MINISTRY OF TRANSPORT, VIETNAM

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

APPENDIX 6

ITS BASIC PLAN FOR NATIONAL HIGHWAY NO.3 (REVISED VERSION)

AUGUST 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.
NEXCO EAST ENGINEERING CO., LTD.
NIPPON KOEI CO., LTD
TRANSPORTATION RESEARCH INSTITUTE CO., LTD
LANDTEC JAPAN INC.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF TRANSPORT, VIETNAM

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FINAL REPORT IN AUGUST 2012

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1. Introduction

1.1 Project Outline

1) Name of the Project and Client

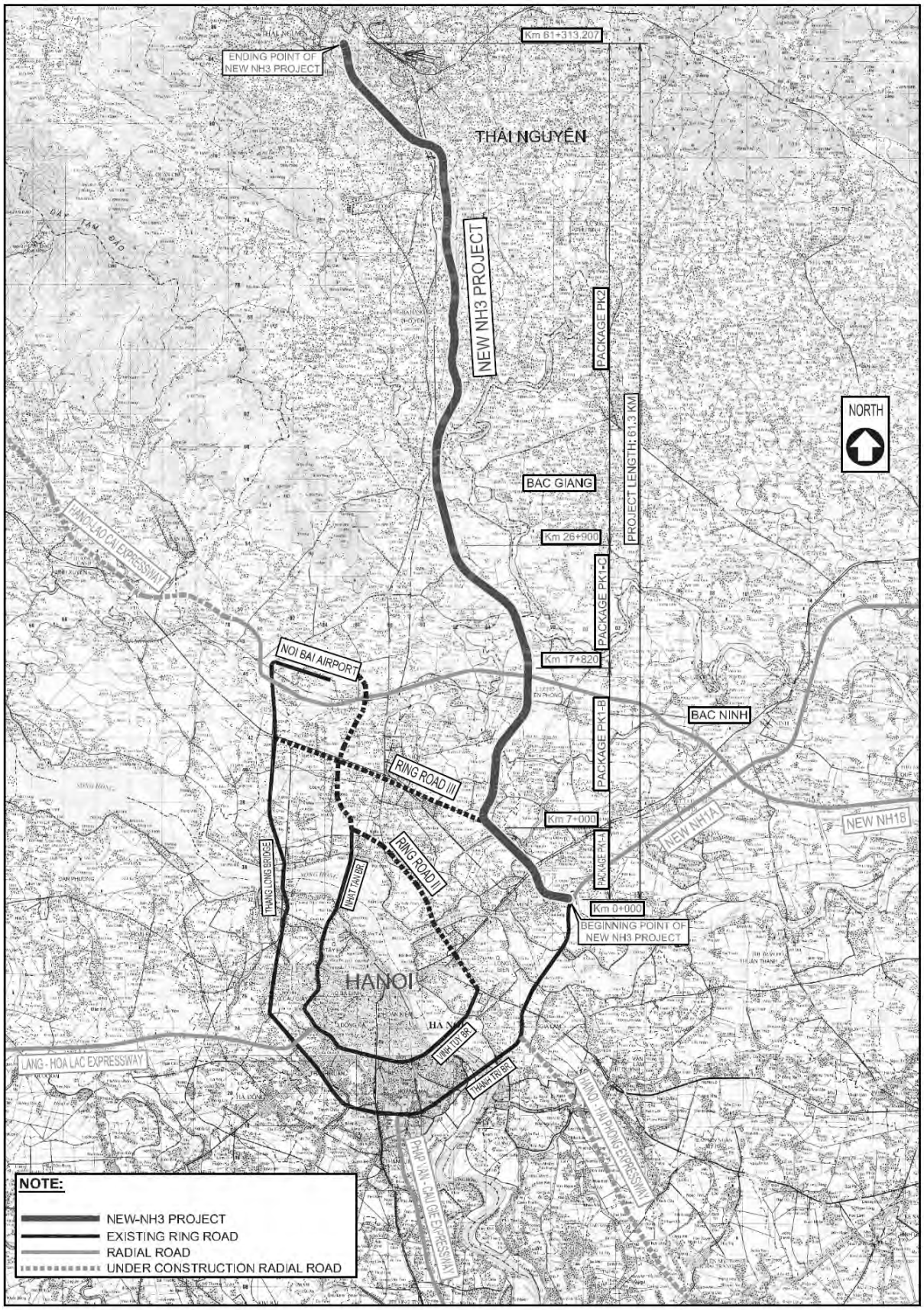
Project's Name:	New National Highway No.3 and Regional Road Network Construction Project Section Hanoi-Thai Nguyen (1)
Employer:	Ministry of Transport
Executing Agency:	Project Management Unit No.2 (PMU2)
Road Operator:	Directorate for Roads of Vietnam (DRVN)

2) Study Area of the Project

Beginning Point:	Ninh Hiep (Intersection with the new NH1A to the north of Phu Dong Bridge), Gia Lam district, Hanoi city
Ending Point:	The point connecting to beginning of Thai Nguyen bypass, Tan Lap ward, Thai Nguyen province
Total Length:	61.313 km
Investment Scope of Stage 1:	Hanoi - Soc Son Section: 26.9km Soc Son - Thai Nguyen Section: 34.4km

3) Project Location Map

Figure 1.1 Location Map of the New NH3



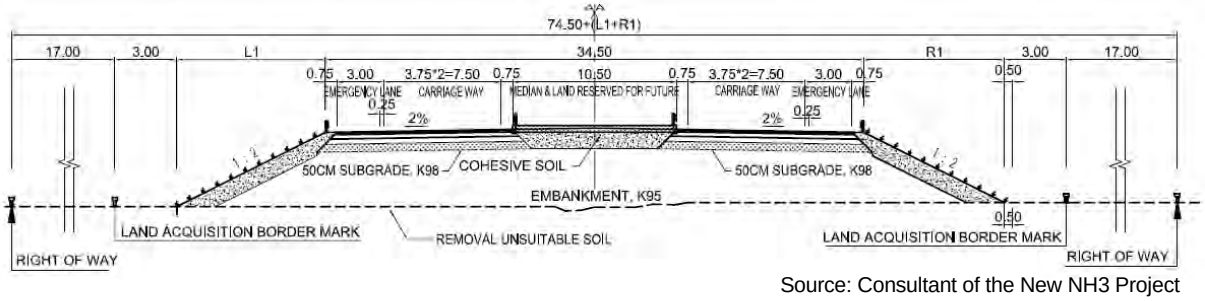
Source: Consultant of the New NH3 Project

4) New NH3 Project Package

(1) Civil Construction Package

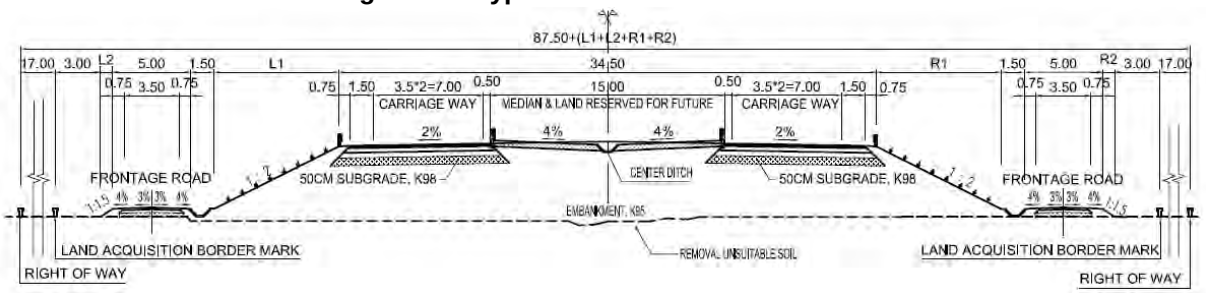
New National Highway No.3 (the New NH3) will be constructed with four contract package including PK1-A, PK1-B, PK1-C and PK2. The works of these packages have been commenced since December 2009. The classification of the New NH3 is designed with expressway class A. The design speed is 100km/h. At 1st stage, the project begins with 4 motorized lanes and 2 emergency lanes (Figure 1.2, Figure 1.3).

Figure 1.2 Typical Cross Section of PK1-A, PK1-B and PK1-C



Source: Consultant of the New NH3 Project

Figure 1.3 Typical Cross Section of PK2



Source: Consultant of the New NH3 Project

(2) Operation and Maintenance (O&M) Package

The O&M Package (PK3) includes:

- Package PK3-A: Facility Construction (Service Area, Toll Plaza, Management Office),

