84

Unit: million Yen/Year Source: Estimated by the Study Team

The following observations are available from the study results above on the O&M costs and the revenues.

In the case of the sections Phap Van – Cau Gie, Cau Gie – Ninh Binh and Ha Noi – Bac Giang, where the toll fees are collected, the O&M costs can be financed by the revenue from toll fee. Additionally a larger amount of favorable balance can be secured from the toll fees plus the relatively smaller concession fees and the ratio of the O&M cost to the total revenue is relatively small (not exceeding 15%). Surplus revenue can be invested for the road

improvement or the facility construction.

In the case of the sections Mai Dich – Tanh Tri, Lang – Hoa Lac, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh, whre the toll fees are not collected, the O&M costs exceed the total revenue from only the concession fees and the annual balances are negative except for the section of Mai Dich – Tanh Tri (Ring Road 3) with a large volume of traffic. Hence, for the section of Mai Dich – Tanh Tri, it is forecasted that the O&M costs can be financed by the concession fee revenue alone. However, it will be necessary for the sections of Lang – Hoa Lac, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh that the O&M costs must be financed by government subsidies even if the concession fee can be collected.

11. Climate Change Mitigation Effect Evaluation on Project

11.1 General

Increase of anthropogenic greenhouse gas emissions due to the use of fossil fuel, deforestation, etc., is the major cause of climate change, including rising temperature and increasing extreme weather events. Climate change is an imminent global threat endangering human security through worsening natural disasters, exhausting water resources, etc. It is expected that greenhouse gas emissions will continue to grow and that the 21st century will encounter serious changes in the climate which are worse than those observed in the 20th century.

Accordingly, JICA has prepared Climate Finance Impact Tool (JICA Climate-FIT), a reference document which contains the following components in order to facilitate consideration of policies and formulation of projects for assisting climate change related measures in developing countries.

- Methodologies for implementing measurement, reporting and verification (MRV) related to quantitative evaluation of mitigation projects that contribute to reduction or sequestration of greenhouse gases (GHG)
- Concepts and guidelines for mainstreaming adaptation considerations into projects that contribute to reduction of vulnerability against climate change, and sustaining and increasing adaptive capacity and resilience

11.2 JICA Climate-FIT

For basic Concept of JICA Climate-FIT, mitigation measures against global warming are intended to stop the progress of global warming by reducing (or sequestrating) GHG emissions and stabilize the concentrations of GHG in the atmosphere.

For the selected 6 sectors and 25 sub-sectors, methodology sheets summarizing GHG emission reduction methodologies were prepared. The five items included in the methodology sheets are: i) typical project outline, ii) applicability, iii) methodology on emission reduction, iv) data required for estimation and monitoring, and v) others.

11.3 Analysis of Emission Reduction

For analysis using JICA Climate-FIT, this project considered in ones related from a prepared tool most. This project reduces the traffic congestion by introducing a system using electricity of the ITS implementation and is understanding of the business to realize reduction of the consumption of the gasoline which is car energy. Therefore it was not the field of the railway, but it was the field of traffic, and as for freight / passenger transportation improvement (electrification), was selected out of contents of the release reduction by the electrification.

Each parameter used a value estimated from a vehicle kilometer using a prepared default value. Input value and estimated results were shown in the following tables.

Table 11.1 Parameter for Emission Reduction

Parameter	Description	Value	Unit
$FC_{BL,I,y}$	Consumption of fuel i associated with the operation of the existing railway in year y	201662500	t/year
$EF_{fuel,i}$	CO_2 emissin factor of fuel i	74100	t-CO_2/TJ
NCV_i	Net calorific value of fuel i	43	TJ/t
$EC_{PJ,y}$	Electricity consumption associated with the operation of the project activity in year y	7493.304	MWh/year
EF_{elec}	CO_2 emission factor of the grid electricity	407	t-CO_2/MWh

Table 11.2 Result of Emission Reduction

		Value	Unit
ER_y	Emission reduction	642,557,220,700,363	tCO_2/year
BE_y	Baseline emission	642,557,223,750,138	tCO_2/year
PE_y	Project emission	3,049,775	tCO_2/year

11.4 Conclusion

It was estimated by JICA Climate-FIT of the associated factor because preconditions were not equal to Climate Change Mitigation Effect Evaluation of this project. As a result, it was the estimation with the associated tool, but it did not follow that we was reliable because conditions were different.

Therefore, this project regards an effect by the ITS implementation including CO_2 estimated in Chapter 10 as an evaluation result.

12. Environmental Social Consideration Study of Project

12.1 General

Since the components of the project are mainly related to the installation of equipment then the detailed environmental impact assessment (EIA) has not been required.However,Environmental Protection Plan needs to be prepared in accordance withthe Law on Environmental Protection No.55/2014/QH13 and the Decree 18/2015/ND-CP issued by the Government of Vietnam.

12.2 Scoping

Potential impacts of the project are assessed by considering the current condition of the project location, the project design and layout, the construction methods involved and the operation of the project. Summary of environmental and social impacts is presented in the following table.

Table 12.1 Summary of Environmental and Social Impacts

No	Impacts	Evaluation/Remark
Pre-Construction Stage		
1	Involuntary Resettlement	No household is allocated on the proposed site for the office. The proposed site is within or nearby interchange area and the site is either closed by access ramp ways or faced highway. Mostly the area belongs to public namely within Right of way (ROW). No one will be resettled by the project implementation.
2	Landscape	Mobilization of construction equipment, establishment of work camps will gives busy and congested looks during pre-construction.
Construction Stage		
Social Impacts		
1	Local economy such as employment and livelihood, etc.	During the construction and equipment installation period, some households located nearby the road doing small business could be affected but in very short of time. Meanwhile employment opportunity for construction labor will be expected. In the operation period of the main center as well as road management office will be quite calm and quiet activities are expected. Basically there is no direct impact to the local economy and very few opportunity to engage local employment due to high technical operation of the ITS required for operation.
2	The poor	There is almost no poor class inhabitant settled but basically vacant space or agricultural land.
	Indigenous and ethnic people	No such indigenous and ethnic people are living in the vicinity.
3	Hazards (Risk), Infectious diseases such as HIV/AIDS	Dusts and emission guess caused by construction activities will be affected as respiratory diseases to construction workers, but it could be temporally and not so serious. Safety management of the construction activities, dust control, periodical watering for settling dust, proper

No	Impacts	Evaluation/Remark
		maintenance of construction vehicles and equipment will be necessary. Education on sanitation, safeguard operation to the workers and information on construction schedule and activities to local peoples are necessary. After the construction there will any problems related hazards infectious diseases are not expected.
4	Accidents	According to require numbers of construction vehicle during the construction period, ration of traffic accident may increase. Management of transportation operation in the construction site is one of the important responses for the contractor. After the construction there will be no such accident expected.
5	Traffic congestion	Some traffic congestion will be expected by transportation of construction materials at access road. Traffic control management will be required during construction period. After the construction, there will be no traffic congestion expected.
Environmental Impacts		
Natural Environment		
1	Topography and Geographical features	No large scale alteration with cutting and embankment is required by this project. No impact on topography and geographical features is expected.
2	Soil Erosion	Almost no large scale of earthwork byexcavationis applied. It may not be caused soil erosion impact so much only few impact within the site due to construction work of building facility.
3	Groundwater	Characteristics of the construction work of building facility are normal practice to drive foundation piles with building foundation.Required excavation for the building foundation is 5m -10 in depth, so that the construction activities may not give so much impact to ground water layer.
	Hydrological Situation	There is no river or lake near the project site. Therefore the project would not be expected any impact to hydrological situation of the river.
4	Flora, Fauna and Biodiversity	The project area is either part of construction site of Interchange area which has been developed or under process of construction and planned status. Natural ecosystem in this area is always in artificial creation as agriculture land mostly in vacant condition. Fauna biodiversity is almost none but only rats, frogs, sparrow and some insects. Protective species both flora and fauna are not existed in this project area vicinity.
5	Meteorology	There is any meteorological impact will be expected due to 2 story building of ITS as ordinary scale of architectural facility.
6	Landscape	Excavation and piling activities, temporally supporting work of Building structure will gives busy and congested looks during construction.
7	Global Warming	During construction, activities of earth work and transportation of materials will require use of machineries, equipment and construction vehicles, those will emit CO_2 gas and affect some global warming. The project will not be

No	Impacts	Evaluation/Remark
		so much affected on global warming because of architectural building construction.
Pollution		
1	Air Pollution	Some air pollution will be expected due to generate vehicle emission and dust by construction activities during the construction period. After construction there is no air pollution expected.
2	Water Pollution	Excavation activities of foundation work may cause temporally impact by construction activities. After construction, no water pollution will be expected.
3	Soil Contamination	When lubricant oils and chemicals leaked into the ground from construction vehicles and equipment, soil contamination will be expected within the site.
4	Solid Waste	Wastes and refuse materials from construction site and workers camp yard are usually generated, these wastes must be checked either dangerous, toxic, spoiled or not, if these risky wastes are identified disposed to the specific place directed by local government. Basically, these wastes can be managed by the contractor during construction period.
5	Noise and Vibration	Operation activities of construction equipment and vehicles generate certain level of noise and vibration and affect nearby living local peoples. These impacts will be temporally during construction period. After construction, there is no noise and vibration expected.
Operation Stage		
Social Impacts		
	Development of ITS services	ITS can lead to the rapid development activities related to transport and traffic on the highways of Northern Vietnam in comparison with other routes.
	Local economic conditions and livelihood	During the operational phase, the ITS main center is expected to calm and quiet. Basically there is no direct impact to the local economy and less job opportunities for local workers becauseof high technology operation of ITS centre.
	Public health	There is not any evidence showing that ITS implementation can be impacted to people's health.
Environmental Impacts		
	Quality of Natural environment	The project will not cause any significant impacts to soil, surface water as well as air and noise along the project route.

12.3 Consideration of Mitigation Measures and Environmental Management/Monitoring Plan

1) Consideration of mitigation measures (Avoiding and minimizing adverse impacts)

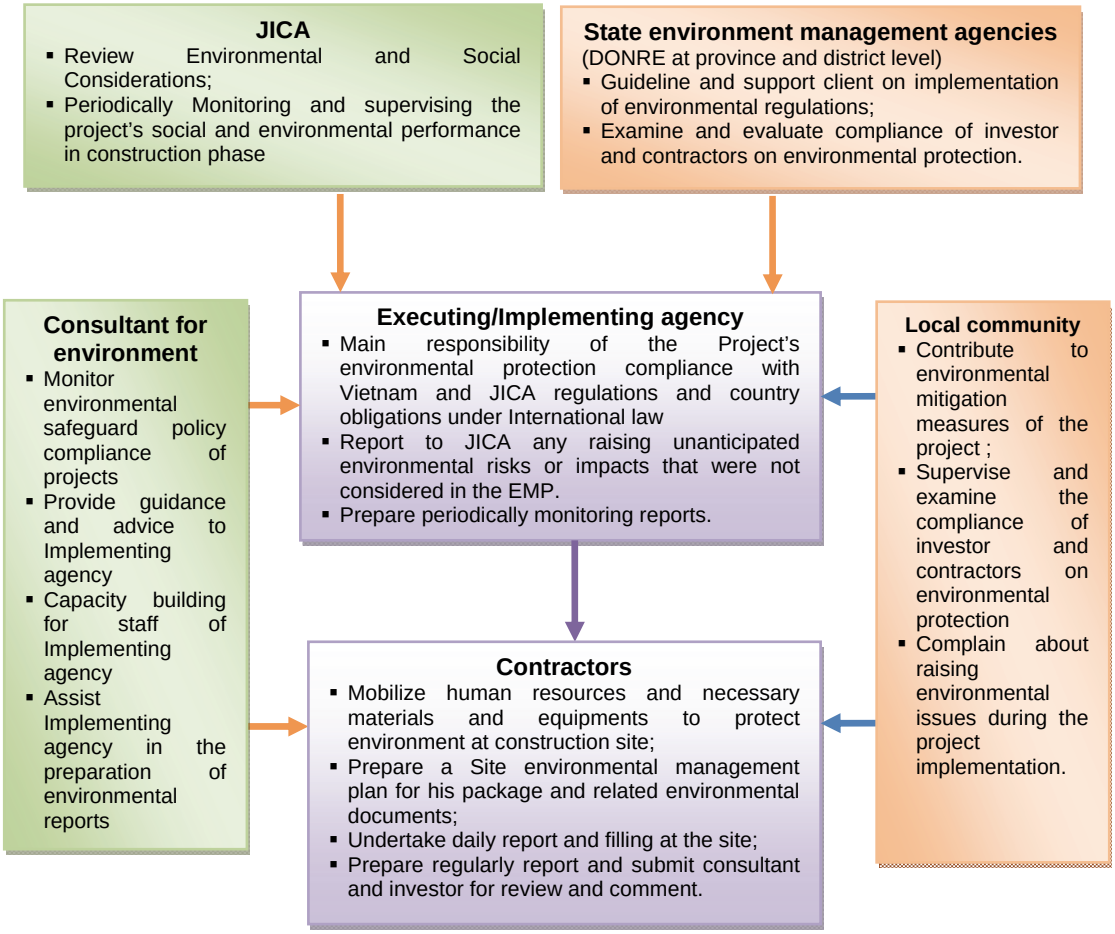
The mitigation measuresduring construction phase mainly focus on minimizing impacts on drainage interruption; traffic and other social problems; impacts on air, noise and water pollution in the project's vicinity area also waste management. Further the solutions to

prevent and cope with risk control are included. Minimizing methods of these negative impacts, on one side they will be implemented by the supervision consultant and the project implementation body, on the other side by the contractors.Mitigation measures for each negative impact shows in environmental management plan as shown in Table 12.2.

2) Consideration of Environmental Management Plan

During the project implementation, management of environmental issues will be taken into account. The organization of environmental management and its responsibility is briefly presented in the Figure 12.1 below.

Figure 12.1 Organization of Environmental Management and Its Responsibility



The expected efforts of the environment management plan are depended on the knowledge and understanding also effects of the training workers and officials. Manager and staff will be informed regularly environment issues through meetings.

The program on environmental training should be conducted specifically by working groups and includes as follows:

(a) Environmental policy, purpose and target to reduce pollution.

(b) Environment control system, procedures and guidelines on environment.

(c) Policy and law on environment, organization and technical methods to minimizing environmental impacts.

(d) Potential environment issues on which the project faces, protecting environment in the working period.

(e) Inventory and appraisal of environmental quality, periodical training programs to response emergency in case of happening the risk.

Detail mitigation measures for negative impacts are shown in the following table.

Table 12.2 Environmental Management Plan (EMP)

Environmental Impact/Issue	Mitigation measures	Location	Time frame	Responsibility		Capital cost
				Implementation	Supervision	
1. Construction stage						
Report to the employer and the consultant for all following items during construction			Each month	Contractors	The project implementation body /Consultant	General BQ item
1.1 Soil						
1.1.1 Disposal of excavated materials and construction debris	(a) Residual spoils will be used according to an erosion protection plan by each contractor. (b) All arrangements for transportation during construction, including maintenance, dismantling and clearing debris, where necessarywill be considered incidental to the work and should be planned and implemented as approved and directed by the consultant.	at construction sites	During construction	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items
1.1.2 Soil erosion	(a) The work will comprise measures to control soil erosion, sedimentation, and water pollution	At construction site, service roads, and equipment storage sites	During construction	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items
1.1.3 Contamination of soil by	(a) An oil interceptor will be provided for wash	At project site. All access	During construction	Contractors	The project implementation body	

Environmental Impact/Issue	Mitigation measures	Location	Time frame	Responsibility		Capital cost
				Implementation	Supervision	
fuel and lubricants	down and refuelling areas. Fuel storage will be in proper bounded areas.	roads.			/Consultant	
1.2 Water						
1.2.1 Erosion and siltation	The contractor will take all necessary precautions to prevent water pollution (due to siltation and increased turbidity).	At project site. All access roads.	During construction	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items
1.2.2 Contamination of water due to construction wastes	(a) All measures will be taken to prevent the wastewater produced in construction from entering directly into canals, rivers, water bodies, or irrigation system, as directed by the consultant.	At project site. All access roads.	During construction	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items
1.2.3 Contamination from fuel and lubricants	(a) Vehicle, machinery, and equipment maintenance and refuelling will be done in a manner to prevent pollution of water.	At project site all access roads.	During construction	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items
1.2.4 Public health, sanitation, waste disposal in worker's camps and safety	(a) The sewage system for worker's camps will be properly designed, built, and operated so that pollution to ground or adjacent water bodies/watercourses does not take place. Garbage bins will be provided in the camps and regularly emptied, and the garbage disposed of in a hygienic manner, to the satisfaction of the relevant standards and the consultant.	At project site. All access roads.	During establishment, operation and dismantling of such camps	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items

Environmental Impact/Issue	Mitigation measures	Location	Time frame	Responsibility		Capital cost
				Implementation	Supervision	
	(b) Health examinations will be regularly provided. Clinics facilities will be provided in construction camps (if necessary).					
1.3 Air pollution						
1.3.1 Dust emission	(a) All vehicles delivering granular and/or fine materials to the site will be covered to avoid spillage.	At project site. All access roads.	During construction	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items
1.3.2 Emission from construction vehicles, equipment and machinery	(a) All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that pollution emission levels comply with the relevant regulations.	At project site. All access roads.	During construction	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items
1.4 Noise pollution						
1.4.1 Noise from vehicles, machinery and equipment	(a) All vehicles, equipmentand machinery used for construction will strictly conform to the noise standards	At project site. All access roads.	During construction	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items
1.5 Traffic accident						
1.5.1 Traffic accident on the expressway	(a) Safety protection tools equipment as rubber cone, fence, safety light and flag man on the shoulder or median side of trench excavation of duct at the road to give travelling vehicle drivers to aware the attention to reduce speed and keep shift to safety carriage lane. (b) Information and warning signage preparation at the	At excavation of trench and installation for duct with optical cable.	During construction	Contractors	The project implementation body /Consultant	Construction costs in the relevant BQ items

Environmental Impact/Issue	Mitigation measures	Location	Time frame	Responsibility		Capital cost
				Implementation	Supervision	
	shoulder to driver's attention for activity on the construction undergoing.					

3) Consideration of Environmental Monitoring Plan

The items of the environmental monitoring during construction period are noise, ambient air quality and surface water. Table 12.3 shows environmental monitoring plan for construction period. Table contains the monitoring items, monitoring details and parameters, reference standard related each monitoring items, timing to monitoring (frequency), executing unit (Agencies) and reporting on the monitoring.

Table 12.3 Environmental Monitoring Plan for Construction Period

Item	Monitoring details	Reference standard	Timing	Executing unit	Reporting
Construction period Prepare and use a monitoring checklist					
Noise	Measure construction noise at varying distances from sources and near sensitive structures if any (e.g. school and hospital). L_{aeq} (6 am – 6 pm and 6 pm – 10 pm) will be measured.	National technical regulation QCVN 26:2010/BTNMT	Once every three months at construction site.	The project implementation body/Consultant	In monitoring report (every 3 month) to Department of Natural Resource and Environment
Air quality	Measure in the area around sources and at prescribed receptors at various distances. Parameters of SPM, PM10, CO, NO_2 and SO_2 will be monitored.	National technical regulation QCVN 05:2013/BTNMT	Once every three months at construction site.	The project implementation body/Consultant	Same as above
Surface Water	Conduct monitoring at the site. Parameters of pH, BOD_5, COD, DO, SS, arsenic, cadmium, lead, copper, chromium (+6), zinc, manganese, iron, mercury, ammonium, fluoride, nitrate, nitrite, cyanide, coliform, and oil/grease will be monitored.	National technical regulation QCVN 08:2008/BTNMT	Once every three monthsat construction site.	The project implementation body/Consultant	Same as above
Traffic Safety	Construction of duct / optical cable installation: Current vehicle traffic safety control for road shoulder and median shall be monitored.	Decree No.11/2010/ND-CP and Decree No.100/2013/ND-CP and Circular No.52/2013/TT-BGTVTQD	During earth work and installation period.	The project implementation body/Consultant	Monitor whenever work activities are carried.

13. Project Implementation Plan

13.1 General

The following items are discussed in this chapter regarding the Project Implementation Plan:

- Organization analysis (on the Project implementation and the system O&M)
- Packages for Implementing the Project
- Project Implementation Schedule
- Important points for the Project implementation.

13.2 Organizational Analysis

Certain changes occurred recently to the entities related to the Project implementation; DRVN established in April 2010 has become more active and VEA was established under MOT in March 2014. PMU3 is directly under the DRVN as shown in Figure 13.4.

Analysis of the organizational framework for the Project implementation is discussed below based on the present conditions of the Project implementation entities.

1) Project Implementation Organizations

For the efficient and economical implementation of the Project with the least technical difficulties in integrating the ITS for all expressway sections in the northern area (including those sections not covered by the Project) at the least additional costs and time, the Project should be implemented by the following simple organizations:

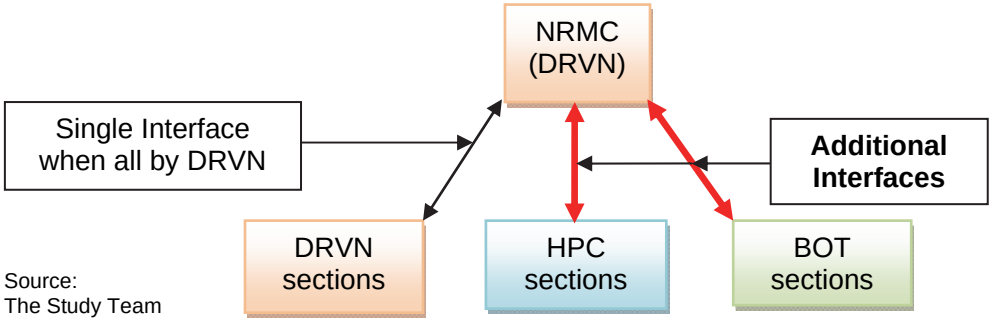
- DRVN (Directorate for Roads of Vietnam) responsible for the overall Project implementation (ITS design, construction or installation and integration) for all expressway sections proposed and the proposed Northern Regional Main Center (as the “Executing Agency” under the JICA loan agreement),
- MOT (Ministry of Transport) responsible for administration and execution of the Project implementation budget (as the “Line Agency”),
- PMU3 directly under DRVN responsible for day-to-day operation and management of the Project including management of the Consultant and the Contractors (as the “Implementing Agency”).

Other entities like HPC (Hanoi People’s Committee) and the private BOT investors can also become the Project implementing entities for their own expressway sections, although such a method/organization of the Project implementation is not recommendable from technical and financial points of view as discussed below.

If HPC and the BOT investors implement ITS work in their own sections of expressway while DRVN implements NRMC and the remaining sections of the expressway network, the interfaces between NRMC of DRVN and these 3 sections of the expressways will increase to 3 as shown in the following figure, from only 1 between NRMC and the DRVN section of the expressways (all of the 7 sections proposed under the Study) when DRVN implements all of the 7 sections proposed. As NRMC is the DRVN responsibility, there will be no external interface when DRVN remains responsible for implementation of all expressway sections proposed.

Resolving of interfacing issues among the different implementation entities (e.g. who shall bear the cost of modification, replacement or, in the worst case, disposal of software/ hardware incompatible with the NRMC installations) will not be easy, because of the conflicts of interest of the respective entities.

Figure 13.1 Number of Interfaces when 3 Entities Implement ITS Projects



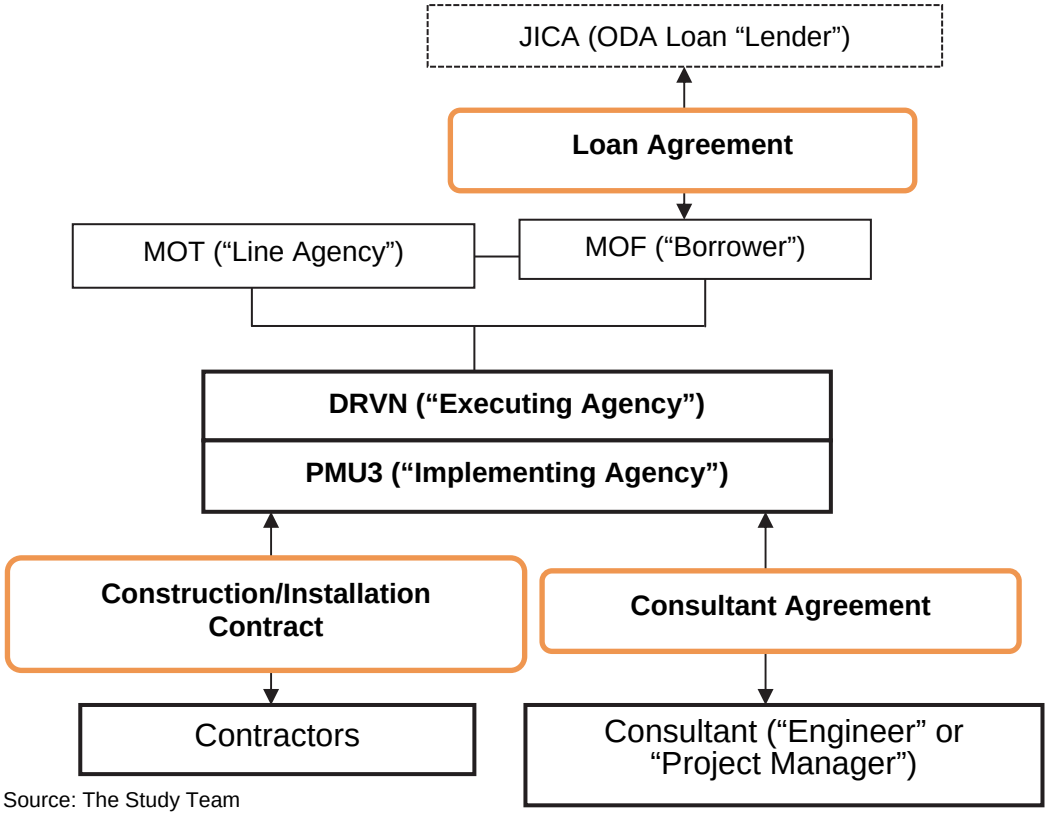
Source:
The Study Team

It is essential that the respective sections are implemented within a same time frame, even when installed by 3 different entities, in order to minimize the undue wasteful costs (including technical disclosure fees), that will become huge as compared to the case that the Project is implemented by a single implementing entity (i.e. DRVN) within a same time frame.

From the above study, it is strongly proposed that DRVN be the single entity responsible for the Project implementation (ITS design, construction or installation and integration) for all sections of the proposed expressway network.

The proposed overall organization for the Project implementation is as shown below.

Figure 13.2 Proposed Overall Organization for Project Implementation



Source: The Study Team

As DRVN is under MOT as decided by the Prime Minister's Decision No. 60/2013/QD-TTg dated 21 October, 2013, MOT must be the direct supervisor of DRVN in the Project implementation.

The existing organizational structure and the Project implementation capability of DRVN, MOT, VEA and PMU3 are assessed below.

(1) DRVN and MOT

a) Existing Organizational Structure

DRVN is one of the directorates and bureaus of MOT as seen in the organizational structure of MOT as shown in Figure 13.3 below. The organizational structure of DRVN is shown in the Figure 13.4. DRVN is organized under MOT in accordance with the Prime Minister's Decision No. 60/2013/QD-TTg dated 21 October, 2013.

MOT is the ministry responsible for nationwide state management of roads, railways, inland waterways, maritime and civil aviation transports, and of public transport services as stipulated by law. MOT has the responsibility for the implementation of tasks and powers as stipulated in the Government Decree No. 178/2007/ND-CP dated 3rd December 2007 on functions, powers, duties, and organizational structure of ministries and ministerial level agencies.

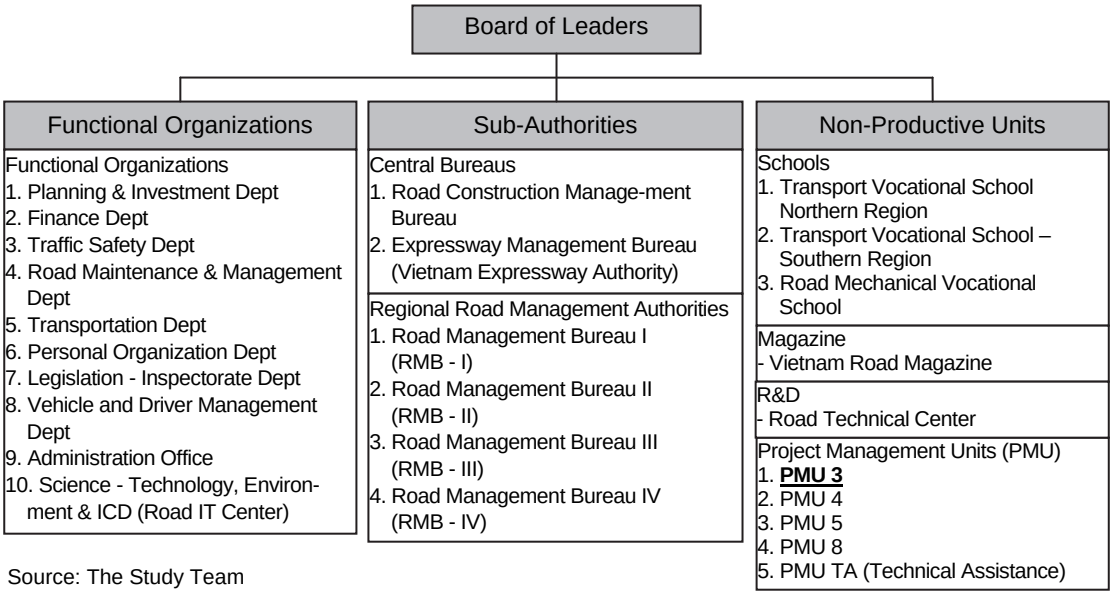
In this Project, MOT is the Line Agency responsible for the overall management of the Project including the following:

- Approval of funding plans, chairing the coordination meetings with other related ministries (e.g. MOF, MPI), reporting to the Prime Minister of the Government for approval of the works outside the MOT authority;
- Chairing the procedures to arrange additional funding sources for the Project;
- Chairing the approval process for construction project, procurement plans, technical design documents, cost estimation, PQ Documents, Bidding Documents, results of PQ/bid/proposal evaluation for selection of the Contractors, Consultants, etc.;
- Monitoring the quality of the works, quality of goods, equipment and facilities for the Project, reviewing the regular reports including the audit reports, etc.
- Approving the O&M plans for the completed facilities; and
- Implementing other works and services as the Line Agency as stipulated by the law.

Figure 13.3 Organizational Structure of MOT

Source: The Study Team

Figure 13.4 Organizational Structure of DRVN



Source: The Study Team

DRVN is responsible for performing the functions of consulting, assisting the Transport Minister in the State management and executing legal issues on road transport nationwide, and organizing public services on road transport legally, as stipulated in the Prime Minister's Decision No. 60/2013/QD-TTg.

DRVN's duties include, among others, the following:

- Management of road infrastructure investment construction,
- Road and expressway management
- Development of TCVN and QCVN.

In this Project, DRVN should act as the Project Executing Agency (as will be defined in the JICA Loan Agreement) directly under MOT and responsible for, among others, the following:

- Preparation of the Project funding plans for submission to MOT approval,
- Preparation of proposals to MOT on meetings with other related ministries,
- Preparation of various reports to MOT (and MOF) the matters pertaining to the Project as required,
- Review of procurement plans, technical design documents, cost estimation, PQ Documents, Bidding Documents, results of PQ/bid/proposal evaluation for selection of the Contractors, Consultants, etc. prepared by PMU3 under DRVN for MOT approval;
- Taking various actions required under the respective Contracts, including approvals of payments to the Contractors and the Consultants and issue of various certificates,
- Superintending the activities of PMU3 acting as the Implementing Agency under DRVN;
- Review and approval of the O&M plans for the completed facilities, for review and approval by MOT,
- Implementing other works and services as the Executing Agency as stipulated by the Loan Agreement and the law.

b) Capability of Project Implementation

MOT has much experience in the administration and execution of budget for implementation of the expressway construction projects and other projects of transport infrastructure construction. The departments in MOT responsible for expressway construction and 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
- Center for Information Technology.

DRVN in MOT was transformed, on 26 April, 2012, from the Expressway Management Office, which was set up in MOT on 1 April, 2011 to be responsible for both expressway O&M and ITS.

As such, DRVN is still a young entity, and neither has sufficient experience as the project implementation entity nor has sufficient qualified staff as required for successful implementation and completion of the Project; it is recommendable that DRVN is assisted by PMU3 in the Project implementation including the procurement of the contractors and the consultant, the construction supervision and the management of the construction and consultant contracts.

DRVN, as the Project Executing Agency, must procure the Contractors and manage their contracts, with assistance from the engineering consultant, who must also be procured by DRVN and the consulting services contract must also be administered by DRVN as the Employer.

(2) VEA (Vietnamese Expressway Authority)

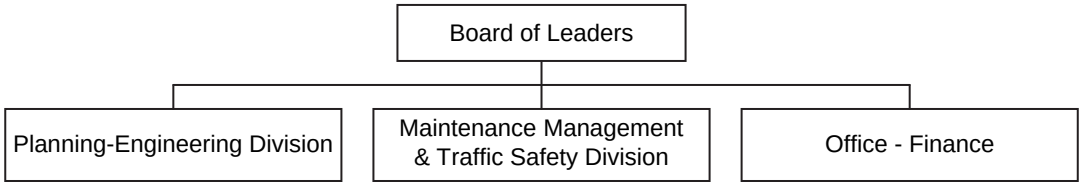
a) Existing Organization Structure

VEA was established in March, 2014. VEA is responsible for the development of the expressway network, the administration of expressway projects by PPP, BOT and BT investments, and the execution of state management tasks over the expressway network.

VEC (explained below) and other expressway project owners will be administered by the government through a single focal point of VEA.

The organization structure of VEA is shown in the figure below.

Figure 13.5 Organizational Structure of VEA



Source: The Study Team

b) Capability of Project Implementation

VEA is a young agency established in March 2014 as stated above. As such, VEA does not have much experience of project implementation. Its capability in terms of human resources for Project implementation is also limited. When VEA needs to undertake certain portions of the Project implementation, supports by an experienced and staffed entity like PMU3 will be indispensable. Nevertheless, VEA has ITS knowledge better than PMU3, therefore, their ITS skills is indispensable for the Project implementation in a proper manner.

As VEA will be responsible for O&M of NRMC, VEA must recruit and train the O&M personnel during the Project implementation period. A period of 3 months for the operation and maintenance training by the Contractor is planned at the end of the construction/ installation period in the Project implementation schedule as shown in Section 13.4.

It is recommendable that the Consultant undertakes on-the-job training of 6 months or so of the operation personnel of the road operators after the construction period, in addition to the O&M training to be provided by the Contractor at the end of the construction period. It is also recommendable that JICA technical assistance is sought for the O&M training using ITS during the Project implementation period as shown in the proposed schedule.