- Package PK3-B: Traffic Information Facilities and Toll Collection System, and

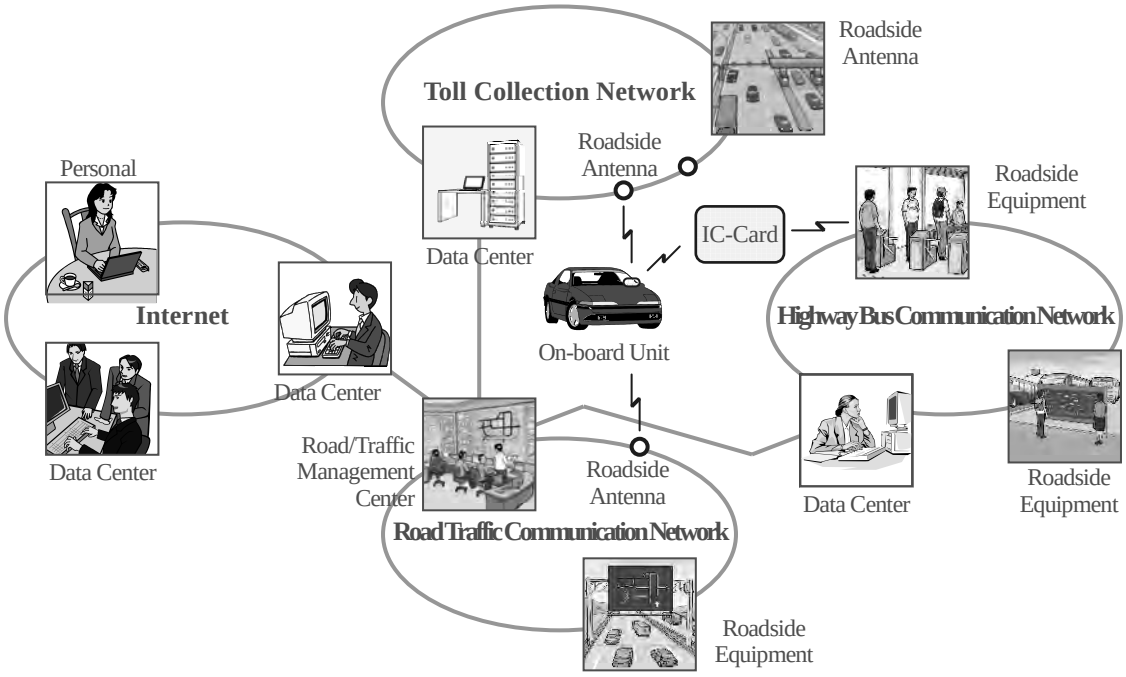
- Package PK3-C: Maintenance Equipment.

The content of this report is concentrated on basic plan of Package PK3-B.

1.2 Introduction of ITS

Intelligent Transportation System (ITS) is a new approach to the transportation problems such as congestion, traffic accident and air pollution. Unlike the conventional measures of physical improvement, it utilizes information and communication technologies to promote efficient, convenient and safe traffic.

Figure 1.4 ITS Network Image



Source: Consultant of the New NH3 Project

Usefulness of IT technologies in transportation system is not only limited to the developed countries but also to developing countries. The ITS offers a wide variety of services toward road administrators, road users, public transport operators, cargo forwarders and general public. The ITS enables to utilize the national highway effectively and safely, and promotes the new model of cultural and industrial system in the country. Applications of ITS to national highway include traffic information/control system, electronic toll collection (ETC) system, communication system, etc.

MOT (Ministry of Transport), PMU2 (Project Management Unit No, 2) and DRVN (Directorate for Roads of Vietnam) positively consider about introducing the ITS to the expressway in Vietnam. Therefore, DRVN (former VRA) strongly requested to introduce ITS to the New NH3 on the discussion with the JICA following up mission dated on 22 May, 2009, considering that the New NH3 introduce an expressway standard. The mission requested to clarify the basic specification and location of ITS facilities by carrying out the study with consideration of alternative options.

1.3 Objective of the Review Works

Under such context, a draft ITS basic plan for the New NH3 was prepared by the consultant of the New NH3 project and submitted to PMU2, executing agency of the New NH3, on April 2011. The draft ITS basic plan for the New NH3 was basically developed in accordance with the JICA draft ITS Standards which have been prepared under the project named “the Study for Supporting ITS Standards & Operation Plan Development in VIETNAM” financed by JICA. However, there have been still discrepancies between ITS

introduction policies of previous draft ITS basic plan for the New NH3 and the JICA draft ITS Standards.

On the other hand, designing and construction of expressway is underway nationwide in Vietnam. In the Hanoi Metropolitan Area, road network consist of the New NH3 and expressways in radial directions and Ring Road No.3 bundles them is to be constructed by around 2013, and ITS introduction is under discussion for realizing efficient road operation. Additionally, in Vietnam, expressway network being constructed by sections funded by different donors, it has become an important issue how operate such sectioned road network and ITS in integrated form.

In such situation, ITS operation framework, key policies on system and the JICA draft ITS Standards are shown as the results of "the Study for Supporting ITS Standards & Operation Plan Development in VIETNAM" conducted following VITRANSS2; however, these results have not been formulated and integration on ITS has not been established. Consequently, it has become critically important to establish a procedure for integrating ITS introduced over different road sections and to show the way to utilize ITS for expressway operation and for addressing potential problems in the metropolitan area.

Under the circumstance, "the Study for Assistance of ITS Integration Project implementation over National Highway No.3 & Hanoi Metropolitan Area financed by JICA" has been carried out to integrate and secure compatibility of ITS over the whole Hanoi Metropolitan Area achieving following items:

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

This report presents the revised ITS basic plan of the New NH3.

2. Operation and Maintenance (O&M) Plan

The operation and maintenance (O&M) plan for the New NH3 are tentatively proposed on the basis of the previous study, 'Proposal on Operation and Maintenance Plan for the New NH3 Construction Project Section Hanoi – Thai Nguyen', February 2007. Further studies will be conducted during the detail design stage and the proposal of the O&M plan will be accordingly modified.

2.1 O&M Framework

The highway operation and maintenance contains various working items as bellow:

- Traffic Management, which includes information collection and provision, traffic surveillance, control of patrols, emergency site management, breakdown assistance services, disaster management and etc,
- Toll Collection,
- Routine Maintenance, which includes inspection, cleaning, vegetation, traffic accident recovery works and traffic regulation and etc,
- Repair Works, which includes pavement renovation, repair of bridges and structures,
- Rehabilitation, which includes pavement rehabilitation, improvement of bridges and structures, restoration of embankment, slope protection and etc, and
- Maintenance of Equipment and Buildings.

1) Highway Operation Framework for the New NH3

It is proposed to establish an Operation and Maintenance Unit, O&M unit hereafter, with subordinate subdivisions for the highway operation and maintenance. It shall be incorporated into the Road Management Office as a core organization.

(1) Traffic Management

- **Overview**

The Road Management Office, incorporated by the O&M unit, will function as a core organization for operation of the New NH3, linked with internal and external organizations, road side equipment, patrols vehicles and personnel.

- **Information Collection and Provision**

The road and traffic information e.g. traffic volume, travel speed, weather conditions, traffic events such as accidents, broken-down vehicles, are transmitted to the Road Management Office as well as the Regional Main Center to be located at Hanoi (the Northern Regional Main Center) in future by either road-side equipment or verbal communication reported from the site as follows;

[Information collected by the road-side equipment]

This includes i) traffic data (volume, speeds etc) from the vehicle detectors on the expressway, ii) visual image on the site from CCTV cameras installed throughout the highway, iii) weather information from the meteorological measurement device, via communication network.

[Verbal communication reported from the site]

This includes the following sources:

- Report from patrol cars and maintenance vehicles on the road via mobile radio communication unit,
- Information or request for assistance from the road users on the road via mobile telephone, and
- Information from relevant authorities such as police, fire departments, municipalities, etc. via telephone or fax.

The verbal information will be responded by the operator in duty in the Road Management Office and processed by the system after inputting the data as necessary. The processed data is to be displayed on the panel at the office and center, provided to the users and the relevant information is reported to the related authorities, issuing the internal instructions to the relevant subsections as necessary. The source of the information provision includes;

Variable Message Sign Board (VMS)

The information of the road and traffic conditions such as weather condition, congestion information, accidents are provided to the users by inputting the traffic information from the office and/or center via communication network.

Verbal Communication Information

Instructions are provided from the office and/or center to the internal subdivisions via internal telephone and to the patrol cars and maintenance vehicles via wireless radio communication units, and relevant information is provided to the external authorities via telephone or fax. Oral responses to the inquiries by telephone from the road users are provided as well.

- **Traffic Surveillance and Control**

The Road Management Office shall be operated by all day long shift throughout the year. Responding to the collected information, the judgement and decision on whether any prompt action shall be taken or not must be made at the office. If the action is judged to be necessary, the instructions to the relevant internal subdivisions of the O&M unit and request to the relevant external authorities shall be immediately made via communication channels. The particular importance is the traffic control measures to be taken swiftly at site for safety of the passing motorist, the roadway and area, rescue of the injured, prevention of the subsequent secondary incident and evacuation.

- **Patrols**

As a subdivision of the O&M unit, the traffic control troops shall be prepared for patrols. The periodic patrols of the highway on shifts of all day throughout the year shall be conducted. Their duties shall include i) detect the incidents on the highway, ii) report to the Road Management Office, and iii) remove the dropped objects which can be potential risks to the traffic.

- **Emergency Response**

On the highway, incidents such as broken-down vehicles, fallen obstacles and traffic accidents would cause heavy traffic accident. Therefore the traffic operation for emergency response is particularly important. On the highway, the traffic control troops in each operation office implements patrol everyday and traffic police also conducts the patrol.