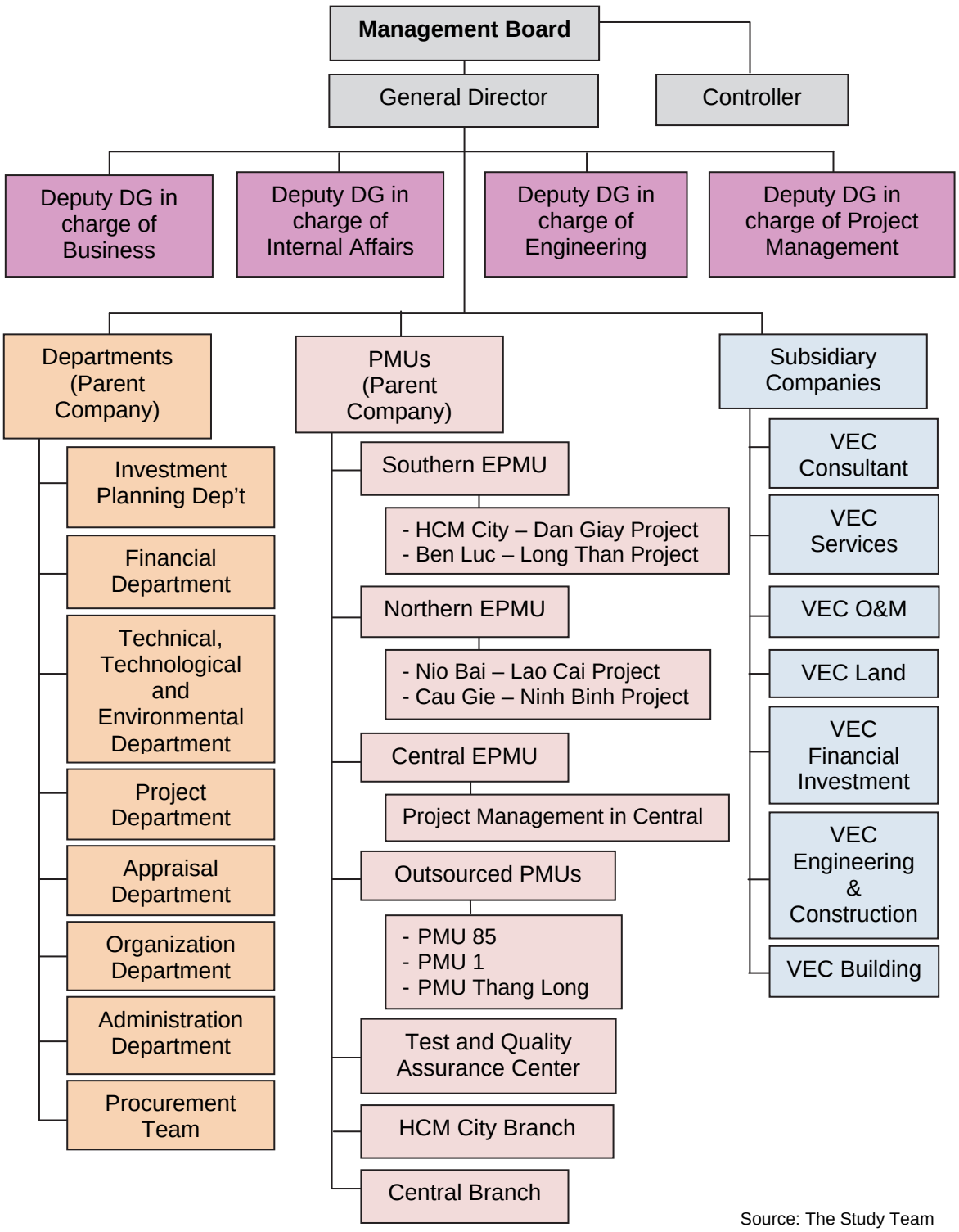
(3) VEC

VEC was established in September, 2004, as a state-owned enterprise under MOT, for investment, development, management, and maintenance of national expressway system. VEC is administered by the government through a single focal point of VEA.

The organization structure of VEC is shown in the following figure. The investment planning department, the project department and the technical, technological and environmental department are responsible for projects implementation.

It is estimated that VEC has not much to do with the Project, but VEC's cooperation must be sought by DRVN, VEA and PMU3 as and when needed, because VEC has a lot of experience in the expressway construction, operation and maintenance.

Figure 13.6 Organizational Structure of VEC



Source: The Study Team

b) Capability of Project Implementation

VEC has sufficient experience in the expressway construction projects including ITS implementation projects implemented for the following sections:

- Phap Van – Cau Gie – Ninh Binh Expressway

- Long Thanh – Dau Giay Expressway
- Noi Bai – Lao Cai Expressway.

VEC-O&M (a subsidiary of VEC as shown in the figure foregoing) has been undertaking O&M of the ITS installed in the Mai Dich–Thanh Tri (Ring Road 3), the Phap Van – Cau Gie and the Cau Gie – Ninh Binh sections.

(4) PMU3 (Project Management Unit No.3)

a) Existing Organization Structure

PMU3 belongs to DRVN as a project management unit as shown in Figure 13.4 above. PMU3 was separated from PMU2 in June 2013.

In PMU3, there are 4 teams under the Leader as follows:

- Planning – Procurement and Contract Management Team responsible for preparation and update of procurement plan for projects, work and disbursement planning and contracts management of all project-related contracts
- Technical and Site Monitoring Team responsible for overall technical issues of projects and management of technical aspects, progress and quality of civil work contracts
- Safeguard Team responsible for resettlement policy framework, monitoring of land acquisition and resettlement works, monitoring safeguard monitoring consultants and reports on safeguard issues
- Financial Management Team responsible for disbursement to contractors/consultants, preparation of project financial statements, supervision of financial statements, etc.

In the Project, PMU 3 will be the Implementing Agency assisting the Executing Agency and undertake the following activities for the Executing Agency:

- Assist Executing Agency in negotiating and signing of loan agreements for the Project with the donors and other relevant ministries and agencies
- Assist Executing Agency in cooperation with relevant ministries, agencies the donors on the issues relating to the Project
- Preparation of various documents needed for procurement of the Contractors, the Consultants, etc. including the PQ and Bidding Documents for procurement of the Contractors and the Consultant Services TOR for review by the Executing Agency
- Evaluation of the proposals from consultants for procurement of the Consultants
- Superintendence of the Consultants' pre-construction activities including the PQ and Bidding Documents preparation, the PQ and bid evaluation for procurement of the Contractors and recommendation of wards of the construction Contracts
- Taking various actions required as "the Employer" of the Contractors and the Consultants in overall management of the Construction and Consultant Contracts including certification of payments to the Contractors and the Consultants;
- Review (and approval) of the Contractors' submittals including the detailed designs, various reports and proposals and the O&M plans
- Superintendence of the Consultants' construction/installation supervision services, including review of the detailed designs, various guarantees, reports and proposals from the Contractors.

The Implementing Agency acts on behalf of the Executing Agency, if an appropriate

authority is granted by the Executing Agency.

b) Capability of Project Implementation

PMU3 has sufficient experience in project management. A core team including senior managers and senior staff members who have rich qualification and experience have moved from PMU2 to PMU3. PMU3 is currently implementing 5 projects and has other 6 projects under preparation for project management (as of February 2015). As such, there is no particular concern over the PMU3's capability of the project implementation.

For legality and for smooth management, operation and maintenance, the ownership of the ITS implemented and completed under the responsibility of DRVN as proposed above should be transferred to the relevant entities as follows:

- Northern Regional Main Center: to be transferred to VEA
- ITS in Mai Dich–Thanh Tri (Ring Road 3), Noi Bai – Bac Ninh and Lang Hoa Lac sections: to be transferred to HPC
- ITS in Cau Gie – Ninh Binh section: to be transferred to VEC
- ITS in Phap Van – Cau Gie and Ha Noi – Bac Giang sections: to remain in the ownership of DRVN.

HPC, VEC and DRVN own the existing part of ITS in Mai Dich – Thanh Tri (Ring Road 3), Cau – Gie – Nin Binh and Phap Van – Cau Gie sections respectively.

2) Institutional Arrangement for Project Implementation

The proposed institutional arrangement for implementing the ITS Integration Project, including the Northern Regional Main Center and the 7 expressway sections and for the ITS O&M, is summarized in table below.

Table 13.1 Institutional Arrangement for Project Implementation

	Proposed Implementation Org.	Existing Contract Type of O&M	Org. of Road Owner	Org. of Road Operator	Remarks
Northern Regional Main Center	DRVN	--	VEA	VEA	
Mai Dich– Thanh Tri	DRVN	Service Contract	HPC	O&M-Company	Existing ITS by JICA Grant is to be transferred from VEC-O&M*
Lang – Hoa Lac	DRVN	Service Contract	HPC	O&M-Company	
Phap Van – Cau Gie	DRVN	Concession Contract	DRVN/BOT	BOT Company	Existing ITS by JICA Grant is to be transferred from VEC-O&M*
Cau Gie – Ninh Binh	DRVN (VEC)	Service Contract	VEC	VEC-O&M	ITS is partially installed already
Ha Noi – Bac Giang	DRVN	Concession Contract	DRVN/BOT	BOT Company	
Noi Bai – Ca Lo Bridge	DRVN	Service Contract	Bac Ninh Prov.	O&M-Company	
Ca Lo Bridge – Bac Ninh	DRVN	Service Contract	HPC	O&M-Company	

Note, *: VEC currently owns the existing ITS in the sections of Mai Dich – Thanh Tri and Phap Van – CauGie and VEC-O&M (VEC's subsidiary company) currently operates and maintains the existing ITS in the said 2 sections.

Source: The Study Team

The specific study results on the institutional arrangement for the Project implementation are summarized in the following table. From the legal and technical points of view, it is recommended that DRVN implements the Project as a whole.

The following concerns exist in the case the Project is implemented by other entities or other schemes:

- ITS integration will not progress efficiently and effectively.
- BOT investors will refuse to implement the ITS installation, because ITS work is not included in their BOT work.
- If ITS installation begins only after completion of the NRMC by DRVN/VEA, several expressway sections must operate without ITS for a long period.
- Effectiveness of the NRMC cannot be fully verified without ITS installation in multiple expressway sections.

Table 13.2 Institutional Arrangement for the Project Implementation

Sections / Subjects	• Mai Dich – Thanh Tri • Noi- Bai – Bac Ninh	• Cau Gie – Ninh Binh	• Phap Van – Cau Gie • Ha Noi – Bac Giang
Existing Contract Type of O&M *1	Service Contract (HPC/ O&M-Company, Bac Ninh Prov./O&M-Company)	Service Contract (VEC/VEC-O&M)	Concession Contract (DRVN/BOT)
Existing Situation of ITS Implementation	• ITS has been partially installed by JICA Grant in these 2 sections. • HPC does not have specific implementation plan for ITS work in these 2 Sections. • HPC has indicated that HPC prefers DRVN's implementation of the ITS work using MOT funds.	• VEC has installed ITS partially in this section. • VEC has indicated that VEC prefers DRVN's implementation of the additional ITS work using MOT funds.	• BOT investor has requested amendment to existing BOT Contract to allow BOT investor to install ITS.
Legal Possibility of ITS Implementation using MOT Funds	• HPC has no objection.	• VEC has no objection.	• Road widening and tollgate construction are included in the scope of existing BOT Contracts. • But, ITS work is not included in the scope of existing BOT Contracts (although MOT knew all ongoing expressway projects include ITS). • As such, DRVN/MOT is not prohibited to implement ITS work in BOT sections without modifications to existing BOT Contracts. • BOT cannot implement ITS work without the modifications (although BOT can implement the road widening and tollgate without the modifications).
Technical Necessity for ITS Implementation by a Single Entity under a Single Contract	• To minimize the technical difficulties caused by conflicts or contradiction among the opinions of different Project Implementation Entities • To realize the necessary functions • To establish the effective ITS Standards • To minimize the unnecessary costs caused by the lack of unification, the required replacement of devices and the payment of technical disclosure fee (→See (2) of Clause 3).		
Recommended Project Implementation Entity	ITS is to be implemented by DRVN/MOT		

*1: Contract types are aforementioned in Section 4.2.

Source: The Study Team

13.3 Packages for Implementing Project

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

Package-1: The systems for traffic information/control and communication, and supply of the O&M vehicles (on a Design and Build basis).

Package-2: The communication ducts and the power supply system (on a Build only basis).

Package-3: The NRMC buildings and the associated works (on a Build only basis).

The functional packages and other items included in each package for implementing the Project are shown in the table below.

Table 13.3 Functional Packages and Other Items in Package for Implementing Project

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

Note: Greyed out area is "For Reference". Source: The Study Team

As mentioned above, Package-1 should be implemented on a Design and Build basis, for certain potential benefits to the Employer. For the potential benefits of the Design and Build contracts, refer to item 3) of 18.4 of Chapter 18 of this report. In the Design and Build contract, the Project Implementation Contractor must develop, for approval by the Employer, its own detailed designs (detailed specifications and the detailed drawings) in strict compliance with the "Basic Design Specifications" shown in this Study report (refer to Chapter 9), before manufacturing or purchasing the equipment components for installation.

13.4 Project Implementation Schedule

The following activities are to be completed in advance of the Project implementation/ construction (installation), as shown in the proposed Project implementation schedule below.

- Appraisal mission
- Loan agreement sign
- Consultant selection
- Training of the relevant personnel on traffic information/control including integrated/ prioritized Information Dissemination before PQ documents preparation
- PQ and Bidding Documents preparation and PQ/Bid evaluation assistance
- Detailed designs of communication ducts, power supply system and NRMC building and associated works
- Design and PQ/bidding documents endorsement
- PQ process for contractors/bidders selection
- Bidding process for Contractors selection.

For Package-1, the bidding period for the Contractors should be 3 months or more to allow the bidders' preparation of their bidding designs and cost estimates based on their biding designs, and the Project implementation period for the Contractors' design and build/installation is to be around 2 years. Additionally, a longer Defect Liability/Notification Period of 2 years is recommended for successful integration of ITS during this period.

For Packages-2 and 3, the bidding period may be 2 months because the Bidders will be give the detailed designs of the Employer before bidding. The construction period may be 15 months or so, as the work volume is not large and the works must be completed well in advance of the cable and equipment installation in the completed ducts and buildings. The Defects Liability/Notification Period may be 1 year for these 2 packages as per the JICA standard.

The proposed Project implementation schedule is shown in the figure in the following page.

A period of approximately 9 months is proposed for the "Consultant Selection" as the standard process period in accordance with the JICA guidelines. Certain parts of the process must be undertaken before JICA's pledge of the ODA loan, in order to complete the installation/construction work by the end of 2019.

The detailed design of communication ducts, power supply system and NRMC building and associated works and preparation of the Bidding Documents for 3 procurement packages shown in table foregoing are proposed as part of the Consultant's services only after selection of the Consultant, unlike the irregular schedule proposed in the SAPI report where the Consultant is selected only after completion of the Bidding Documents.

As stated above, a bidding period of 3 months (1 month longer than the period proposed in the SAPI report) is proposed for Package-1 to allow the bidders to prepare a bidding design as needed for their proper cost estimates.

Certain decisions/authorizations should be made by the Project implementation entity (DRVN or other), including but not limited to the following, before the Bidding Documents preparation:

- Decision of the entity (such as BOT, VEC-O&M, and VNPT) to be responsible for

maintenance of ITS and communications equipment in the Regional Main Center and in each section of the expressway network

- Decision of the entity to be responsible for dispatching tow trucks, police patrol cars and/or ambulance cars for each IC section of the expressway network (to reach the traffic event sites within 30 minutes of the event occurrence, as stipulated in Decree No. 3/2014/ND-CP)
- Authorization of the entity to be responsible for guiding the adjoining expressway sections to comply with the specifications on the cooperation/connection of ITS.

These decisions/authorizations are important and should be made prior to the consultant's commencement of its services for preparation of the contractor prequalification/bidding documents preparation so that the relevant information/requirements can be stipulated in these documents in a proper manner. JICA's technical assistance will be available for this decision-making study process, if DRVN wishes so.

Regarding the Technical Assistance for Expressway O&M using ITS shown in the Schedule:

Proper training of the O&M staff of the road operators is prerequisite for successful operation and management of the completed facilities towards the success of the Project as a whole. The training should commence at an early stage of the Project implementation so that the O&M staff will be able to learn from the Contractors' design, supply, installation and testing activities.

It is recommendable that JICA technical assistance should be sought for the O&M staff training including, but not limited to, the following:

- Improvement/standardization of the expressway O&M procedure by the existing method
- Observation and training of the expressway O&M procedure applied in Japan
- Training of the expressway O&M procedure using the ITS installed under the Project
- Improvement of the expressway O&M procedure using the ITS installed under the Project.

If the proposed training of 12 months or so under JICA technical assistance as shown at the last line of the Project implementation schedule is undertaken, the on-the-job training services by the Consultant proposed as Optional after completion of the Contractor's implementation/installation may be cancelled.

Figure 13.7 Poposed Project Implementation Schedule

Activities	Year & Month: 2015 (2 3 4 5 6 7 8 9 10 11 12)	2016 (1 2 3 4 5 6 7 8 9 10 11 12)	2017 (1 2 3 4 5 6 7 8 9 10 11 12)	2018 (1 2 3 4 5 6 7 8 9 10 11 12)	2019 (1 2 3 4 5 6 7 8 9 10 11 12)	2020 (1 2 3 4 5 6 7 8 9 10 11 12)	2021 (1 2 3 4 5 6 7 8 9 10 11 12)	2022 (1 2 3 4)
1) Basic Design (This Study)								
2) Fact Finding Mission & Appraisal Mission								
3) Pledge								
4) Loan Agreement Signing								
5) Consultant Selection								
6) Consultant Services Agreement Signing								
7) Training on Traffic Information/Control including Integrated/Prioritized Information Dissemination (JICA assistance)								
8) PQ Documents Preparation and Approval (3 Packages)								
9) JICA Concurrence to PQ Documents								
10) PQ Application Period for Contractors (3 Packages)								
11) PQ Evaluation and Approval (3 Packages)								
12) JICA Concurrence to PQ Evaluation Results								
13) Consultant's Detailed Design of Communication Ducts, Power Supply System and Building (For Packages-2 and 3)								
14) Bidding Documents Preparation and Approval (3 Packages)								
15) JICA Concurrence to Bidding Documents								
16) Bidding Period (3 Packages)*1								
17) Technical Bid Evaluation and Approval (3 Packages)								
18) JICA Concuurence to Technical Bid Evaluation Results								
19) Price Bid Evaluation and Approval								
20) JICA Concurrence to Price Bid Evaluation Results								
21) Contract Negotiation (3 Packages)								
22) JICA Concurrence to Contract Negotiation Results								
23) L/C Open and L/Commitment Issue (3 Packages)								
Consulting Services — 24) Pre-construction (Procurement) Services (3 Packages)								
Consulting Services — 25) Construction Supervision Services (Package-1)								
Consulting Services — 26) Construction Supervision Services (Package-2 & 3)								
Consulting Services — 27) Training Period Services (for Contractor's training)								
Consulting Services — 28) Training Servcies (Optional)								
Consulting Services — 29) Defects Liability Period Services (Package-1)								
Consulting Services — 30) Defects Liability Period Services (Package-2 & 3)								
Contractor Works — 31) Implementation Work (Package-1) D&B								
Contractor Works — 32) Implementation Work (Package-2 & 3) Build only								
Contractor Works — 33) Training Period Work (3 packages)								
Contractor Works — 34) Defects Liability Period Work (Package-1)								
Contractor Works — 35) Defects Liability Period Work (Package-2 & 3)								
Technical Assiatance for Expressway O&M using ITS (by JICA assistance) Recommended								

Source: The Study Team

13.5 Important Points for Implementation

The following are the important points for the Project implementation:

- The NRMC and the ITS installation in each section of the proposed expressway network should be implemented as a whole simultaneously, to accomplish the full integration of the ITS in all sections through the NRMC with minimal technical difficulties and at a minimum cost. In order to alleviate unnecessary technical difficulties and undue additional costs, piecemeal implementation of the Project should be avoided.
- The Project implementation should be managed as a whole by a single entity, preferably by DRVN, in order to minimize the potential interface issues among the packages and sections. If the Project implementation is undertaken by multiple entities in multiple packages and sections, the interface management will become significantly more difficult for MOT and DRVN because of the potential conflict of interests of the respective implementation entities and their Contractors.
- Package-1 should be implemented on a design and build (D&B) basis, wherein the Contractors will prepare the detailed designs and supply and install the ITS equipment components, with a single-line responsibility for the design and installation. Use of JICA Standard Prequalificaiton and Bidding Documents, (probably for the Plant Design, Supply and Installation) is needed.
- Pacakges-2 and 3 should be implemented on a build/construct only basis, wherein the Contractors are responsible for construction of the works based on the detailed designs to be prepared by the implementation entity (in fact the Consultant employed by the implementation entity) to suit the particular site conditions. Vietnamese general contractors are suitable to undertake these packages. Use of JICAStandard Prequalificaiton and Bidding Documents for the procurement of Works is needed.
- The Consultant should be employed before commencement of preparation of the documents for the contractor prequalification (PQ). The Consultant should undertake the procurement activities for selecting the Contractors, including preparation of the Prequalification and Bidding Documents including detailed designs of the Package-2 and 3 works, and the construction supervision activities including the contracts administration services. According to the proposed schedule, the Consultant selection process must commence approximately 4.5 months before signing the Loan Agreement.
- Relevant operation personnel should be trained under JICA assistance before PQ documents preparation for understanding on the outline of expressway traffic control and the specific merits of the Traffic Information/Control System including the Integrated/ Prioritized Information Dissemination.
- By the recent Decree No. 59/2015/ND-CP dated 18 June 2015, it is permtted to assign, in certain cases, a sigle Consultant for the design and construction supervision services in a series.
- Special care should be exercised for the traffic safety during the construction period, because the construction sites include the expressways already open for traffic. Third party liability insurance of sufficient coverage should be maintained throughout the Project implementation period.

- JICA's technical assistance should be sought for the consultant selection (including preparation of the TOR and other bidding documents) and for the aforementioned various decisions/authorizations by DRVN to be made prior to the Contractor prequalification and bidding activities, as well as for the expressway O&M using ITS which should be commenced before completion of the Contractor's implementation/installation work so that the O&M staff of the road operators will be able to learn from the Contractors' installation and testing activities.

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 at roadside and a communication network for making connection among them. The testing/inspection shall be performed including software as an 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.

14. Setting-up of Operational Structure and Training Outline

14.1 General

In this chapter, the following items are to be discussed and described:

- Stepwise Setting-up of Operational Structure
- Operating Organizations
- Important Points of Training
- Outline of Training on Traffic Information/Control.

14.2 Stepwise Setting-up of Operational Structure

1) Institutional Arrangement for System Operation

The institutional arrangement recommended for operating the System installed in the Northern Regional Main Center and the 7 expressway sections are summarized in table below.

Table 14.1 Institutional Arrangement for System Operation

	Existing Contract Type of O&M	Public Road Owner or Investor	Road Operator
Northern Regional Main Center	--	VEA	VEA
Ring Road 3 **	Service Contract	HPC	O&M-Company
Lang – Hoa Lac	Service Contract	HPC	O&M-Company
Phap Van – Cau Gie **	Concession Contract	DRVN/BOT	BOT
Cau Gie – Ninh Binh ***	Service Contract	VEC	VEC-O&M
Ha Noi – Bac Giang	Concession Contract	DRVN/BOT	BOT
Noi Bai – Ca Lo Bridge	Service Contract	Bac Ninh Prv.	O&M-Company
Ca Lo Bridge – Bac Ninh	Service Contract	HPC	O&M-Company

Note, **: ITS is partially installed already by JICA Grant, ***: ITS is partially installed already.

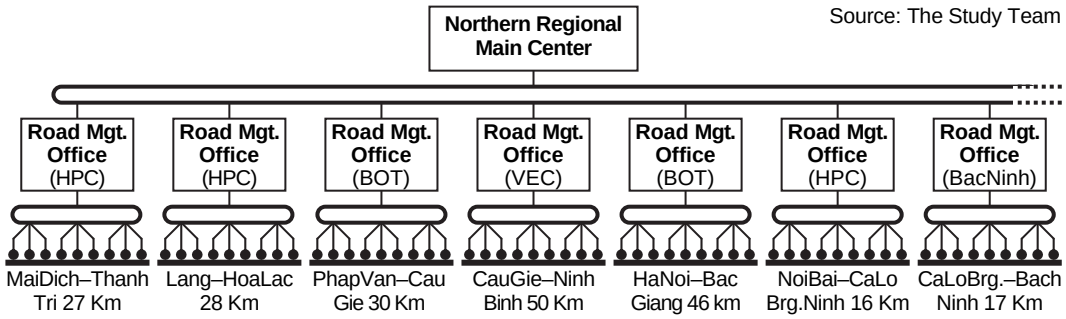
Source: The Study Team

2) Necessity of Stepwise Setting-up of Operational Structure

The structure shown in the figure below is originally recommended for operating the System installed in the Northern Regional Main Center and the 7 expressway sections.

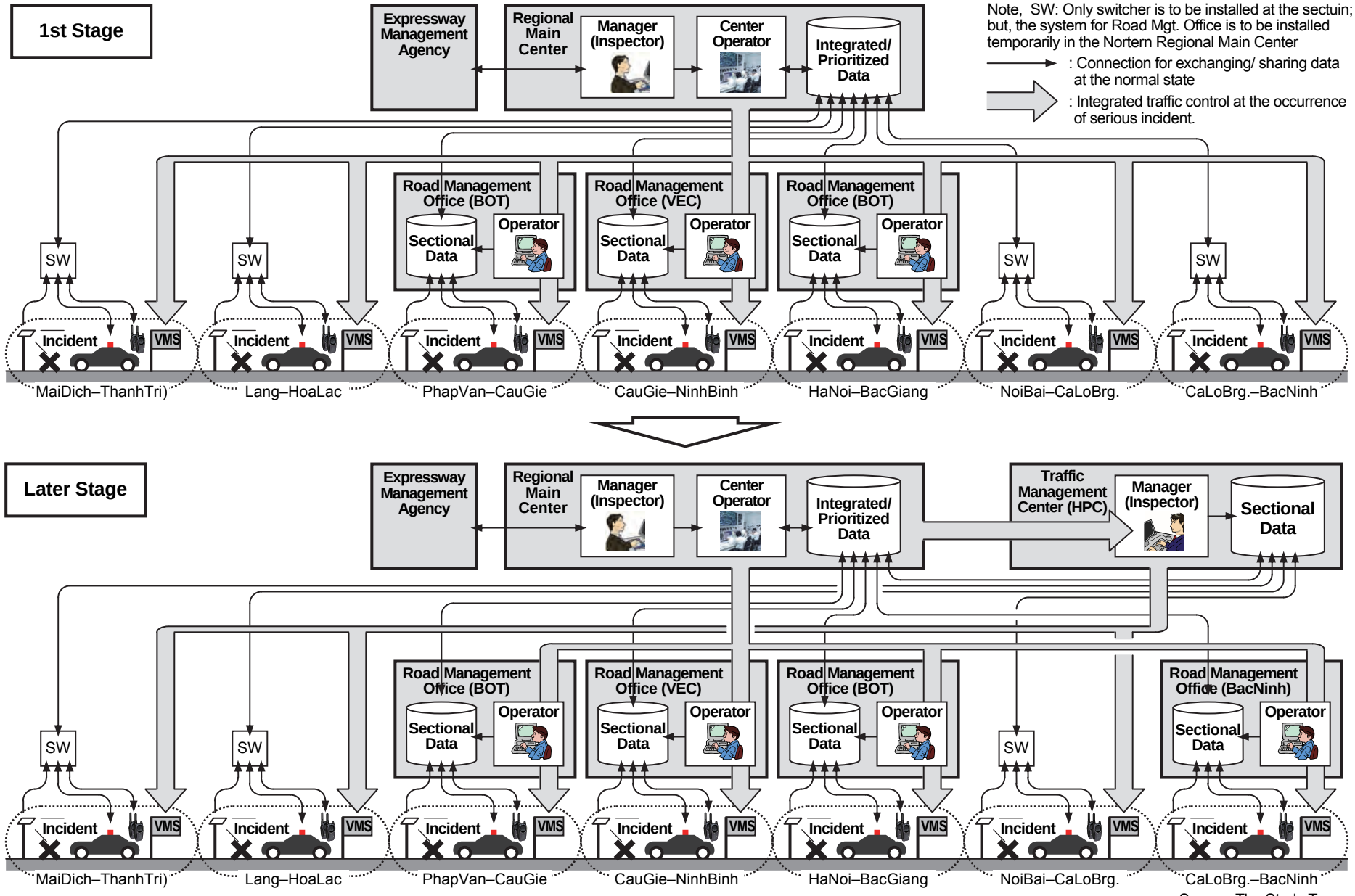
Figure 14.1 Originally Recommended Operational Structure

Source: The Study Team



However, the stepwise setting-up of operational structure is required as illustrated in the following page. Because, HDOT introduced the Study Team their policy of traffic control that the traffic of the road sections under HPC is to be controlled/managed from the Traffic Control

Figure 14.2 Conceptual Illustration of Stepwise Setting-up of Operational Structure

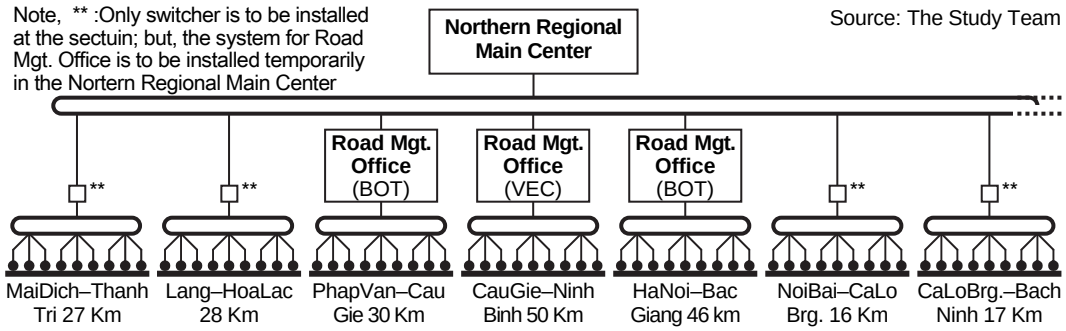


Source: The Study Team

Center, which will be installed at the Kimmar Street, and HDOT clearly stated the Road Management Offices are not necessary for the road sections under HPC. Bac Ninh Provice have not developed their specific plans for implementing the road management offices.

The originally recommended operational structure it to be modified as shown in the figure below as the 1st stage immediately after completion of the Project. The road management office systems for the sections of Mai Dich–Thanh Tri (Ring Road 3), Lang–Hoa Lac, Noi Bai–Ca Lo Bridge and Ca Lo Bridge–Bach Ninh are to be installed temporarily in the Northern Regional Main Center.

Figure 14.3 Operational Structure in the 1st Stage



3) Operational Organization to be set up in the Project (as the 1st Stage)

The system installed by the Project is to be utilized for the expressway operation. For this purpose, the organizations and systems of road management offices need to be integrated and cooperated. The operational structure to be set up, as the 1st stage, for the expressway sections in the Project Area is illustrated in the following page: the Operational Organization to be set up in the Project.

The Northern Regional Main Center is owned and operated by the Expressway Management Agency and comprises the units of center operators, system maintenance, administration and others under the General Manager.

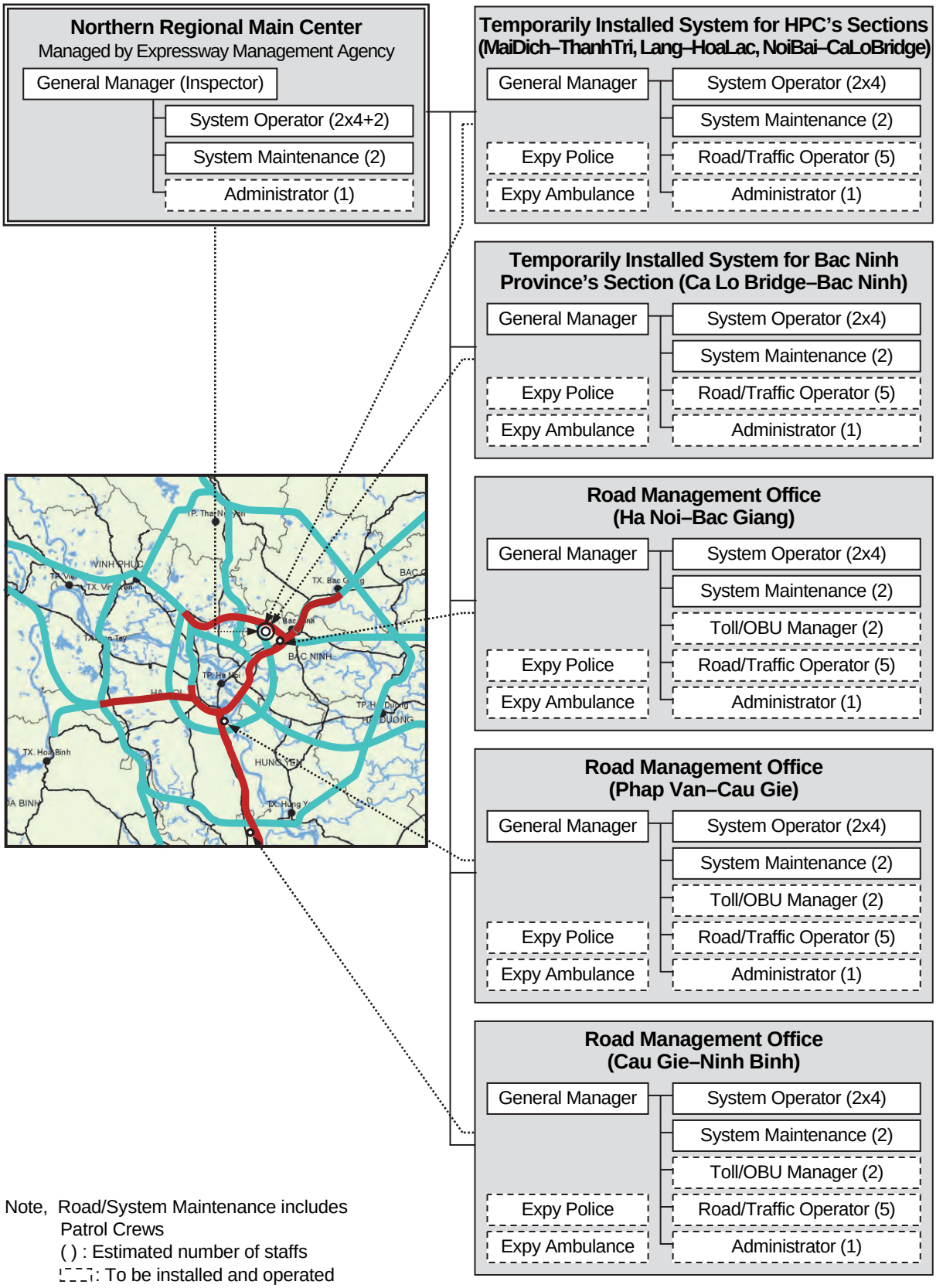
Each road management office is operated by the staffs of road operator which comprise the units of system operators, system maintenance and road/traffic operators, and administration and others under the General Manager. The expressway sections in the Project Area are operated respectively by the Road Owners as shown below.

- BOT: Phap Van – Cau Gie and Ha Noi – Bac Giang
- VEC-O&M: Cau Gie – Ninh Binh
- O&M company: Mai Dich – Thanh Tri, Lang – Hoa Lac, Noi Bai – Ca Lo Bridge and Ca Lo Bridge – Bac Ninh.

In the road management office, the unit of road/traffic operators includes the patrol crews. The patrol crews are to perform the activities in a team with the expressway police and the expressway ambulance.

The basic policy and the discussion results of the framework of expressway operation using ITS are shown in Chapter 5 and respective roles of the Expressway Management Agency and the Public Road Owners and Investors are mentioned in Chapter 5 and Appendix-1.

Figure 14.4 Operational Organization to be set up in the Project



Note, Road/System Maintenance includes Patrol Crews
( ) : Estimated number of staffs
[ ] : To be installed and operated outside the Project.

Source: The Study Team

14.3 Operating Organizations

The system is to be operated and maintained by the following organizations:

- Expressway Management Agency
- Public Road Owners and Investors (VEC, HPC and Bac Ninh Province)
- Road Operators (VEC-O&M and other O&M-Companies)
- Telecom Service Company.