In case of emergencies such as accidents, fires and disasters, the O&M unit shall be responsible for traffic control and safety measures at site. Once the incident is found, the information needs to be immediately transmitted to the relevant subdivisions of the O&M units as well as to the relevant authorities. In coordination with these agencies, the O&M unit shall carry out the traffic management including temporary roadway closure, partial lane regulation, temporary speed limit, detour guidance, temporary entrance closure. The instructions to the subdivisions and request for assistance to the relevant authorities include:

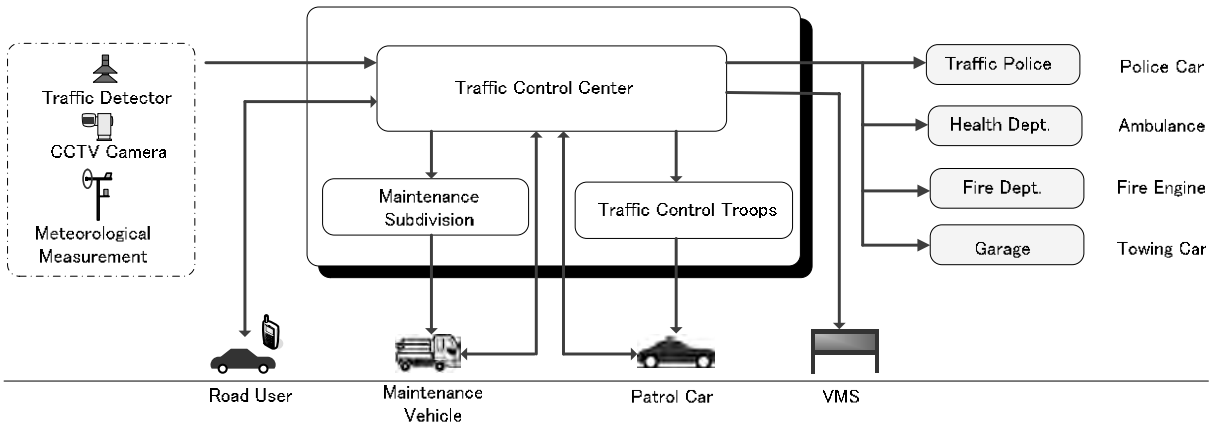
- Instruction to the traffic control troops of the O&M unit for dispatching the patrol cars,
- Instruction to the relevant subdivisions of the O&M unit for dispatching the maintenance vehicles and technicians,
- Request to the relevant fire department for dispatching the fire engines,
- Request to the relevant health department for dispatching the ambulance,
- Request to the police department for dispatching the police cars and placemen, and
- Request to the garages for dispatching the towing vehicles.

- **Breakdown Assistance Service**

When a broken-down vehicle in need of assistance is found, a repair crew of the contracted garage shall be dispatched to the site upon the request of the users through the Road Management Office. The vehicle shall be towed away to the selected garage if necessary.

The conceptual illustration of the highway operation framework is shown below;

Figure 2.1 Overall Highway Operation Framework



Source: Consultant of the New NH3 Project

(2) Toll Collection

For the New NH3 project, the toll collection system combined with "Semi-automatic system" based on the bar code payment at initial stage and non-stop ETC is proposed to introduce. They will be implemented at the barrier toll gate with six (6) lanes on one direction at the location of KM38+600 installed at the Road Management Office nearby. Thus, the O&M unit shall have a function for supervising the toll collection and executing the toll collection activities by the subordinated unit.

2) Highway Maintenance for the New NH3

The highway maintenance works are basically classified into three types, i) routine, ii) periodic and iii) emergency maintenance.

- **Routine Maintenance**

It is based on the routine (daily) inspection of the condition of such as pavement, cut and fill slopes, drainage, bridges, other structures and ITS facilities to monitor any defects and damage. The results of the routine inspection shall be promptly reported to the Road Management Office for follow-up maintenance works to be undertaken either continuously throughout the year or at certain intervals in every year.

- **Periodic Maintenance**

It is based on detailed inspection performed at certain time intervals such as seasonally or yearly depending on the type and kind of facilities. It includes checking and testing the conditions of structures, facilities and equipment. The defects and damages shall be reported for repairs or remedies. The maintenance plans covering several years are to be developed.

- **Emergency Maintenance**

It comprises the works to restore the road and facilities to their normal operating conditions after they are damaged by such as road accidents, natural causes and etc. It is basically not possible to foresee the frequency, but such maintenance requires the immediate action.

The table below summarises the typical activities of each type of the maintenance work.

Table 2.1 Typical Maintenance Activities

Type	Activity
Routine	Clearing of pavement
	Mowing and maintenance of plants
	Clearing of ditches and culverts
	Repair of traffic signs and road markings
	Shoulder grading
	Pothole patching and crack sealing
	Repair of sealants and expansion joints of bridges
	Repair o cut and fill slopes
	Cleaning of lighting facilities along highway, toll plaza, service area
	Clearing of VMS
Periodic	Re-graveling
	Resealing/surface dressing
	Overlay
	Maintenance of traffic signs and road markings
	Periodic inspection and testing of ITS facilities e.g. power receiver/distributer generators, lighting, VMS, meteorological measurement equipment, etc
	Periodic replacement of parts of communication and electric equipment
Emergency	Removal of debris or obstacles from natural caouses
	Repair of damage of road and facilities caused by accidents, malfunctions

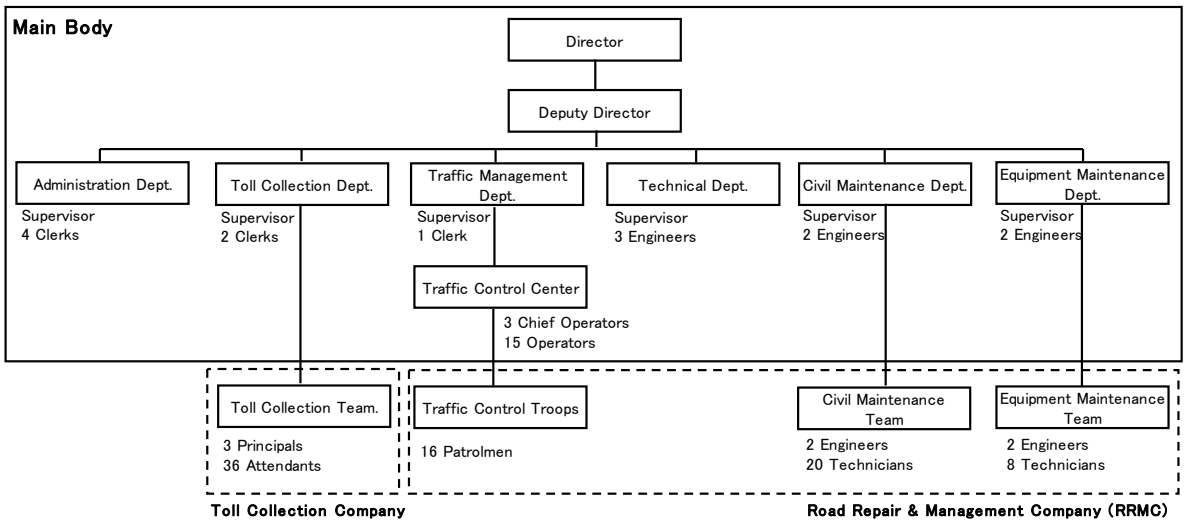
Source: Consultant of the New NH3 Project

2.2 Proposed Organization for O&M for the New NH3

1) Organization Chart

According to the operation and maintenance framework thus far, it is proposed to establish a new O&M unit as shown in the figure below.

Figure 2.2 Proposed O&M Unit Structure for the New NH3



Source: Consultant of the New NH3 Project

In Vietnam, DRVN, Directorate of Roads of Vietnam, a subordinate administrative agency under MOT, is responsible for management, planning and implementation of maintenance of national highways throughout the country. And RRMU (Regional Road Management Units) are in charge of management of road maintenance work under DRVN. Each RRMU has RRMC (Road Repair and Management Companies) under its jurisdiction, which undertake the actual road maintenance works. Consequently, responsibility for management of the New NH3 was supposed to be RRMU2, under which RRMC 238 (the Road Repair and Management Company No.238) may undertake the maintenance work. However, setting up of the new O&M Unit is supposed, and it will be independent of RRMU2, and let a RRMC to undertake O&M works on the New NH3, as specified by the decision No. 683/QD-BGTVT dated 16th March, 2005. The organization structure is proposed in line with this policy.

The proposed O&M unit is composed of the main body and compani(es) under a director, assisted by a deputy director. The main body is responsible for supervising and planning work implemented by the company. It is composed of six (6) departments: i) Administration Department, ii) Toll Collection Management Department, iii) Traffic Management Department, iv) Technical Department, v) Civil Maintenance Department, vi) Equipment Maintenance Department.

The compani(es) shall be responsible for actual O&M works for the New NH3 comprised of five (5) groups corresponding to specialized O&M work, which includes i) Toll Collection Team, ii) Traffic Control Unit, iii) Traffic Control Troops, iv) Civil Maintenance Team, and v) Equipment Maintenance Team.

2) Tasks and Responsibilities

The specialized departments in the main body supervise and control one corresponding group of the specializations. For instance, the Toll Collection Department supervises the Toll Collection Team, the Civil Maintenance Department supervises the Civil Maintenance Team and the like.

As patrolling on the highway shall be closely coordinated with traffic control activities, the Traffic Control Troops are assigned under the Traffic Control Unit and Traffic Management Department supervise all activities related to the traffic control.

The tasks and responsibilities are summarized as below;

Table 2.2 Tasks and Responsibilities of Main Body

Name of Department	Major Tasks and Responsibilities
Administration Deparment	Financial reports, tax duties and related works
	Budget allocation, consolidated budget paln and related works
	Personal management including staff training and labor management, and related works
	Office management such as electricity, water supply, office equipment and related works
Toll Collection Department	Supervision of toll collection and related works
	Contract agreement on toll collection work including setting acceptance targets, and related works
Traffic Management Department	Mid-term and long term planning of traffic management of the highway, and related works
	Assurance of traffic safety including analysis of traffic and accidents, and related works
	Supervisio of traffic surveillance, information provision and traffic control activities, and related works
	Contract agreement on supervising traffic surveillance, information provision and traffic control including setting acceptance targets, and related works
Technical Deparment	Technical standards and regulations development, and related works
	Plan, desing and execution of rehabilitiation, and related works
Civil Maintenance Deparment	Mid-term and long-term planning of managing highway maintenance and repair works, and related works
	Supervision of maintenance and repair work, and related works
	Contract agreement on maintenance and repair work including setting acceptance targets, and related works
Equipment Maintenance Deparment	Mid-term and long-term planning of maintenance work of highway facilities and equipment including ITS, and related works
	Supervision of operation, testing and maintenance work of highway facilities and equipment including ITS, and related works
	Contract agreement on maintenance work of highway facilities and equipment including ITS, and related works

Source: Consultant of the New NH3 Project

Table 2.3 Tasks and Responsibilities of Company

Name of Division	Major Tasks and Responsibilities
Toll Collection Team	Execution of toll collection activities
Traffic Control Unit	Execution of collecting information on traffic conditions, processing collected information, providing traffic information to road users and public
	Execution of traffic control including handling extraordinary conditions and coordination with Traffic Police, Fire Department, Department of Health
	Receiving and responding to road users' inquiries
	Monitoring the traffic conditions and incidents
	Communication/coordination with external and internal authorities
Traffic Control Troops	Execution of patrolling on highway, handling the accidents on site and removing dropping obstacles in cooperation with Traffic Control Unit and Traffic Police
Civil Maintenance Team	Execution of routine maintenance and repair work of civil structures and data collection
Equipment Maintenance Team	Execution of routine maintenance, testing, inspection and repair works of facilities and equipment including ITS

Source: Consultant of the New NH3 Project

3) Required Human Resources

For the main body of the O&M unit, director and deputy director shall be assigned being in charge of the responsibility of the operation and maintenance for the New NH3. In each department, one (1) supervisor will be assigned for the responsibility of the its speciality of the department and supported staff such as clerks and engineers.

For the companies, working shift and combination of chiefs and subordinates are considered. For instance in the toll collection team, 3 teams will work for 24-hour operation with rotation of three shifts, of each team consisted by one principal and attendants for toll collection works.

Table 2.4 Number of Staff for Main Body

Department	Director	Supervisor	Cleark	Engineer	Total
Director	1				1
Deputy Director	1				1
Administration Department		1	4		5
Toll Collection Department		1	2		3
Traffic Management Department		1	1		2
Technical Department		1		3	4
Civil Maintenance Department		1		2	3
Equipment Maintenance Department		1		2	3
Total					22

Source: Consultant of the New NH3 Project

Table 2.5 Number of Staff for Compani(es)

Team	Position	Staff No.	Remarks
Toll Collection Team	Principals	3	3 shift
	Attendants	36	6 lanes * 2 directions * 3 shift
Traffic Control Unit	Chief Operators	3	3 shift
	Operators	15	5 consols * 3 shift
Traffic Control Troop	Patrolmen	16	
Civil Maintenance Team	Engineers	2	
	Technicians	20	
Equipment Maintenance Team	Engineers	2	
	Technicians	8	

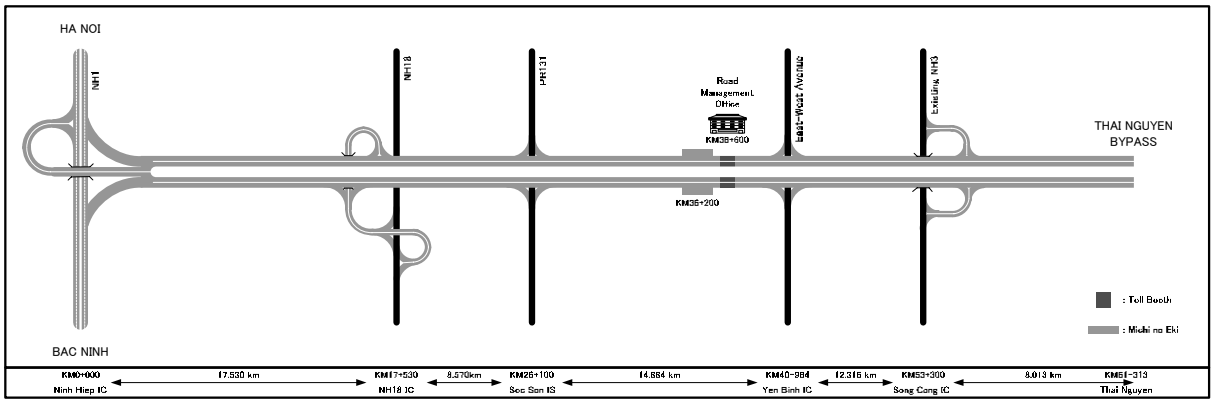
Source: Consultant of the New NH3 Project

2.3 O&M Facility

1) Location of O&M Facilities

Location of O&M facilities are planned as shown in figure below;

Figure 2.3 Location Plan of O&M Facilities

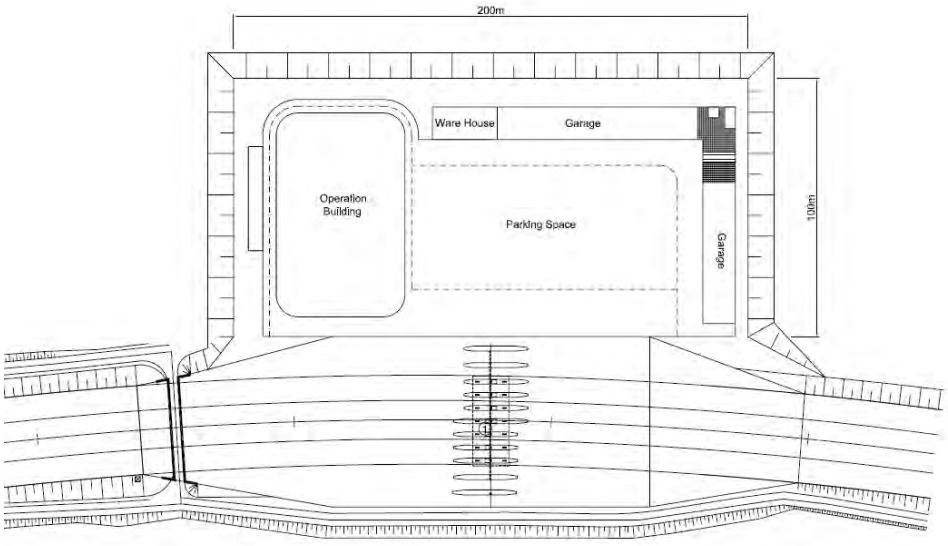


Source: Consultant of the New NH3 Project

2) O&M Building

According to the proposed O&M organizations and in consideration of efficiency and conveniences of operations, O&M unit shall be located at the roadside of tollgate of the New NH3. The facilities to be accommodated in this O&M unit include i) office building to house all offices for the O&M unit, traffic control center, maintenance crews and toll collection team, ii) garages, iii) warehouses and iv) parking space. The yard to accommodate is required the area of over 20,000 m^2. The tentative layout plan for toll plaza and O&M unit facilities are illustrated below.

Figure 2.4 Layout Plan of O&M Facilities



Source: Consultant of the New NH3 Project

3) Service Area (Michi no Eki) Building

The michi-no-eki is to be located at both sides of the highway at KM36+200 point as shown in **Figure2.5**. The preparation of the michi-no-eki will be implemented by other authorities, independent from the New NH3 project. Therefore in this report the basic facility items which can be considered appropriate and the required space are only shown below;

Table 2.6 Facilities for Michi-no-Eki

	Area (m2)	Number	Total (m2)
(Information Center)	60	1	60
(Restaurant)	1000	1	1000
(Kiosk)	10	11	110
(WC)	120	2	240
(Rest House)	166	5	830
(Gas Station)	152	2	304
(Repairing Work Shop)	315	1	315
(Bus station)	17	2	34
	Total		2860

Source: Consultant of the New NH3 Project

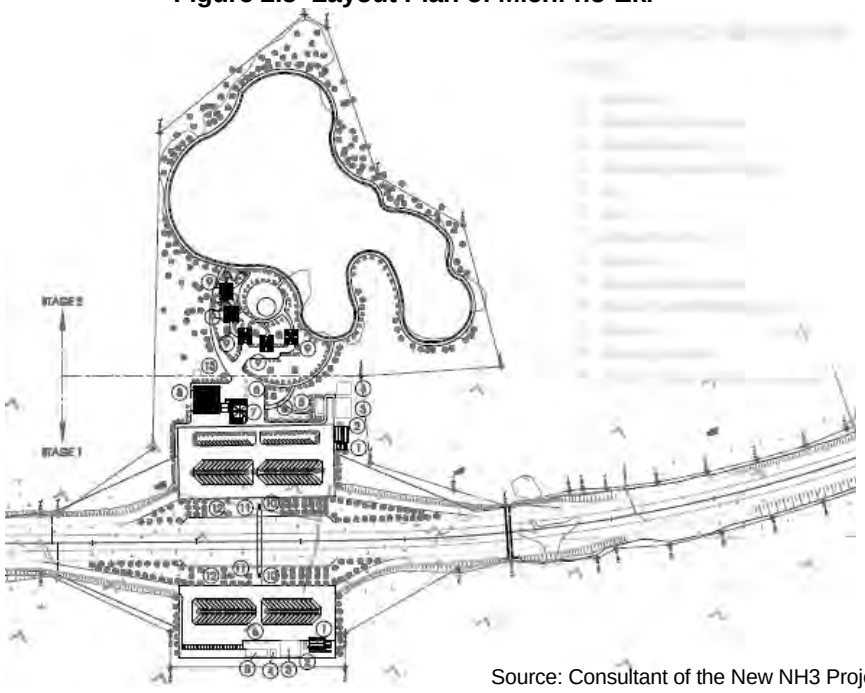
Table 2.7 Required Areas for Michi-no-Eki

Parking:	Car:	50 x 5*5=1,250m^2
	Large vehicle	24 x 10*6=1,440m^2
	Bike	150 x 3*1=450m^2
Passage and Access way		6m x 400m = 2,400m^2
Pedestrian square		30m x150m=4,500m^2
Buildings		3,000m^2
Backyard space		2,000m^2
Green zone		13,000m^2
Total minimum one side		30,000m^2

Source: Consultant of the New NH3 Project

This area is located near the pond. Considering ensuring the future landscaping and development, it is recommended to acquire the land with the area of pond, if possible. In this case the total area becomes around 180,000 m2. The tentative layout is illustrated in figure below.