1) Expressway Management Agency

(1) Roles

The roles below are to be fulfilled by the Expressway Management Agency for system operation. Details of the roles and operation framework are shown in Chapters 4 and 5.

- Ownership/funding of the Regional Main Center
- Operation/maintenance of hardware/software of ITS
- Regulation on hardware/software in compliance with the ITS Standards
- Monitoring of the whole expressway network in the Regional Main Center
- Exchange monitored information/data of traffic conditions/events
- Guidance to the road management offices for integrated/prioritized information dissemination in the event of serious incident
- Decision to enforce a serious traffic restriction, such as closure, in consideration of the integration over different expressway sections
- Integrated management on the data from traffic information/ control
- Development of inspection/budget plan of expressway improvement/maintenance
- Evaluation of road operator's achievement in the expressway operation.

(2) 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.

(3) 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.

Details of the training program including trainees are to be hereinafter mentioned.

2) Public Road Owners and Investors (DRVN, VEC, HPC and Bac Ninh Province)

(1) Roles

The roles below are to be fulfilled by the Public Road Owners and Investors for system operation. Details of the roles and operation framework are shown in Chapters 4 and 5.

- Ownership/funding of road structure/facilities other than ITS
- Ownership/funding of facilities of ITS
- Operation/maintenance of hardware/software of ITS (in the case of service contract)
- Submission of the application for utilization of radio frequency.

The technical, technological and environmental department is responsible for system O&M.

(2) 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

They established a road management office for expressway operation at Vuc Vong.

VEC has a sufficient number of university-educated information/communication engineers who have enough capability to operate ITS.

(3) 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 traffic information/control system installed 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 item is to be provided for the operators and the maintenance crews in the Regional Main Center and road management offices using the system installed 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 to be hereinafter mentioned.

3) Road Operators (VEC-O&M and Other O&M-Companies)

(1) Roles

The roles below are to be fulfilled by the Road Operators for system operation. Details of the roles and operation framework are shown in Chapters 4 and 5.

- Funding of facilities of ITS (in the case of concession contract)
- Operation/maintenance of hardware/software of ITS
- Acquisition of information through the special call number or sensors of ITS
- Traffic event data input at the road management office or roadside and sharing them with the Regional Main Center and other organizations
- Traffic information/control of an expressway section
- Dispatch of a patrol crew to the incident site
- Identification of the situation/gravity of an incident
- Enforcement/removal of a traffic restriction
- Incident handling/clearance works

(2) Capability of System Operation

VEC-O&M 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

VEC-O&M has a sufficient number of university-educated information/communication engineers who have enough capability to operate ITS.

(3) 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 traffic information/control system installed 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 item is to be provided for the operators and the maintenance crews in the Regional Main Center and road management offices using the system installed 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 to be hereinafter mentioned.

4) Telecom Service Company

(1) Roles

The roles below are to be fulfilled by the Telecom Service Company for system operation. Details of the roles and operation framework are shown in Chapters 4 and 5.

- Funding/maintenance of facilities of trunk communication system of ITS
- Operation of trunk communication system of ITS.

(2) Capability of System Operation

Telecom service companies have suffucient experience for operating and maintaining the trunk communication system of ITS.

14.4 Important Points of Training

1) Major Training Items

The major training items are enumerated for the respective fields of expressway operation below.

(1) Items for Traffic Information/Control

The following items are proposed for the Traffic Information/Control:

- How to properly monitor traffic conditions and traffic incidents using roadside equipment of the Traffic Information/Control System, and how to make judgements on traffic conditions and gravity of traffic incidents occurred
- How to properly implement data management and how to exchange data among multiple expressway operators using Traffic Information/ Control System
- How to properly implement incident clearance in cooperation with related organizations using Traffic Information/ Control System
- How to properly conduct information dissemination in cooperation with related expressway operators using Traffic Information/ Control System.

(2) Items for Vehicle Weighing

The following items are proposed for the Vehicle Weighing:

- How to properly implement lane operation for overloading regulation using Axle Load Scales.

(3) Items for System Maintenance

The following items are proposed for the System Maintenance:

- How to implement integrated management of data available from Traffic Information/ Control, Toll Collection and Vehicle Weighing systems
- How to properly and promptly implement recovery work of the system by identifying fault locations on the communication network of ITS.

2) Target Trainees

The trainees for the respective major training items are shown below.

Table 14.2 Trainees for Major Training Items

Training Items	Trainee	
(1) How to properly monitor traffic conditions and traffic incidents using roadside equipment of the Traffic Information/Control System, and how to make judgements on traffic conditions and gravity of traffic incidents occurred	Regional Main Center	- Manager - Operator
	Road management office	- Manager - Operator - Patrol crews
(2) How to properly implement data management and how to exchange data among multiple expressway operators using Traffic Information/ Control System	Regional Main Center	- Manager - Operator
	Road management office	- Manager - Operator - Patrol crews
(3) How to properly implement 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) How to properly conduct information dissemination in cooperation with related expressway operators using Traffic Information/ Control System	Regional Main Center	- Manager - Operator
(5) How to implement integrated management of data available from Traffic Information/ Control, Toll Collection and Vehicle Weighing systems	Regional Main Center	- Manager
(6) How to properly and promptly implement recovery work of the system by identifying fault locations 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: The Study Team

14.5 Outline of Training on Traffic Information/Control (including Integrated/Prioritized Information Dissemination)

1) Objectives of Training

The objective of the training is to gain the basic knowledge and skills on the expressway traffic control, which is to be performed by the road operators using the Traffic Information/Control System, to be installed in the Project, responding promptly and appropriately to the respective traffic events occurred such as an incident.

The training is to be implemented focusing on the following points:

- To promote the operators' understanding on the principles of utilizing traffic information/ control system (with its sustainable enhancement) for realizing the traffic control harmonized with the existing road/traffic conditions of expressway network in Vietnam and the smooth and efficient transport for the drivers
- To promote the operators' understanding on the Traffic Information/Control System including Integrated/Prioritized Information Dissemination, which can be established based on the traffic event data using the technology developed in Japan.

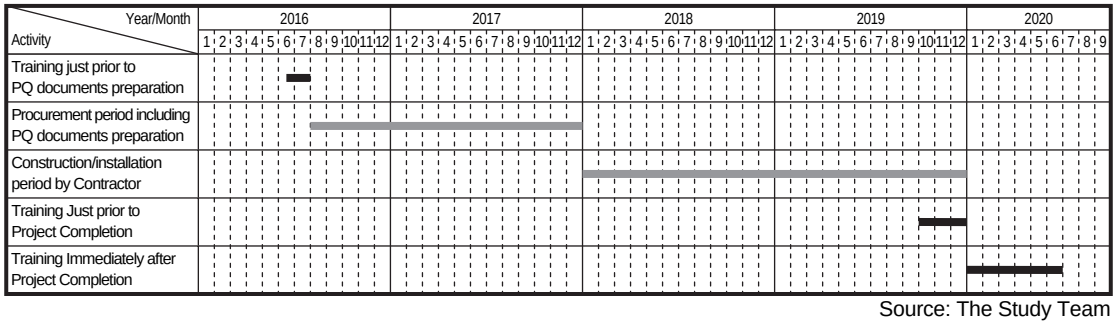
Certain items on the maintenance of installed system are to be included in the training.

2) Time Schedule

In reference to the proposed schedule of the Project Implementation, the following stages are recommended as the timing of implementing the training:

- Just prior to the PQ documents preparation: 1 month and half for developing a basic understanding on the outline of expressway traffic control and the specific merits of the Traffic Information/Control System including Integrated/Prioritized Information Dissemination
- Just prior to the Project Completion: 3 months for developing an understanding on the practical expressway traffic control and especially on the cooperation between the manual works and the use of Traffic Information/Control System
- Immediately after the Project Completion: 6 months for developing an understanding on the practical operation of Traffic Information/Control System using the System installed by the Project.

Figure 14.5 Recommended Time Schedule of Training



Source: The Study Team

The training is to be implemented in the respective timings to promote sufficient and proper understanding on the Traffic Information/Control System among the concerned parties in Vietnam.

3) Major Subjects

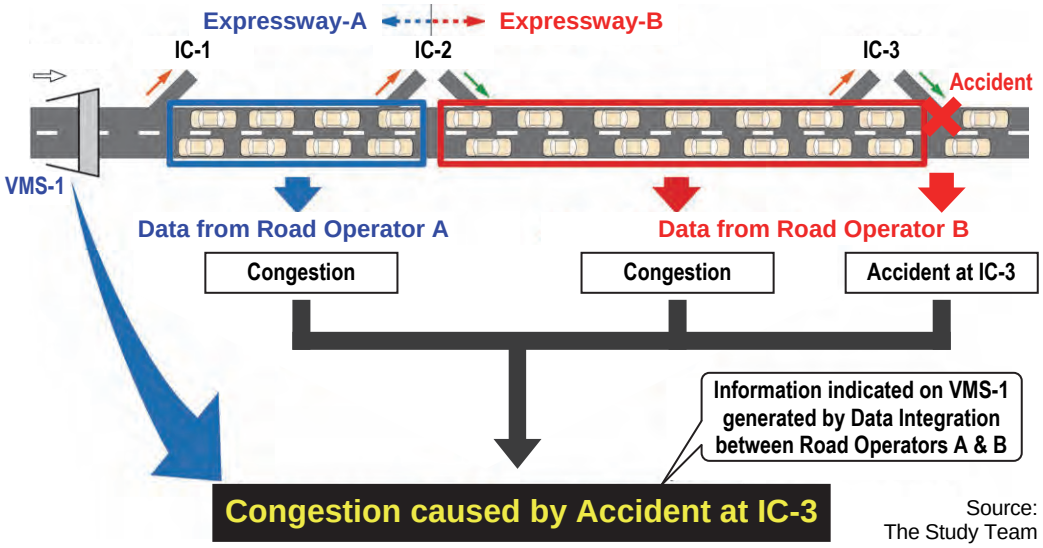
In this section, the major subjects are shown for the trainings, which are to be implemented for the VEA staffs and the management staffs of respective road operators who will become the instructors of the system operators of traffic information/control. The trainings are necessary for establishing a self-sustained management structure for the expressway traffic control in Vietnam.

(1) Importance of Data/Information Integration

The processes of data organization implemented in the Traffic Information/Control System are to be presented in the training focusing on the following points:

- To promote understanding on the contribution of traffic information dissemination to the drivers to prevent secondary incidents (e.g., other traffic accidents caused by a traffic accident) and to prevent revenue losses
- To enhance understanding on the importance of data/information integration among many different road operators to solve the current issues/problems.

Figure 14.6 Conceptual Image of Data/Information Integration between Different Road Operators



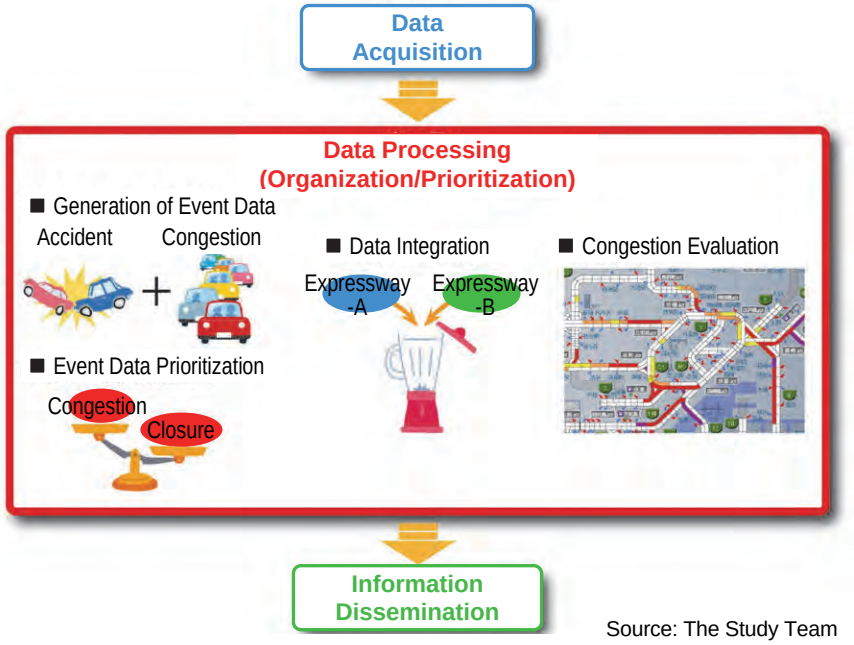
Source:
The Study Team

(2) Data Processing for Organization/Prioritization

The processes of data organization implemented in the Traffic Information/Control System are to be illustrated in the training focusing on the following points:

- To promote understanding on the roles of traffic information/control system in the practical expressway traffic control
- To promote understanding on the processes of organizing data into information (particularly on the importance of setting coefficient values of prioritization criteria) and setting priorities on them in the traffic information/control system
- To promote understanding on the contribution of man-machine coordination for performing the efficient traffic information/control.

Figure 14.7 Conceptual Image of Processes of Data Organization/Prioritization



Source: The Study Team

(3) Necessity of Sustainable Enhancement of System

The necessity of sustainable enhancement of the system is to be presented in the training, for securing the continuous improvement of expressway traffic control, focusing on the following points:

- To promote understanding on the necessity and effectiveness of adjustment (tuning) of the system responding to the changes in conditions of expressway traffic
- To promote understanding on the necessity of extensibility of the system responding to the extension of expressway network.

15. Comments to Draft ITS Standards

15.1 General

The following Items are to be discussed in this chapter:

- Organization for Developing Draft TCVN
- Major Issues to be Resolved
- Comments to Draft TCVN Prepared by Sub-Groups.

Where, the detailed documents of the third item are to be presented in APPENDIX 5.

15.2 Organization for Developing Draft TCVN

The ITS Standards: TCVN is now under development in Vietnam. The Drafts of TCVN are being prepared and discussed in the organization consists of the following 8 Sub-Groups under DOST/ MOT:

- Sub-Group 1: ITS System Architecture
- Sub-Group 2: Traffic Monitoring & Control on Expressways
- Sub-Group 3: Traffic Database and Message System on Expressways
- Sub-Group 4: CCTV Camera System on Expressways
- Sub-Group 5: VMS on Expressways
- Sub-Group 6: Communication System on Expressways
- Sub-Group 7: ETC System on Expressways
- Sub-Group 8: Management Office/Center on Expressways

15.3 Major Issues to be Resolved

For the reason that the discussion of TCVN has begun separately in each Sub-group without sharing a total concept, the following issues have become evident for the Drafts prepared by the Sub-groups:

- Ambiguity in the common basis to be shared among all Sub-groups for discussing the ITS Standards; that has been caused by delay of the Draft TCVN on ITS System Architecture in Sub-group 1
- Inconformity among the required performances/specifications prepared by respective Sub-groups; that has been caused by the lack of the shared basis for discussion on ITS
- Inconformity between the required performance/specifications in TCVN and the needs of ITS users in Vietnam, although the needs have been clarified as the ITS User Services in the ITS Master Plan and the report of SAPI; that has been caused by the lack of the shared basis for discussion on ITS
- Insufficiency of the specifications prepared by Sub-groups in actually securing the connectivity of interfaces and the inter-operability of data, where they are to be used only as the basic requirements or references for the interfaces and data; that has been caused by the lack of experimental proof through the actual implementation or testing in the project

- Insufficiency of the specifications in securing valid bid proposals from the suppliers and in evaluating appropriateness for the costs of system implementation/operation; that also has been caused by the lack of experimental proof.

15.4 Comments to Draft TCVN Prepared by Sub-Groups

Reviews were performed, by the Study Team, on the following Draft TCVN and comments have been submitted officially to DOST/MOT:

- Sub-Group 2: Traffic Monitoring & Control on Expressways
- Sub-Group 5: VMS on Expressways
- Sub-Group 7: ETC System on Expressways
- Sub-Group 8: Management Office/Center on Expressways

Specific descriptions of the comments by the Study Team are compiled in APPENDIX 5.

16. Specifications for System Connection/Cooperation

16.1 General

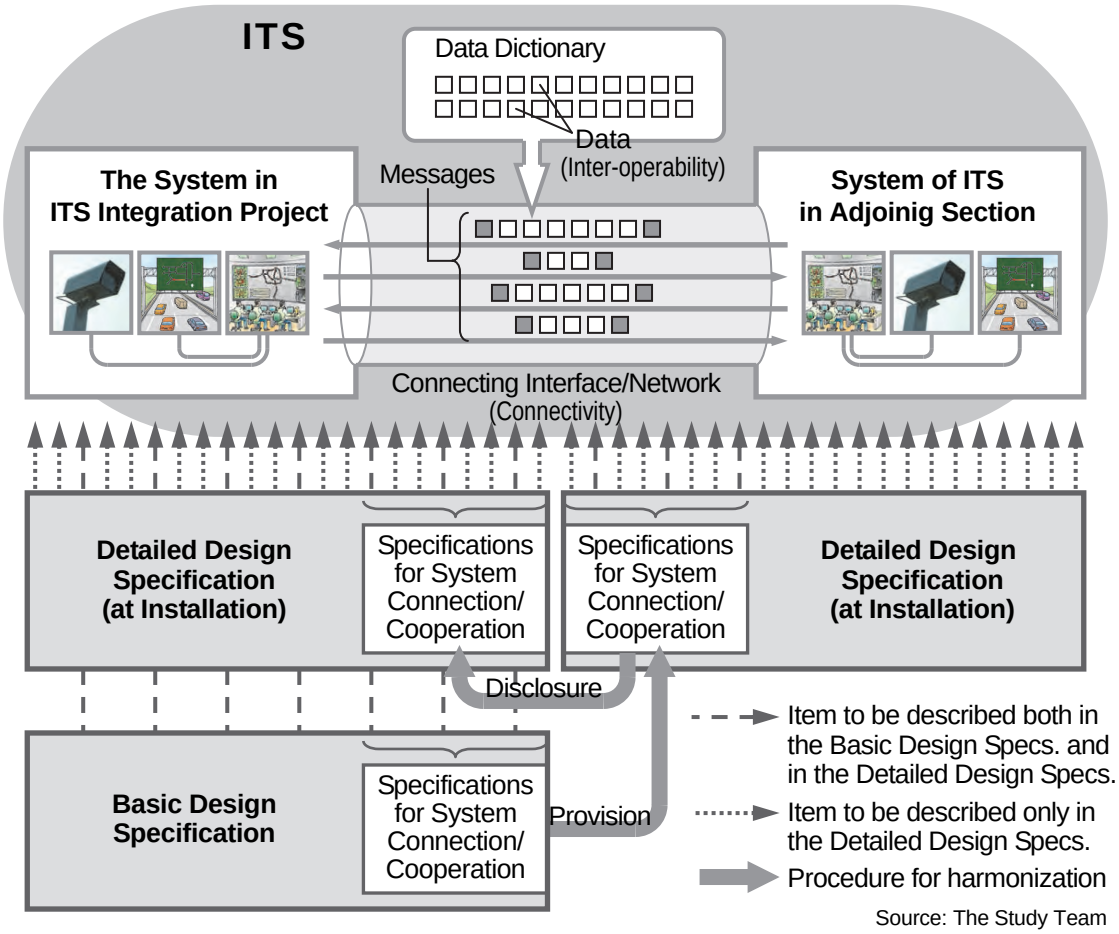
The Northern Regional Main Center is to be installed by the ITS Integration Project; however, a number of ITS equipment components and communication networks are to be installed separately by other projects of the expressways with their Road Management Offices. Such separated ITS installation can mess up the connectivity of network and of the interoperability of data between the systems in the respective sections and in the Northern Regional Main Center. For avoiding such potential problems, the Study provides the Specifications for System Connection/Cooperation and the following discussion results in this chapter:

- Procedure of system integration with other expressway projects
- Target connecting interfaces with adjoining sections
- Specifications for respective system functions & data dictionary.