Figure 2.5 Layout Plan of Michi-no-Eki



Source: Consultant of the New NH3 Project

4) O&M Vehicles and Equipment

The required vehicles and equipment for the operation and maintenance for the New NH3 are tentatively proposed as follows;

Table 2.8 Vehicles and Equipment for Maintenance

Item	Quantity
Staff car with RC (radio communication)	2
Patrol car with RC	4
Brsh-type sweeper with RC	1
Vacuum-type sweeper with RC	1
Water sprinkler with RC	1
High-pressure washer with RC	1
High-crane lifter with RC	1
Maintenance truck with RC	3
Movable sign-board vehicle with RC and sign	4
Tractor shovel with RC	1
Trimmer	10
Chemicals spray	10
Chain sow	5
Mower	5
Temporary sign	50
Rubber cone	100
Guide arrow	50

Source: Consultant of the New NH3 Project

Table 2.9 Vehicles and Equipment for Repair Works

Item	Quantity
Asphalt Cutter	1
Air Compressor (180psi)	1
Plate Compactor (60kg)	2
Pneumatic Breaker (30kg)	2
Dump Truck (40t) with RC	1
Crane Truck (5t)	1
Roller	2
Grader	1
Bulldozer	1

Source: Consultant of the New NH3 Project

2.4 Highway Operation in Future

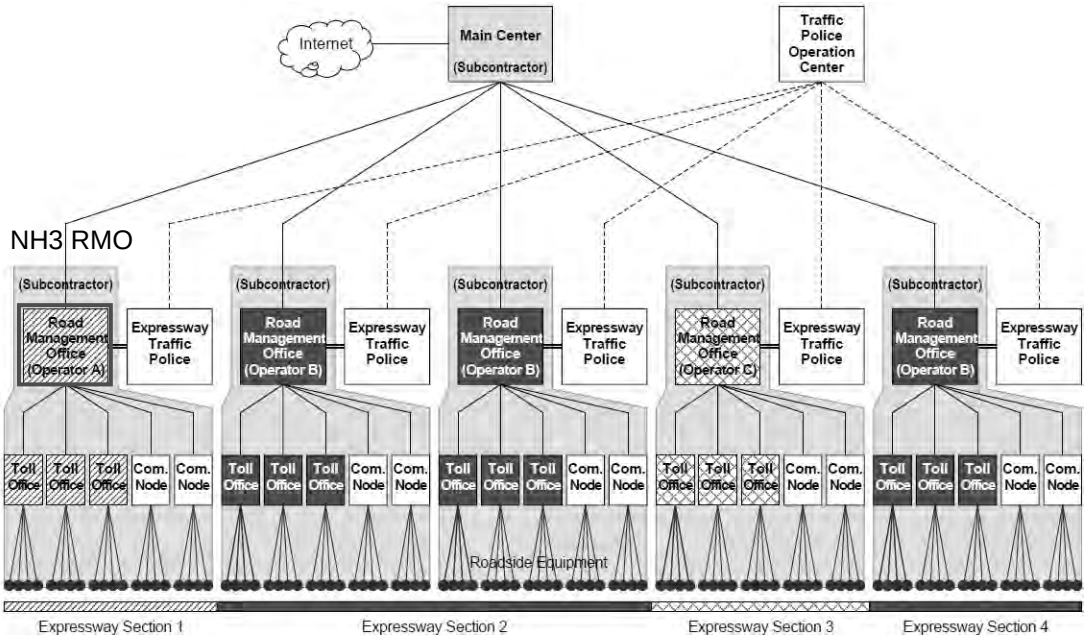
As described in the previous chapter, the Northern Regional Main Center is planned to prepare in the future. The major responsibilities of road management center and the Regional Main Center are defined as follows;

- Regional Main Center: It will be in charge of traffic monitoring, traffic control and traffic information dissemination.

- Road Management Office: It will be in charge of patrol for surveying current traffic conditions on the highway, system maintenance and implementation, and management of toll offices.

The framework for traffic control regarding establishment of the Regional Main Center is proposed by the JICA draft ITS Standard, on the condition of establishment of expressway traffic police, as below;

Figure 2.6 Framework for Traffic Control



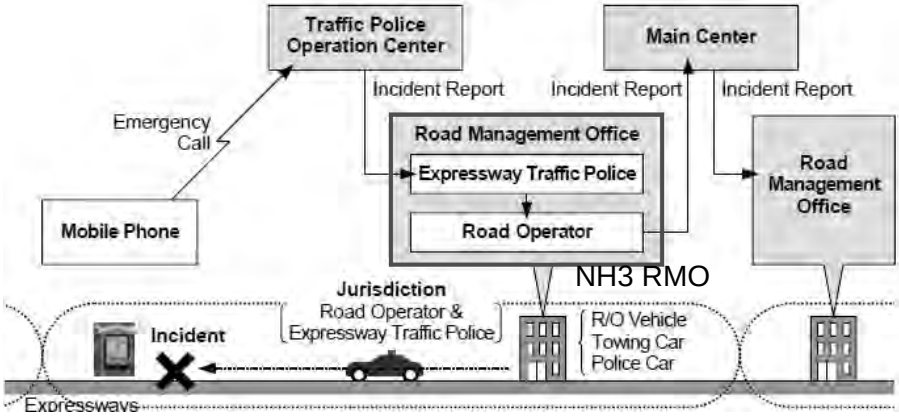
Source: ITS Standards & Operation Plan Study Team

The affected major change of the operation procedures can be listed as follows, in consideration of the basic concept of the JICA draft ITS Standard;

- **Procedure of Incident Notification**

On the condition of the establishment of the traffic police operation center and the Regional Main Center, the procedure of the incident notification in the case of adopting the mobile phone from the user becomes as below;

Figure 2.7 Incident Notification in Future

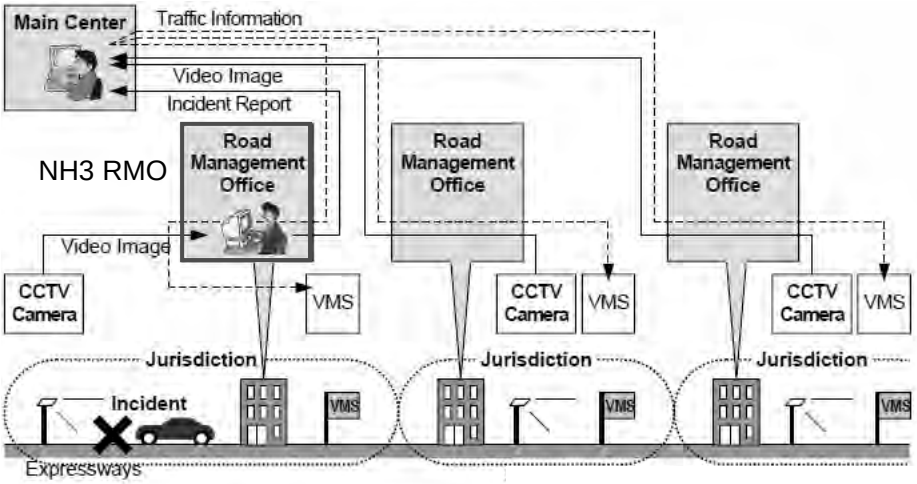


Source: ITS Standards & Operation Plan Study Team

- **Procedure of Incident Management**

The road/traffic monitoring at incident site is to be conducted by the individual road management office including the New NH3 Road Management Office being in charge of addressing/clearing the incident. However the information regarding the traffic event such as incident will be provided to VMS, Variable Message Sign, from the Regional Main Center, and CCTV camera will be controlled by both the Regional Main Center and individual road management office as follows;

Figure 2.8 Incident Management in the Future



Source: ITS Standards & Operation Plan Study Team

3. Traffic Information/Control System

3.1 Highway Operation

The formulation of the traffic information/control system plan follows the basic policy of the operation and maintenance plan (O&M Plan) for the highway including the organization of O&M unit, traffic management, etc. which are mentioned in chapter 2.

It shall also be noted that the basic policy of O&M plan will be updated following the O&M plan of the Northern Regional Main Center, accordingly the systems as required, as well, in order to ensure suitable implementation of the New NH3 Road Management Office under the Northern Regional Main Center in future.

3.2 Phased Development Plan of Traffic Information/Control System

According to the operation plan of the JICA draft ITS Standard, the Regional Main Center will become in charge of the traffic monitoring, traffic control and information dissemination. On the other hand, as described in the previous chapters, the Road Management Office of the New NH3 will be equipped with full functions till the establishment of the Northern Regional Main Center. This means some functions of the traffic information/control system of the New NH3 need to be handed over to/shared with the Northern Regional Main Center when established. Thus, the phased system operation plan of traffic information/control system must be considered as:

Phase-1: Operation with full required functions for the traffic control and management on the New NH3

Phase-2: Operation with handed over/shared functions with Northern Regional Main Center

1) Traffic Information/Control System in Phase 1

Though the New NH3 Road Management Office will be equipped with traffic monitoring, traffic control and traffic information dissemination functions until the establishment of the Northern Regional Main Center, traffic information/control system introduced in the New NH3 need not have full-scale system components, since 1) total length of targeted road is less than 62km and 2) almost all traffic control/management functions will be transferred to the Northern Regional Main Center.

Aiming at reducing the implementation cost and efficient functional transition to the Northern Regional Main Center, the traffic information/control system will be introduced by following the implementation coverage and policy below.

Coverage of the System

The traffic information/control system shall have following traffic control/management functions on the New NH3.

- Incident Notification

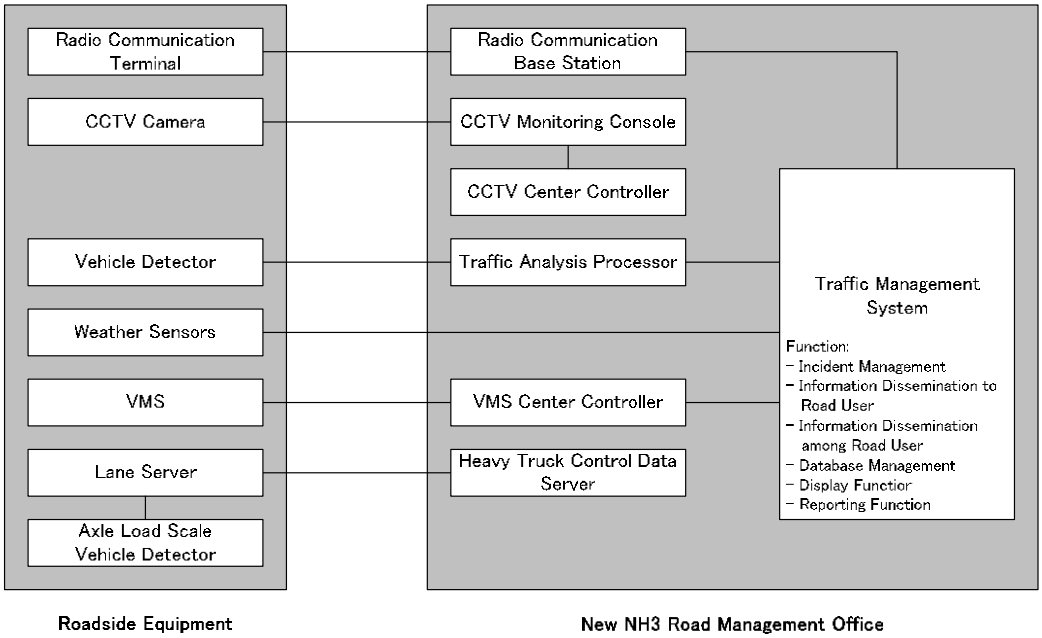
- Road/Traffic Monitoring
- Traffic Event Data Management
- Traffic Information Dissemination
- Heavy Truck Control

The system covers the traffic control/management functions of the New NH3 and does not include the functions of other connecting expressways such as NH1A and NH18.

Implementation Policy

(1) The traffic information/control system in the New NH3 Road Management Office and roadside equipment are configured as figure below.

Figure 3.1 Traffic Information/Control System Component Phase-1 (Without the Regional Main Center)



Source: ITS Integration Project (SAPI) Study Team

(2) Traffic Management System, which is vital component of the traffic information/ control system, will be provided to manage, monitor, control and integrate the data collected directly from roadside equipment or through each system processing server, and have traffic event data management and traffic supervision functions.

(3) Incident notification function from road users by using mobile phone will be introduced in the New NH3. Apart from this, mobile radio communication system will be provided to communicate with road operation vehicles/workers on the expressway, and radio communication base station will be constructed in the New NH3 Road Management Office.

(4) Following system components in the New NH3 will be provided for realizing the road/traffic monitoring function:

- CCTV monitoring system
- Vehicle detector system
- Weather monitoring system

In the Road Management Office, separate processing server or console/controller for each system except weather monitoring system will be introduced to collect and process the data from roadside equipment. Weather data processing will be made by traffic management system because the weather monitoring system consists of only one set of roadside sensors and provision of exclusive processing is to be not required.

(5) Traffic information dissemination function to road users by using VMS will be introduced in the New NH3. VMS center controller to control VMS at roadside will be provided in the road management office. Traffic information system, which is defined as one of traffic information dissemination package in the JICA draft ITS Standard, will not be introduced in the New NH3 Project since the system aims to provide traffic event data with other organizations and such function can be realized by oral communication through public telephone in this phase.

(6) As for heavy truck control function, axle load scale and related equipment at roadside and heavy truck control data server in the Road Management Office will be provided in Phase-1. The system is to be only utilized by the traffic inspector at roadside or the office for enforcement of overloaded vehicle and no system transfer is needed even after the Northern Regional Main Center is established.

(7) Each system component shall have future expandability and compatibility with the Northern Regional Main Center after-mentioned.

2) Traffic Information/Control System in Phase 2

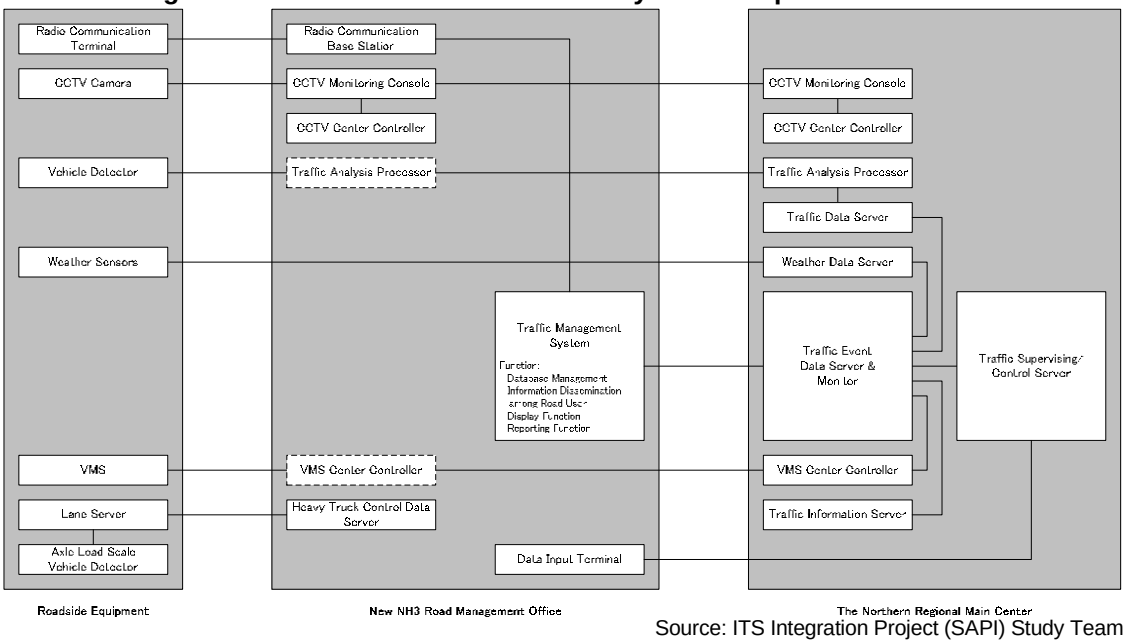
Coverage of the System

The traffic information/control system shall keep necessary monitoring functions for the New NH3 and major traffic monitoring/control/information dissemination functions will be transferred to the Northern Regional Main Center.

Implementation and Transition Policy

(1) The traffic information/control systems in both of the New NH3 Road Management Office and the Northern Regional Main Center are configured as figure below.

Figure 3.2 Traffic Information/Control System Component Phase-2



Source: ITS Integration Project (SAPI) Study Team

(2) The Northern Regional Main Center will be equipped with traffic event data server consolidating the data collected from or processed at each roadside equipment and/or road management office. The traffic management system in the New NH3 Office will be functioning as a counterpart equipment of traffic data server.

(3) Mobile radio communication system is a system to be utilized in the operational coverage of the Road Management Office. Therefore, the radio communication base station will continue to be used in Phase-2 without any functional changes from Phase-1.

(4) CCTV monitoring system will be extended to connect to the Northern Regional Main Center through CCTV monitoring console with keeping camera control function in the New NH3 Management Office. By using Network Video Recorder (NVR) as CCTV center controller, the system expansion to the Northern Regional Main Center may be possible without major modifications of CCTV monitoring system in the New NH3 Road Management Office.

(5) The vehicle detector and weather sensor will be directly connected with traffic analysis processor and weather data server installed in the Northern Regional Main Center in Phase-2. Though the diversion of traffic analysis processor hardware itself installed in the New NH3 Road Management Office in Phase-1 is difficult, it may be possible to transfer both traffic analysis processor software and weather processing software to the servers in the Northern Regional Main Center.

(6) The heavy truck control system in the Road Management Office will remain unchanged even after the Northern Regional Main Center is established.

(7) Data input terminal and other required equipment will be additionally provided in the New NH3 Road Management Office in this phase.

3.3 Proposed Traffic Information/Control System Packages

The traffic information/control system consists of various applications as shown in **Table 3.1**. These are categorized into 1) data acquisition system, 2) information dissemination system and 3) traffic management system.

The data acquisition system is to collect highway and traffic information which generally include traffic volumes, travel speeds, degree of congestions, visual traffic flow conditions and incidents such as accidents, breakdowns, road works and disasters from various sources.