16.2 Procedure of System Integration with Other Expressway Projects

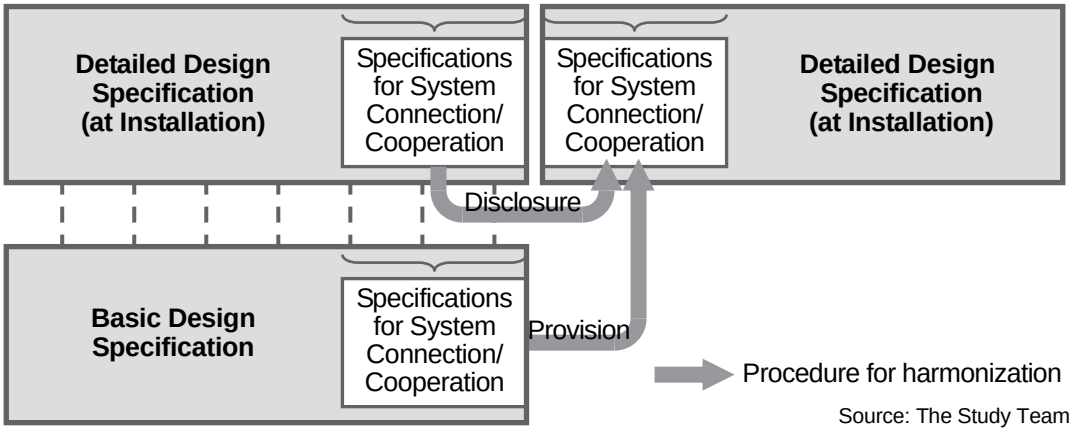
The position of the Specifications for System Connection/Cooperation is shown in the relation with the Basic Design Specifications and the Detailed Design Specifications as below.

Figure 16.1 Position of Specifications for System Connection/Cooperation (in the Case that ITS is installed in Adjoining Section earlier than ITS Integration Project)



Source: The Study Team

Figure 16.2 Position of Specifications for System Connection/Cooperation (in the Case that ITS is installed in ITS Integration Project earlier than Adjoining Section)

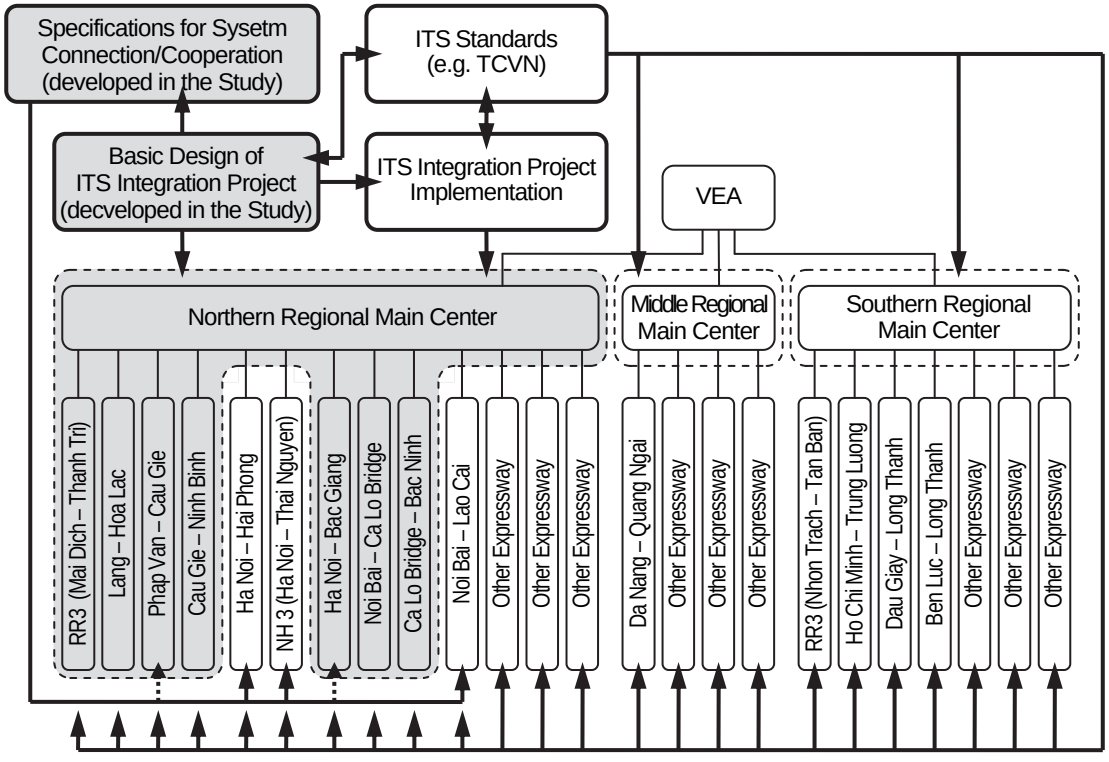


Source: The Study Team

As shown in the figures above, there can be two cases that ITS is installed in the adjoining section earlier than the ITS Integration Project and that ITS is installed in the ITS Integration Project earlier than the Adjoining Section. The Study, the Basic Design of the ITS Integration Project, provides the Specifications for System Connection/Cooperation to the party of the detailed design of ITS for the adjoining section in both cases.

For ITS integration over the whole expressway network, the Middle and Southern Regional Main Centers are required to be set up in harmonization with the Northern Regional Main Center to be established in the Project. For this purpose, it is assumed that the results of the Study are to be utilized to integrate ITS over the Middle and Southern Areas as shown below.

Figure 16.3 Total Picture of ITS Integration over Whole Expressway Network



Note, RR : Ring Road, NH : National Highway, ▭ : Scope of the Study.

Source: The Study Team

16.3 Target Connecting Interfaces with Adjoining Sections

ITS equipment components of the adjoining road sections including the following three sections are planned to be installed separately from the ITS Integration Project in near future; because these adjoining sections are not included in the Scope of the Project:

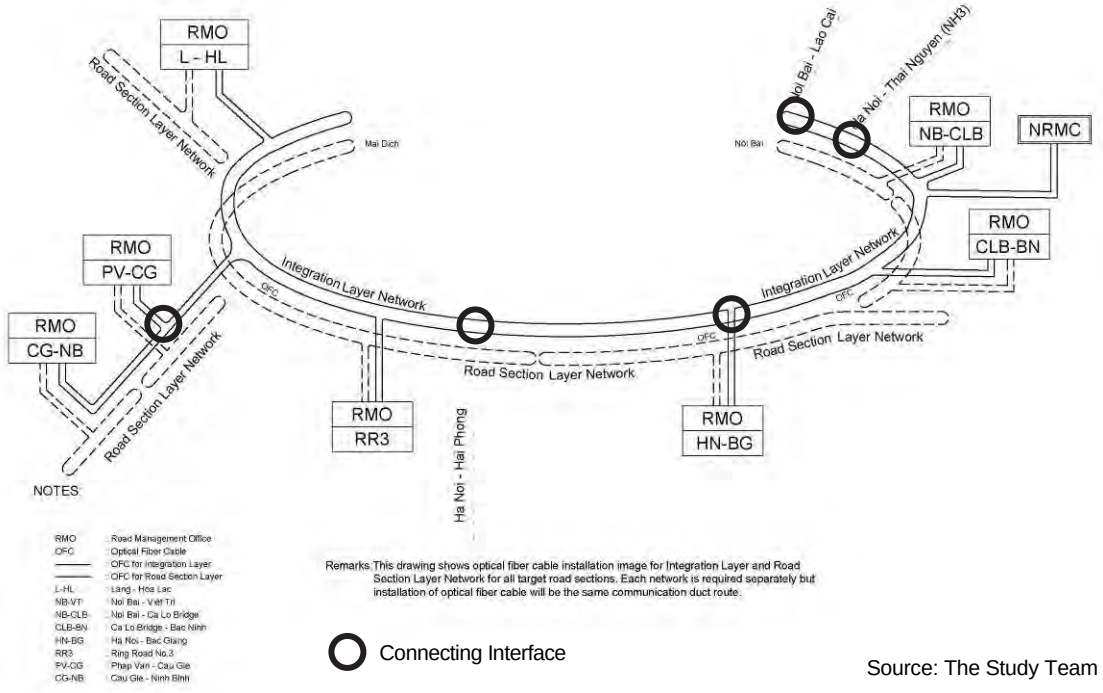
- Ha Noi – Hai Phong
- Ha Noi – Thai Nguyen
- Noi Bai – Lao Cai.

Additionally, some certain parts of ITS equipment components of the following two road sections are planned to be installed separately from the Project as the investment by BOT companies in near future; although these sections are included in the Scope of the Project:

- Phap Van–Cau Gie
- Ha Noi–Bac Giang.

ITS installation at these road sections separated from the Project can cause the problems that the connectivity of network and the interoperability of data cannot be secured between their systems and the System installed in the Project. In order to avoid such problems, the specifications at the connecting interfaces are to be defined in this document.

Figure 16.4 Target Connecting Interfaces on Optical Fiber Cable Network

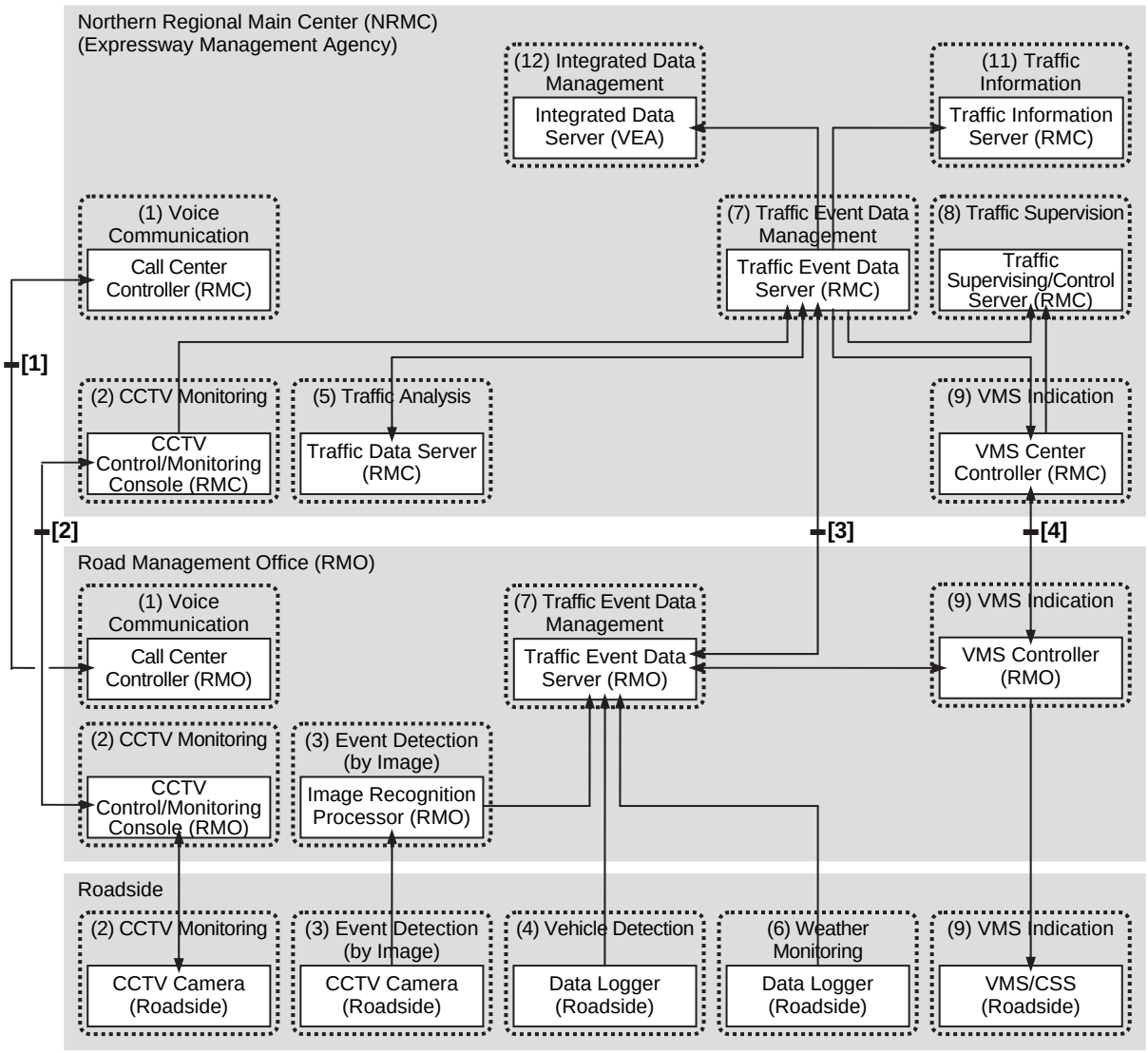


Source: The Study Team

The target connecting interface between the Northern Regional Main Center and the Road Management Office of Adjoining (or BOT) Section are shown as the interfaces [1] to [5].

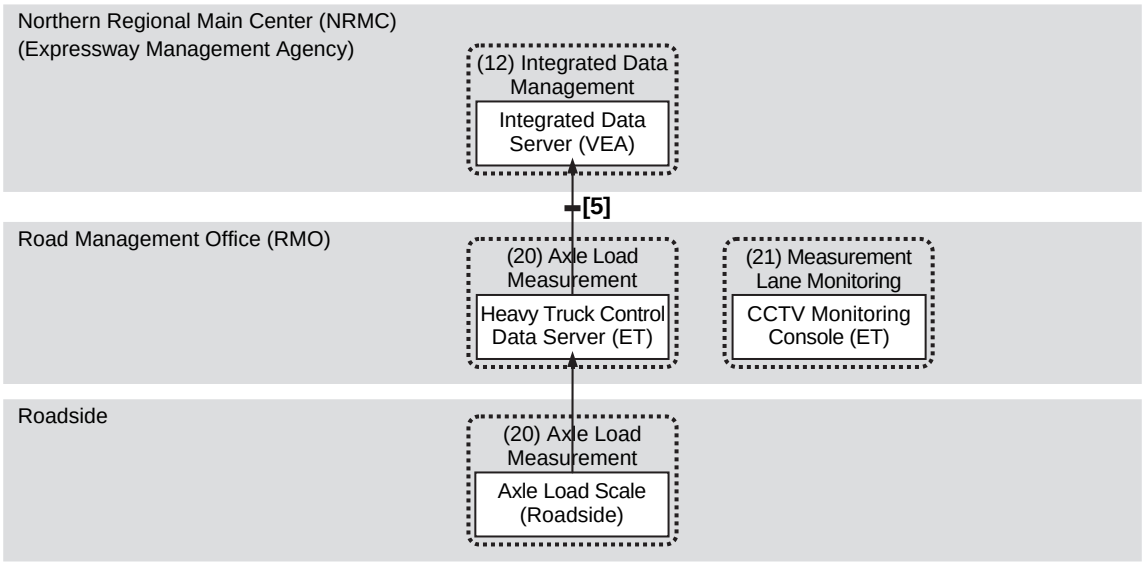
- [1] for Voice Communication
- [2] for CCTV Monitoring
- [3] for Traffic Event Data Management
- [4] for VMS Indication
- [5] for Integrated Data Management.

Figure 16.5 Target Connecting Interfaces for Traffic Information/Control



Source: The Study Team

Figure 16.6 Target Connecting Interfaces for Integrated Data Management



Source: The Study Team

16.4 Specifications for Respective System Functions & Data Dictionary

The following items are defined for the Specifications for System Connection/Cooperation through the discussion of the Study:

- Two cases of structuring connecting network/interfaces
- Physical specifications of target connecting interface
- Requirements on system functions
- Specifications for voice communication
- Specifications for CCTV monitoring
- Specifications for traffic event data management
- Specifications for VMS indication
- Specifications for integrated data management
- Data Dictionary.

Additionally, in the case of the precedent ITS installation in Adjoining (or BOT) Section, it is required in the Specifications that VEA shall instruct the road operator of the Section to disclose the detailed design specifications of their system to the ITS Integration Project, when that is requested by the Project for securing the connection of communication network.