The information dissemination system is to provide the drivers and other receivers with essential highway and traffic information processed and integrated in the Road Management Office through various methods, such as; variable message sign to the drivers, information exchange through LAN to the internal relevant authorities, internet to the public.

The traffic management system is a centralized traffic information and control system to manage and integrate all information related to highway and traffic conditions, incidents and any other required information in the Road Management Office.

The traffic information/control system for the New NH3 is proposed to be composed of following systems as a standard level of system in initial stage.

Table 3.1 Proposed Traffic Information/Control System Package

Category	System Component
Data Acquisition System	Vehicle Detector System
	Weather Monitoring System
	CCTV Monitoring System
	Heavy Truck Control System
	Mobile Radio Communication System
Information Dissemination System	Variable Message Sign (VMS) System
Traffic Control Centre System	Traffic Management System

Source: Consultant of the New NH3 Project

The necessity and purpose of introduction of each traffic information/control system package are summarized as below.

- **Vehicle Detector System**

In planning for road widening or asphalt repair in future, it will be required to measure a total traffic volume and a large-sized vehicle traffic volume on the highway, continuously. To meet such requirements for highway operation and maintenance, the vehicle detector system shall be introduced in the Project. In the initial stage, one (1) vehicle detector sensor in each section at upstream of each interchange will be installed to mainly measure the total traffic volume and the large-sized vehicle traffic for the purpose of proper recognition of the traffic conditions. In future, the interval of each vehicle detector sensor would be shortened to detect congestion on the highway.

- **Weather Monitoring System**

The weather monitoring system is one of indispensable systems to measure weather conditions, take appropriate countermeasures such as road closure and maximum speed limit reduction in bad weather condition, and provide warning information to the drivers. Table below shows the example of traffic control criteria of Japanese expressway.

Table 3.2 Traffic Control Criteria for Disaster Management

Cause of Disaster	Operation by Highway Operator		
	Special Patrol	Alert Operation	Emergency Operation
		Speed Control Lower the regulartory speed (ex. to 50km/h)	Roadway Closure
Earthquake	Subject to Earthquake Inspection Manual	Over 50 gal	Over 80 gal, or Actual damage confirmed
Heavy Rain	Accumulated Rain between 100mm and 150mm	Accumulated Rain > 150mm, or Hourly Rain > 30mm	Accumulated Rain > 300mm, or Hourly Rain > 50mm after Accumulated Rain reaches 220mm
Strong Wind	—	Storm Warning Issued	Maximum Wind Speed > 25m/s
Tsunami	—	Tsunami Warning Issued	Major Tsunami Warning Issued
Dense Fog	—	Visibility between 50m and 100m	Visibility less than 50m
Others	—	Disasters probable	Closure judged to be necessary

Source: Emergency Operation Criteria for Tomei Expressway, Japan

In consideration of the total length of the highway, 61.3km, and sensor locations of other expressway connecting with the New NH3, at least one (1) set of weather sensor which consists of anemometer, thermometer, rainfall gauge and visibility meter shall be introduced in the project. The basic plan tentatively proposes to install one set of the weather sensor at the New NH3 Road Management Office. However the exact location including the necessity of the additional monitoring sensors in different location will be reviewed in the detailed design stage by investigating the surrounding weather conditions in detail.

- **CCTV Monitoring System**

In order to detect abnormal condition on the highway from Road Management Office visually, the CCTV monitoring system shall be introduced in the Project. As mentioned in JICA draft ITS Standard and MOT decision No.2503/BGTVT-KHCN dated 4 May 2011, utilization of CCTV camera is currently more and more popular due to reasonable price and its remarkable advantages in image centralization recording and traffic management. Accordingly, PTZ (Pan-Tilt-Zoom) camera will be basically installed at each 2km interval on main carriageway.

- **Heavy Truck Control System**

The heavy truck control system will be introduced to detect and enforce the overloaded vehicles for protecting the highway structure and pavement in conformity with Vietnamese Standard 22TCN307-2006 “Vehicle General Specification for Safety” below.

Table 3.3 Allowable Maximum Vehicle Weight

Allowable Maximum Vehicle Weight (Axial Load)	
Single axle	10 t
Double axle	11 t (d < 1.0) 16 t (1.0 ≤ d <3.0) 18 t (d ≥ 3.0) d: Axle space (m)
Triple axle	21 t (d ≤ 1.3) 24 t (d > 1.3) d: Nearest axle space (m)

Vietnamese Standard 22TCN307-2006 "Vehicle General Specification for Safety"

Considering the conditions of axle load scale arrangement on the New NH3 such as access control of expressway (open system), land space for enforcement, etc., it is proposed that the axle load scale will be installed at location closely back from toll barrier.

- **Mobile Radio Communication System**

The mobile radio communication system is necessary for the highway operation and maintenance to communicate with patrol car on the highway and the Road Management Office at the time of patrol or in case of emergency. One (1) mobile base station at the Road Management Office will be procured in the project to cover the entire highway.

- **Variable Message Sign (VMS) System**

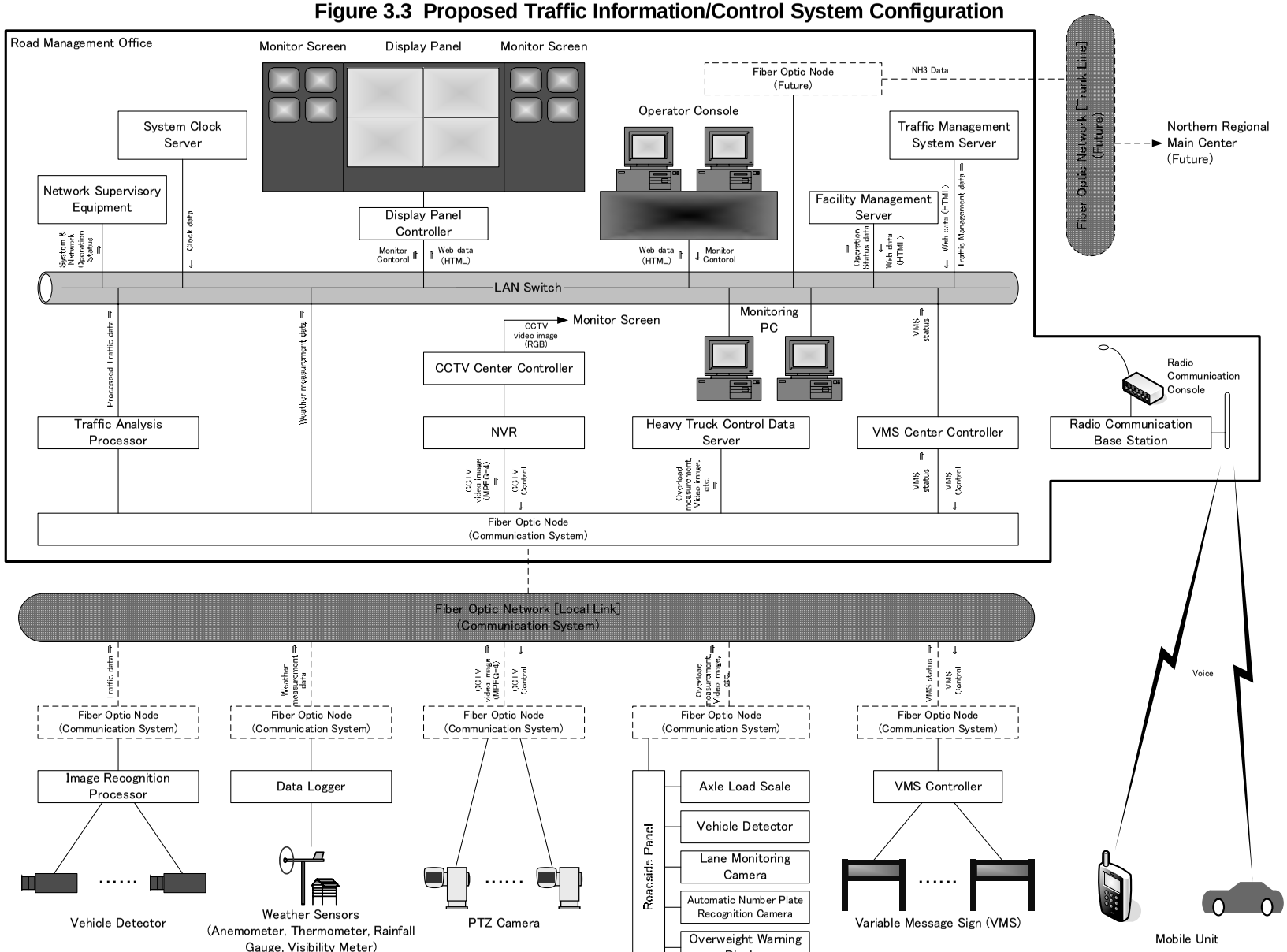
The variable message sign (VMS) system is to provide the information of the road and traffic conditions, weather conditions and others on the highway to the driver. The VMS is one of the most effective measures for the highway information provision. Therefore, the VMS will be installed at upstream of each ingress and egress to/from the highway.

- **Traffic Management System**

In order to manage and integrate all information related to highway and traffic conditions, incidents and highway operation by the road operator, traffic management system shall be provided in the Project. Also, the traffic management system shall have expandability to transfer the information on the New NH3 to the Northern Regional Main Center to be established in future.

The proposed traffic information/control system would be initially configured as **Figure 3.3**.