17. Required Conditions for Project Implementation

17.1 General

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

- The Project is to be implemented by DRVN as a whole and the System installed is to be operated/maintained by the organizations assigned to the respective sections.
- The Northern Regional Main Center is to be located at NH18 – PR295 Interchange.
- Road management offices are to be integrated in a single hierarchical structure under the Northern Regional Main Center by decision of MOT.
-

17.2 Organizations for Project Implementation and O&M

Required Condition:

The Project is to be implemented by DRVN as a whole and the System installed is to be operated/maintained by the organizations assigned to the respective sections.

The Project is to be implemented by DRVN as a whole and the System installed is to be operated/maintained by the organizations (the Public Road Owners or Investors) assigned as the road operators of respective sections as shown in the table below.

Table 17.1 Institutional Arrangement for Project Implementation and O&M

	Proposed Implementation Org.	Existing Contract Type of O&M	Org. of Road Owner	Org. of Road Operator	Remarks
Northern Regional Main Center	DRVN	--	VEA	VEA	
Mai Dich– Thanh Tri	DRVN	Service Contract	HPC	O&M-Company	Existing ITS by JICA Grant is to be transferred from VEC-O&M*
Lang – Hoa Lac	DRVN	Service Contract	HPC	O&M-Company	
Phap Van – Cau Gie	DRVN	Concession Contract	DRVN/BOT	BOT Company	Existing ITS by JICA Grant is to be transferred from VEC-O&M*
Cau Gie – Ninh Binh	DRVN (VEC)	Service Contract	VEC	VEC-O&M	ITS is partially installed already
Ha Noi – Bac Giang	DRVN	Concession Contract	DRVN/BOT	BOT Company	
Noi Bai – Ca Lo Bridge	DRVN	Service Contract	Bac Ninh Prov.	O&M-Company	
Ca Lo Bridge – Bac Ninh	DRVN	Service Contract	HPC	O&M-Company	

Source: The Study Team

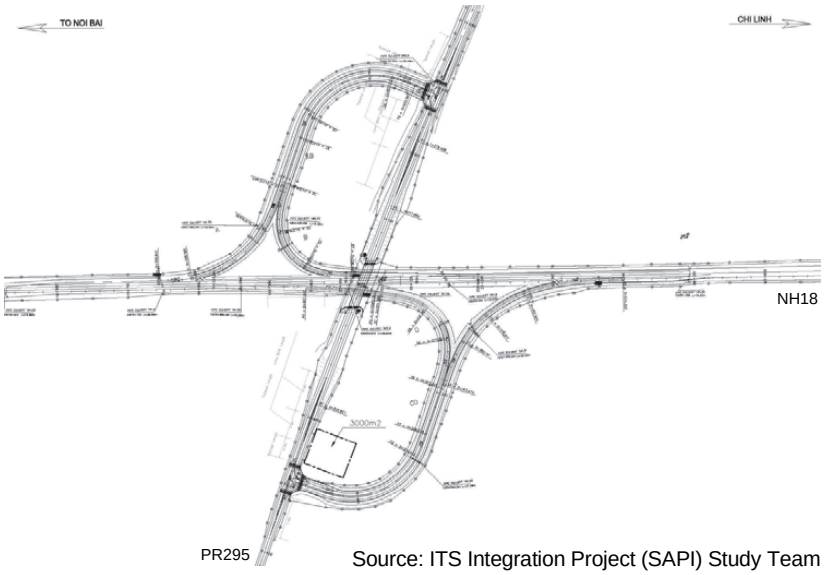
17.3 Land Preparation for Northern Regional Main Center

Required Condition:

The agreed 3000 m^2 of land located at the NH18 – PR295 Interchange is to be prepared for the Northern Regional Main Center.

The agreed 3000 m^2 of land located at the NH18 – PR295 Interchange as shown in the figure below is to be secured and prepared for the Northern Regional Main Center.

Figure 17.3 Location of Northern Regional Main Center



Source: ITS Integration Project (SAPI) Study Team

17.4 Hierarchical Structure for System Operation

Required Condition:

The Systems of Road Management Offices are to be installed at the respective agreed locations and to be integrated in a single hierarchical structure under the Northern Regional Main Center in cooperation with the police office and the ambulance service.

The Systems of Road Management Offices are to be installed respectively at the agreed locations shown in the table below.

Table 17.2 Agreed Locations of Systems of Road Management Offices

Section	Location of System
Mai Dich – Thanh Tri	Northern Regional Main Center (Temporarily)
Lang – Hoa Lac	Northern Regional Main Center (Temporarily)
Phap Van – Cau Gie	Road Management Office
Cau Gie – Ninh Binh	Road Management Office
Ha Noi – Bac Giang	Road Management Office (with a space of 30 m2)
Noi Bai – Ca Lo Bridge	Northern Regional Main Center (Temporarily)
Ca Lo Bridge – Bac Ninh	Northern Regional Main Center (Temporarily)

The Systems of Road Management Offices are to be integrated in a single hierarchical structure under the Northern Regional Main Center in cooperation with the police office and the ambulance service.

Figure 17.2 Northern Regional Main Center and Road Management Offices

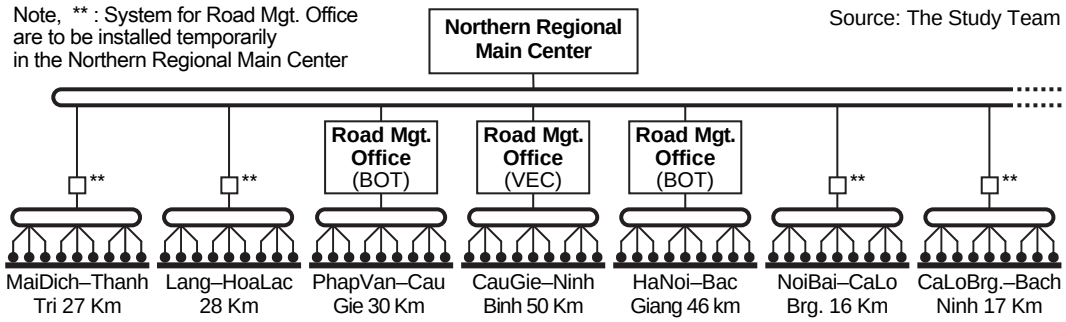
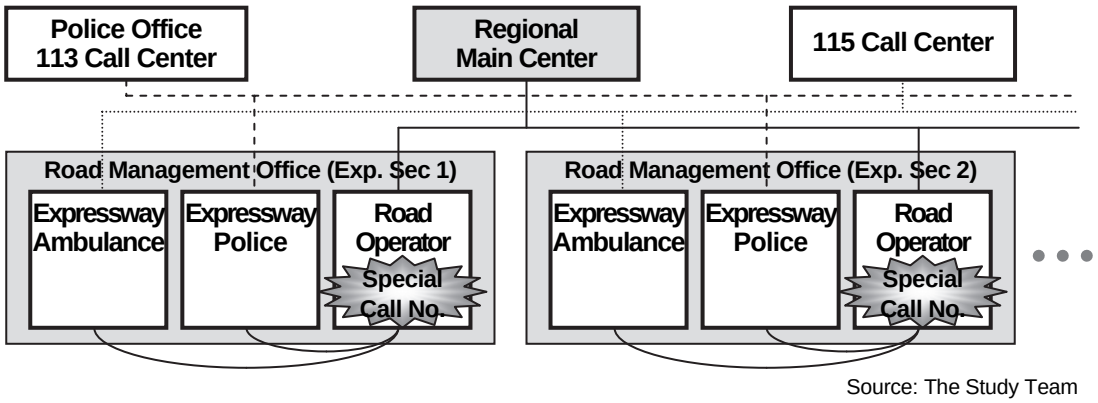


Figure 17.3 Cooperation with Police Office and Ambulance Service



Source: The Study Team

17.5 Destribution of Specifications for System Connection/Cooperation

The Specifications for System Connection/Cooperation prepared in the Study, including the requirements on system functions and the data dictionary, are to be distributed to the road operators of the following sections;

- Adjoining Sections: Ha Noi – Hai Phong, Ha Noi – Thai Nguyen, and Noi Bai – Lao Cai.
- BOT Sections (in the Project Scope): Phap Van–Cau Gie, and Ha Noi–Bac Giang.

Additionally, in the case of the precedent ITS installation in Adjoining (or BOT) Section, it is required in the Specifications that VEA shall instruct the road operator of the Section to disclose the detailed design specifications of their system to the ITS Integration Project, when that is requested by the Project for securing the connection of communication network.

However, it is required for the BOT Sections that the following parts of Traffic Information/ Control System are to be installed in the Project for securing connectivity, inter-operability and functional continuity:

- Phap Van – Cau Gie Section: The components for connection/inter-operation
- Ha Noi – Bac Giang Section: The roadside equipment components, ducts and power supply between Ha Noi and Bac Ninh, and the components for connection/inter-operation including the components to be installed in a space 30 m^2 in the Road Management Office.

18. Important Points on Procurement

18.1 General

This chapter describes various findings of the site surveys conducted, the potential difficulties and the recommendable measures to overcome these potential difficulties pertaining to the procurement for the Project. The surveys were conducted in Hanoi and Ho Chi Minh areas through interviews and/or questionnaires to the concerned parties.

Most of the findings below have been taken into account in preparing Chapter 13 of this report.

18.2 Findings on General Procurement Situations in Vietnam

To collect updated information pertaining to the general situations in Vietnam of project-related procurement (i.e. selection of a consultant and contractors through prequalification and bidding), the surveys were conducted.

The surveys covered DRVN, VEA, VEC, PMU3, ITS development project contractors, international consultants and other relevant parties. Detailed information on their procurement experience and human resources was received from PMU3 in particular. The findings of the surveys are summarized below.

In general, it seems that no particular concern exists regarding the general procurement situations in the construction industry, as discussed below.

1) Local Construction Industry and Contractors in General

Construction activities have been booming nationwide, inclusive of Hanoi region. Many infrastructural facilities and private buildings have been and still are being built in Hanoi area. Improvement of infrastructural facilities is considered the key to the successful achievement of modern industrialization of the nation by 2020 as planned by the Vietnamese government.

Japan has been granting to Vietnam for more than 20 years the ODA loans for improvement of various infrastructural facilities including roads and expressways. A large number of JICA ODA loan-financed projects have been or are being built in Vietnam. Several large infrastructure projects of roads, bridges, railways, ports and airports, were implemented on a STEP basis.

To date, ITS projects were implemented for 3 sections of the expressway network in Hanoi area, and an ITS project in the Long Thanh – Dau Giay expressway section is in progress, on a design and build basis, as a JICA ODA loan-financed project. Selection of the Contractor for ITS D&B for the Da Nang – Quan Ngai section will commence soon.

As such, the local contractors are well experienced in procurement activities for JICA ODA loan-financed projects, mostly in joint venture with Japanese contractors. In ITS-related projects, local contractors have worked only as subcontractors to foreign prime contractors.

Building works of a small to medium scale may be undertaken by local contractors alone without any significant problems.

The local contractors, as well as the Japanese contractors in the region, have sufficient knowledge about the JICA procurement guidelines, the JICA prequalification and bidding procedures and the JICA standard prequalification/bidding documents for the JICA ODA loan-

financed projects, and it is not expected that significant problems arise during the procurement/ selection of the contractors for this Project due to the contractors' inexperience of these procurement procedures, guidelines and standard prequalification/bidding documents.

2) Local Engineering Consultants in General

Local engineering consultants also have been involved in the consulting services for a large number of JICA ODA loan-financed infrastructure development projects including road, expressway and building projects.

Local engineering consultants specialized in ITS/ICT projects exist but their technical and human resources capability is not sufficient for undertaking the procurement and construction supervision services required under this Project including, but not limited to, procurement of the contractors, preparation of own detailed design of building works, review of the contractors' designs, construction supervision and contracts administration.

As such, the local engineering consultants must be in a JV with international engineering consultant(s), to undertake and successfully complete the required consulting services for the Project.

3) Procurement of Contractors and Consultants in General

As stated above, local contractors and engineering consultants are well experienced in JICA ODA loan-financed projects in Vietnam. They are familiar with the standard procurement procedures of JICA for ODA loan-financed projects and the relevant documents such as the JICA procurement guidelines and the standard prequalification and bidding documents, in particular those for the Works on a construction only, quantity re-measurement basis.

4) Local Laws and Regulations

There are certain Vietnamese laws and regulations in conflict with the JICA procurement guidelines and the JICA standard conditions of contract. However, it is found in the surveys that experienced local personnel in charge of procurement are of the opinion that the JICA procurement guidelines (and the JICA Standard Prequalification/Bidding Documents including the standard conditions of contract) are clearer and easier to operate, and the JICA guidelines and conditions have been accepted by the relevant local parties as the governing guidelines and conditions in the previous JICA ODA loan-financed projects.

As such, it is recommended that the JICA guidelines and conditions are strictly observed in the Project to be financed by a JICA ODA loan.

It should be noted that, by the recent Decree No. 59/2015/ND-CP dated July 18, 2015, it has become possible, in certain cases, that a single consultant undertakes both the design and the construction supervision services in a row.

18.3 Findings on Procurement Situations of Similar Projects in Vietnam

Site surveys on the procurement situations in Vietnam were also conducted regarding the similar projects involving ITS/ITC-related works. The findings are described below.

1) Completed or Ongoing ITS Projects

There are several completed or ongoing ITS projects in Vietnam. Some of them are JICA ODA loan-financed projects such as the ITS development project of HCMC – Long Thanh – Dau Giay (part of the North-South Expressway Construction Project) being undertaken by a Japanese JV contractor. Some of the other are JICA grand aid projects such as the traffic control system development project for expressways in Hanoi successfully completed by a Japanese contractor. There are contracts for build/install only based on consultant's designs, as well as design and build/install contracts based on the basic designs prepared by consultants.

The bidding documents for the design and build basis contract used in the above-mentioned ITS development project of HCMC – Long Thanh – Dau Giay were the JICA's Sample Bidding Documents (it is now changed to the Standard Bidding Documents) for Procurement of Plant Design, Supply and Installation, inclusive of the General Conditions of Contract for Plant Design, Supply and Installation.

As such, for this ITS Integration Project to follow the JICA procurement guidelines and the JICA Standard Bidding Documents, no significant problem is foreseen in procurement activities for selection of the Contractors (most likely international contractors in JV with or subcontract with local contractors).

2) Civil and Building Works Projects

Regarding the proposed communication ducts, power supply system and building works (Packages-2 and 3) in the Project, no significant problem is foreseen also in implementing and completing the activities for selecting the Contractors in accordance with the JICA procurement guidelines using the JICA's Standard Bidding Documents.

3) Important Points

To enjoy all possible benefits available including the lower loan interest rate, it is advisable that the Special Terms for Economic Partnership (STEP) scheme be applied to the Project. Although it has not been applied to JICA ODA loan-financed ITS development projects in Vietnam, the scheme has been applied to a large number of JICA ODA loan-financed infrastructure development projects in the country, as stated hereinbefore.

18.4 Findings on Bidding Procedures and Contract Conditions

Findings in the surveys and studies conducted on the bidding procedures and the contract conditions used on Vietnam, in particular on the JICA standard procurement procedures and the JICA Standard Bidding Documents containing the Standard Conditions of Contract are described below.

1) Bidding Procedures ordinarily employed in Vietnam

For JICA ODA loan-financed projects implemented in Vietnam, the standard bidding procedures and the relevant guidelines of JICA are well observed and complied with. A number of ADB loan-financed projects have been implemented in Vietnam in compliance with the ADB procedures and guidelines, which are very similar to those of JICA's.

As such, many local officials and consultants are considered sufficiently familiar with the standard bidding procedures of JICA, although assistance from Japanese consultant(s) is normally provided to them to expedite and properly operate the process.

PMU3 of DRVN has extensive experience in procurement activities in accordance with the JICA/ADB procurement procedures and guidelines. PMU3 is expected to assist DRVN in the Project implementation services including the procurement services.

2) Conditions of Contract Ordinarily applied in Vietnam

Use of the JICA Standard General Conditions of Contract contained in the JICA Standard Bidding Documents, with no significant modifications, is mandatory for JICA ODA loan-financed projects.

There are two different editions of Standard General Conditions in the JICA Standard Bidding Documents; one is for Plant Design, Supply and Installation (PLANT) and the other for construction of Works (WORKS). The former is suitable for design and build contracts and will be applicable to the Project, with exception of the building works portion. The latter is for contracts for build/construct only based on the detailed designs supplied by the Employer, and is applicable to the communication ducts, power supply system and NRMC building and associated works portion (Packages-2 and 3) of the Project.

Both editions of the JICA's Standard General Conditions have been used in Vietnam.

3) Important Points on Bidding Procedures and Contract Conditions

The following is a list of important points regarding bidding procedures and contract conditions:

a) It is considered that the contracts for Package-1 of the Project should be a design and build (D&B) contract, for the following potential benefits:

- Single-line responsibility for the design, supply and installation will be borne by the Contractor alone; not involving the Employer's (design consultant's) design responsibility,
- The overall Project implementation period can be shortened, because bidding process can commence based on the basic designs only without waiting until completion of the time-consuming detailed designs by design consultants,
- The overall Project implementation period can be also shortened, because the Contractors can commence the supply and installation section by section wherever the detailed design is approved, without waiting for completion of the detailed designs for the entire sections,
- Latest version of the rapidly advancing ITS technology can be efficiently incorporated into the Contractors' design, because contractors/suppliers are closer to such latest technologies as compared to the design consultants, and
- Proprietary hardware/software of the respective contractors/suppliers can be proposed in the bids, unlike the bidding based on the fixed detailed design prepared by design consultants.

Packages-2 and 3 contracts should be on the basis of build/construct only based on the Employer's detailed designs to be prepared by the design consultant to suit the particular site conditions. This will be a conventional design-bid-build contract.

b) It is important that the Standard General Conditions contained in the JICA Standard Bidding Documents shall not be significantly modified, as clearly stated in the Standard Bidding Documents.

c) It is also important that other conditions and/or requirements of contract, inclusive of the time for completion and the scope of work set out in the bidding documents, are not modified just before signing the Contract. Modifications of the contract conditions and/or requirements must be made in a proper manner through the specified variation process.

d) As the JICA Standard Bidding Documents are not specifically written for ITS projects, the Standard General Conditions contained therein might need to be reinforced and/or improved to suit this particular ITS integration project. The reinforcements and/or improvements should be done through the particular conditions, as no alteration to the general conditions is allowed.

18.5 Findings on Consultants Selection

Selection of an engineering consultant for the procurement assistance, detailed designs and construction supervision services is undertaken often in Vietnam. PMU3 of DRVN has extensive experience in procurement of engineering consultants. As such, no specific difficulties are foreseen in the process of selecting the engineering consultant(s) to provide the similar consulting services for the Project. The following are recommendations regarding the consultant selection activities:

1) Timing of Consultant Appointment

On behalf of the Project implementation entity (e.g. PMU3 of DRVN most likely), the engineering consultant should prepare, at the onset of the consulting services, the prequalification documents based on the JICA Standard Prequalification Documents, including the instructions to applicants, and the bidding documents based on the JICA Standard Bidding Documents, including the instructions to bidders, the specifications and drawings and the contract conditions, as needed for selection of the Contractors. To maintain the consistency of the procurement services and to maintain a single point of responsibility for the whole procurement process, the prequalification and bid evaluation and the contract negotiation thereafter should also be undertaken by the consultant who prepared the above-mentioned prequalification and bidding documents.

As such, it is recommendable that the engineering consultant for the consulting services is appointed prior to the commencement of the Contractor selection process beginning with the prequalification documents preparation.

2) International and National (Local) Consultants

In order to accomplish the tasks in a proper and efficient manner, the consultant for the Project must be fully familiar with the JICA procurement guidelines, procurement procedures and the JICA Standard Prequalification and Bidding Documents for both “PLANT” and “WORKS”.

Further, as the Project is an ITS development project of a higher technology level, the consultant’s personnel must have not only sufficient experience of similar consulting services but also sufficient knowledge of modern ITS technology, to ensure successful implementation

of the consulting services required.

These qualification requirements must be clearly stated in the RFP/TOR for the consulting services.

It will be essential that the prime consultant is a fully experienced and qualified international consultant when a joint venture is formed with local consultant(s), because the local consultants have little experience/capability in the field of ITS.

3) TOR for Consulting Services

As stated above, the consultant must prepare the prequalification and bidding documents for selection of the contractors through international competitive biddings in strict compliance with the JICA procurement guidelines and procedures. The bidding documents must include the specifications and the drawings of ITS equipment and components sufficient for the bidders to estimate the bid price without difficulties. The bidding documents for Packages-2 and 3 must include the detailed design drawings and specifications of the works.

The consultant must also provide the construction supervision services after award of the construction Contracts. The consultant should also be responsible for supervising the operator training by the Contractors at the end of the construction period.

The consultant must be responsible for proper management of the Contractors' coordination of the interface requirements among the proposed 3 contract packages of the Project as well as the external interface requirements between the Project and the adjoining projects by others.

The TOR for the consulting services must be prepared by the Project implementation entity and must clearly stipulate the scope of these services and the relevant requirements. In fact, JICA has prepared a draft of the proposed TOR based on the previous SAPI study report. This draft should be reviewed and finalized based on the results of this Study.

Before finalizing the TOR, the Project Executing Agency should seek JICA's technical assistance for the decision-making study (refer to Section 13.4) before the Consultant commences the Bidding Documents preparation.

It is recommendable that the Consultant undertakes on-the-job training of 6 months or so of the operation personnel of the road operators after the construction period, in addition to the O&M training to be provided by the Contractor at the end of the construction period.

4) Shortlisting of Consultants

In order to shorten the consultant selection period, it is recommended that the latest version of a list of engineering consultants held by JICA will be used for shortlisting of the consultants to be invited for submission of the proposals.

A negotiated contract may also be proposed to JICA by the Project implementation entity, if the need is verified to the satisfaction of JICA. As shortlisting, TOR preparation and bidding of consulting firms can be avoided, the negotiated contract can be concluded in 3 months or so.

5) Important Points on Consultant Selection

- The consultant should be employed before commencement of the process for prequalification of the contractors so that the consultant can prepare the prequalification

documents as an integral part of the procurement-related documents. Certain parts of the consultant selection activities will have to be implemented by the Employer at its risk depending on the timing of the JICA loan agreement, in order to complete the Project by a specific completion date.

- The consultant must be fully qualified to undertake and successfully complete the required services pertinent to modern ITS technologies and engineering.

18.6 Findings on Contractor Selection

Similar to the selection of engineering consultant(s), selection of the construction contractors has been undertaken often in Vietnam. The project implementation entities like PMU3 of DRVN have extensive experience and knowledge about the international competitive bidding procedures in accordance with the JICA procurement guidelines and procedures. As such, no specific problem is foreseen in the process of the Contractor selection for the Project.

The following are recommendations regarding the Contractor selection activities:

1) Prequalification/Bidding/Contract Packages

As discussed in section 13.3, the Project should be divided into the following 3 packages for implementation:

Package-1: Design, supply and installation of the Traffic Information/Control System, the Communication System and the Vehicles, on a D&B lump sum basis,

Package-2: Installation of the Communication Ducts and the Power Supply System on a unit price or a lump sum, build/construct only basis, based on the Consultant's detailed design, and

Package-3: Construction of the Northern Regional Main Center building and the associated works on a unit price or a lump sum, build/construct only basis, based on the Consultant's detailed design.

The proposed packaging as above allows (i) local contractors' participation in Package-2 and 3 as the prime contractor and (ii) implementation of Package-1 by a single international contractor without major interfacing/integrating difficulties.

Refer to 2) below for the benefits of prequalification/bidding in multi-packages as compared to the single-package prequalification/bidding.

2) Prequalification Criteria

Major part of the Project (Package-1) will be implemented on a D&B basis. Therefore, the Contractor must be fully qualified not only for supply and installation of the ITS equipment but also for the detail design of the systems and the equipment and for the integration of the completed systems. As such, prequalification should be conducted before bidding, to check the contractors' experience and capability as needed to shortlist the qualified bidders only. Qualification of the human resources for key positions, such as the project manager and the system integration specialists, to be made available for the Project should be carefully evaluated (this can be done in Technical Bid evaluation, if not done in prequalification evaluation).

PQ criteria must be developed with utmost care so that the Contractors selected will be fully capable of successfully undertaking and completing the required works.

The standard qualification criteria shown in the JICA Standard PQ Documents are discussed and a draft of the proposed qualification criteria is shown in Appendix 5.

As shown in Appendix-5, the Contractor must be capable of undertaking the continuous improvements of the system of "Integrated/Prioritized Information Dissemination" for 10 years or so after the installation under the Project, therefore Applicants' experience of continuous improvements of the system over a sufficiently long period after the installation should be carefully evaluated during the prequalification.

It is preferable that the prequalified bidders are fully familiar with the JICA Standard Bidding Documents inclusive of the conditions of contract for the design, supply and installation of plant.

Successful completion of JICA ODA loan-financed project(s) in the region may be another prequalification criterion.

The relationship between the number of bidding/contract packages and the number of prequalification applicants (contractors) is normally as follows:

- If the Project is bid in one package, the bidders must have sufficient experience in all of the pertinent fields (i.e. ITS field including ETC field and building work field).
- To the contrary, if the Project is bid in 3 packages as proposed, the bidders qualified only for the specific field can participate in the specific bidding package.
- As such, number of the bidders in the proposed 3-package bidding will be significantly more than that in the single-package bidding, and accordingly the bidding competition will be more promoted as compared to the single-package bidding.

Therefore, it is recommendable, from competitive bidding point of view, that the Project is divided into 3 packages as proposed in section 13.3.

3) Prequalification, Bidding and Contract Negotiation

The contractors prequalification and bidding and the Contract negotiation, including the prequalification evaluation and the bid evaluation should be implemented in strict accordance with the JICA procurement guidelines and procedures. The engineering consultant to be employed by the Project implementation entity (e.g. DRVN) should undertake these activities under the management and supervision of the Project implementation entity.

PMU3 of DRVN has sufficient knowledge and human resources for managing and supervising the consultant performing these procurement services.

The prequalification and bid evaluation reports must be reviewed and approved by the Project implementation entity before being submitted to JICA for concurrence.

It is often observed that the Employer (Project implementation entity) demands the successful bidder to accept modifications to the contract conditions/requirements (such as additions to the scope of work, reduction of the time for completion) at the last minute of the Contract negotiation and the bidder reluctantly accepts such conditions and/or requirements so as to secure the Contract. Such unfair demands will negate the bidders' sincere efforts made during their bid preparation. Any modifications to the contract conditions and/or requirements

should be made only with equitable adjustments to the Contract Price and/or the Time for Completion.

4) Important Points on Contractor Selection

- Package-1 of the Project should be implemented on the basis of D&B, lump sum price as proposed. The bidding period for the bidders' preparation of their bids for Package-1 must be long enough for the bidders to prepare their designs for bidding purpose and estimate their bid prices based on the bidding designs.

  The current JICA procurement guidelines require a minimum of 45 days for international bidding, preferably 90 days for a large work. In fact, an extension of 30 days (from 60 days to 90 days) was requested by the bidders in the ITS development project being implemented near Ho Chi Minh City. As such, the period for the D&B bidding of Package-1 should be 90 days or more.

  The bidding period for Packages-2 and 3 (communications ducts and power supply system, and NRMC building and associated works to be constructed based on the given detailed design either on a lump sum basis or a unit price basis) may be shorter than 90 days if necessary, because the detailed designs (including bill of quantities) will be prepared by the consultant and shown to the bidders during the bidding.
- Any alteration to the contract requirements/conditions demanded unilaterally by the Employer at the last minute of the contract negotiation with the successful bidder should be avoided to achieve the original objectives of the Project within the specified Time for Completion. It should be noted that the JICA Standard Bidding Documents prohibit any change to the bidding conditions and requirements after the Base Date (as defined in the JICA standard conditions of contract) without a fair adjustments to the bid/Contract price and/or the Time for Completion.

18.7 Findings on Procurement Management/Administration

Findings on the procurement management and administration are summarized below. The institutional arrangements proposed are also discussed in section 13.2.

1) Organization for Procurement Management/Administration

The Project Executing Agency (as will be defined in the JICA ODA Loan Agreement) or the entity to be responsible for the Project implementation (including the procurement management/ administration) is not named yet at this point of time, but DRVN is recommended to take that position. PMU3 or VEA of DRVN or another entity may also be the Project Executing Agency, if so named in the Loan Agreement.

As mentioned below, DRVN is neither well experienced nor sufficiently staffed to assume the full responsibility for the Project implementation, therefore, certain organizational reinforcement to DRVN as the Project implementation entity will be indispensable, prior to commencement of the procurement process.

2) Experience and Human Resources Available

As DRVN and VEA are relatively young entities (established in 2012 and 2014 respectively)

as compared to PMU3 and VEC, their qualified human resources available for the management/ administration of the procurement process are limited.

To the contrary, as mentioned herein before, PMU3 of DRVN has sufficient knowledge and qualified human resources available for the procurement management/administration in strict accordance with the JICA procurement guidelines and procedures. It is recommended that PMU3 is actively involved in the procurement management and administration services. Assistance from PMU3 will greatly improve the performance of DRVN as the Executing Agency.

3) Important Points on Procurement Management/Administration

- The procurement activities for this JICA ODA loan-finance project should be performed, managed/administered in strict accordance with the JICA procurement guidelines and procedures.
- DRVN is recommended to be the Executing Agency/implementation entity for the Project. However, under the present situation, DRVN will not be fully capable of successfully undertaking the assigned duties as described above, it is recommendable that DRVN acts as the leader of the Executing Agency with strong assistance from PMU3 in the field of project management inclusive of the procurement management/administration.
- PMU3 is suitable for procurement management/administration, but does not have sufficient knowledge of ITS technology as compared to VEA. It is advisable that VEA also is involved in the procurement management/administration to assist PMU3 in the technological aspects.

18.8 Potential Procurement Difficulties and Recommendable Counter-measures

Based on the above-mentioned findings of the surveys and discussions, the potential procurement difficulties and the recommendable countermeasures are summarized below.

1) Conflict between the JICA Procurement Guidelines and the relevant Vietnamese Laws

- There exist certain conflicts between the JICA procurement guidelines, procedures and Standard Conditions of Contract and the relevant local laws and regulations.
  However, experienced local personnel in charge of procurement have experienced no major difficulties in conducting the procurement/contract management/administration in strict accordance with the JICA procurement guidelines, procedures and conditions of contract.
- It is recommended, therefore, that the JICA procurement guidelines, procedures and the JICA Standard Conditions of Contract should govern any conflict with the relevant Vietnamese laws and regulations in the Project.
- It is also recommended that Package-1 of the Project are contracted on a D&B basis in accordance with the JICA “Standard Bidding Documents under Japanese ODA Loans Plant Design, Supply and Installation”, whereas Packages-2 and 3 is on a build/construct only basis in accordance with the JICA “Standard Bidding Documents Procurement of Works”. Note that the JICA Standard Conditions of Contract shall not be modified without an express prior permission from JICA.

2) Organizational Difficulties

- DRVN seems currently incapable as the Project Executing Agency in terms of the experience and the human resources. If DRVN is named as the Project Execution Agency, it is indispensable to make certain reinforcement to their human resources in order for successful implementation and completion of the Project in accordance with the Project implementation time schedule.
- A group of qualified personnel must be hired by DRVN, or a qualified entity is assigned to DRVN as an assistant/associate, to properly manage, supervise, review and approve the consultant's procurement services including preparation of the prequalification and bidding documents, the prequalification and bid evaluation, and the contract negotiation.
- It is recommended that PMU3 will assist DRVN and take the lead in the procurement management/administration, and the contracts management/administration afterward, for the Project. VEA should assist PMU3 in the field of ITS technology.

3) Consultant Selection Issues

- Although the Project Implementation Plan included in the previous SAPI report implied that the consultant participates in the Project only after the construction bids are submitted (this is not a normal case), it is recommended that the consultant is employed at an earlier stage of the Project, to assist the Project Executing Agency throughout the contractor selection process from the prequalification and bidding documents preparation till the signing the Contracts. If this is realized, the Project Executing Agency's burden in the contractor selection process will be significantly reduced.
- As stated above, the consultant should be employed at an earlier stage, and the proposed scope of the consulting services should include:
  - Preparation of the contractor prequalification documents for the 3 packages,
  - Prequalification evaluation including preparation of the evaluation reports,
  - Preparation of contractor bidding documents including the specifications and drawings and the bill of quantities for the 3 packages,
  - Detailed designs of the communication ducts, the power supply system, the NRMC building and the associated works for Packages-2 and 3,
  - Bid evaluation including preparation of the evaluation reports,
  - Contract negotiation with the successful bidders and preparation of the contract documents,
  - Construction supervision including the interface coordination management and the contracts administration,
  - O&M personnel training assistance, and
  - Defects liability period services.
- The Project is an ITS integration project involving the modern, state-of-the-art technologies. Therefore, an international consultant sufficiently experienced in ITS projects should be employed.

  It is recommended that the single consultant employed by the Employer handles all of the proposed 3 packages and coordinate the interfaces not only among these 3 packages but also between the Project and the adjoining projects by others.

  Qualification requirements for the engineering consultant(s) must be clearly stated in

the RFP/TOR for the consulting services.

- It is also recommended that at least a qualified local consultant familiar with the local civil and building codes and standards is included in the consultant's team or become a sub-consultant for preparation of the detailed design of the buildings included in Package-3 in compliance with the applicable local codes and standards.
- The Project Executing Agency must prepare RFP/TOR for consultant selection with utmost care at an early stage of the Project.
  It is recommended that JICA technical cooperation be sought in preparing RFP/TOR and selecting the consultant, as needed to shorten the selection period. JICA will assign specialist(s) to assist the Project Executing Agency in the consultant selection process, inclusive of preparation of the RFP/TOR and proposal evaluation. This consultant selection process should commence and finish as early as practicable, in order to complete the Project as early as practicable by a specific date of completion.
- The ordinary process of the consultant selection in accordance with the JICA procurement guidelines and procedures will take approximately 9 months.
  To shorten this lengthy consultant selection period, and the overall Project implementation period accordingly, a negotiated contract with a qualified international consultant should be considered. The overall Project implementation period can be shortened by approximately 6 months in that scenario.

4) Contractor Selection Issues

- The Project should be divided into the proposed 3 packages, and Package-1 should be bid on an international competitive bidding basis, whereas Packages-2 and 3 may be bid on either an international competitive bidding or a local competitive bidding basis.
- However, it will be best for the Project Executing Agency that all of the 3 packages are contracted out to a single Contractor, wherein the single Contractor will be responsible for the interface management among the 3 packages in his hands. In addition, the total contract price for the 3 packages in that case can normally be discounted as compared to the total contract price in the case that each of the 3 different contractors is awarded a single contract. A clause requiring this potential discount should be included in the Instructions to Bidders.
- It is recommended that Package-1 should be D&B contracts on a lump sum basis, whereas Packages-2 and 3 should be a build/construct only contract on a unit price basis, for the reasons discussed hereinbefore. Packages-2 and 3 should encourage local contractors' participation in the Project.
- The prequalification criteria must be carefully developed to suit the Project involving system integration of multiple sections to be operated by multiple entities.
- It is strongly recommended that the Project Executing Agency, as the Employer under the Contracts, should determine all bid/contract requirements/conditions (including those decisions/authorizations stipulated in section 13.4 before finalizing the Bidding Documents so that it will not be necessary to unilaterally alter the bidding/contract requirements/ conditions during the contract negotiation just before signing the Contract.
- It is necessary that the bidders are given a sufficient bidding period so that they can prepare necessary bid designs and estimate the bid prices accordingly. A bidding

period of at least 90 days will be necessary at least for Package-1.

5) STEP Scheme Introduction

It is recommended that the STEP (Special Terms for Economic Partnership) scheme is applied to the Project, in order to enjoy merits of quality Japanese ITS technology/engineering at a lower rate of interest of the JICA ODA loan.