Figure 3.3 Proposed Traffic Information/Control System Configuration



Source: ITS Integration Project (SAPI) Study Team

3.4 Location Plan

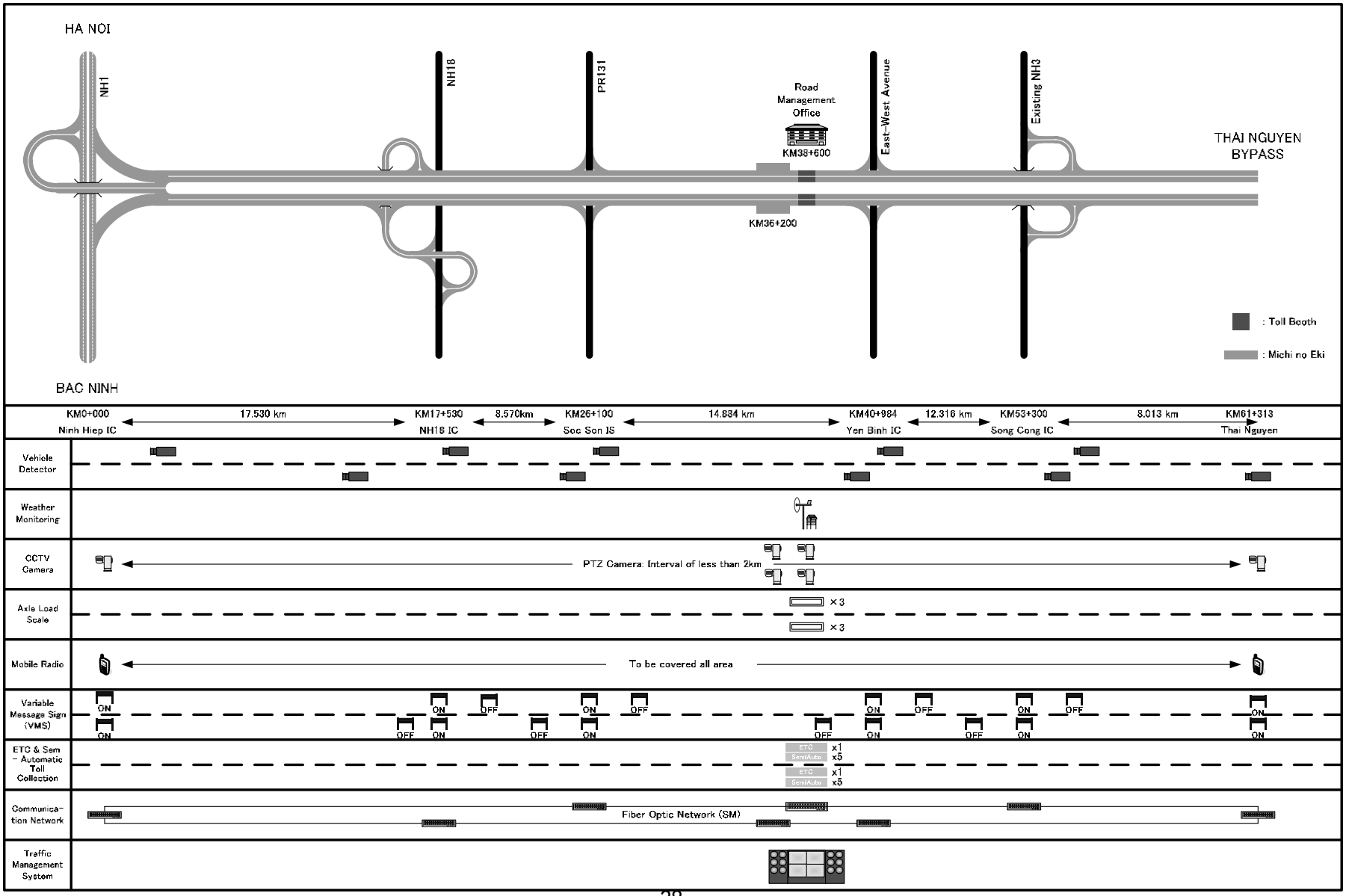
The location plan of the traffic information/control system facilities is proposed as below table, and the location map is illustrated as **Figure 3.4**.

Table 3.4 Location Plan for Traffic Information/Control System

No	Facilities	Location Plan	Unit	Quantity	Remarks
1	Vehicle Detector System	One each between Interchanges	sets	10	Image Recognition
2	Weather Monitoring System	Road Management Office	set	1	
3	CCTV Monitoring System	PTZ Camera: 2km interval on main carriageway, and tollgate and michi-no-eki	sets	44	PTZ Camera
4	Heavy Truck Control System	Toll barrier	sets	6	
5	Mobile Radio Communication System	Road Management Office	set	1	Mobile Base Station: 1 Vehicle Mounted Unit: 20 Mobile Unit: 20
6	Variable Message Sign System	Upstream of each entering points, Upstream of each exit points (except beginning and ending points)	sets	20	Entering points: 12 Exit points: 8
7	Traffic Management System	Located at km 38+600	lot	1	

Source: ITS Integration Project (SAPI) Study Team

Figure 3.4 Location Map for Proposed Traffic Information/Control System



Source: ITS Integration Project (SAPI) Study Team

3.5 Basic Functions and Specifications

1) Vehicle Detector System

(1) Basic Functions of Vehicle Detector System

Generally, the vehicle detector system is installed to detect and process data on a traffic volume, a large-sized vehicle traffic, a time occupancy rate and a vehicle average speed for the purpose of followings;

Item	Main Purpose
1. Traffic volume	Use as statistics for planning of future road widening
2. Large-sized vehicle traffic (Vehicle length)	Use as statistics for planning of future structure and pavement repair
3. Time occupancy rate	Detect traffic congestion and incident from time occupancy rate
4. Vehicle average speed	Provide travel time information to the drivers

Source: Consultant of the New NH3 Project

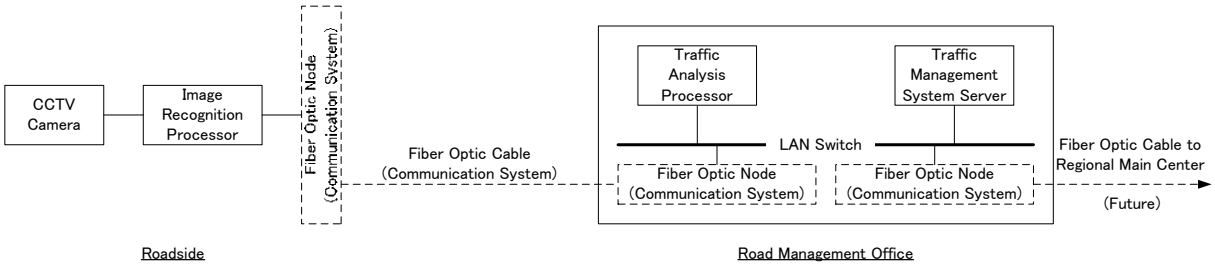
The vehicle detector system in the New NH3 Project will be introduced with the aim of measuring the traffic volume, the large-sized vehicle traffic, the vehicle average speed and traffic congestion and incident at merging/diverging sections on the highway for saving the initial costs, and would be expanded in future to detect the traffic congestion and incident on the entire highway.

The vehicle detector system shall detect vehicles, measure and calculate the required traffic data separately for each lane. Unit duration of detection, measurement and calculation shall be within 1 minute. All data shall be periodically transmitted to the traffic analysis processor installed in Road Management Office through the fiber optic cable network and transferred to the Northern Regional Main Center in future. The transmitted data shall be processed, stored, retrieved in a server and monitored on a display. The vehicle detector system must have an overall detection accuracy of 97 % or better in vehicle counting for any types of vehicles expected to pass the highway.

(2) Vehicle Detector System Configuration

The vehicle detector system is composed as **Figure 3.5** below.

Figure 3.5 Vehicle Detector System Configuration



Source: ITS Integration Project (SAPI) Study Team

(3) Location of Vehicle Detector Roadside Equipment

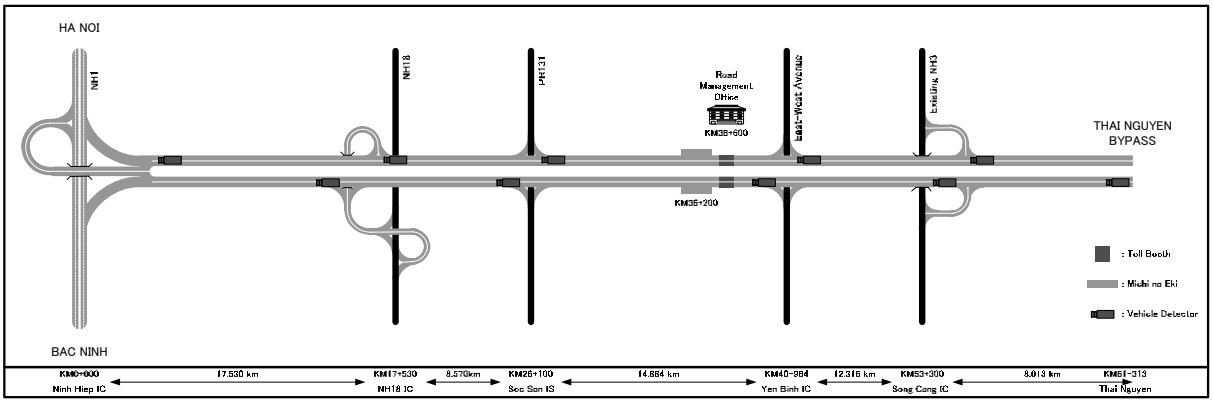
Table 3.5 Vehicle Detector Roadside Equipment Location

No.	Location	Bound	Quantity	Remarks	No.	Location	Bound	Quantity	Remarks
1	KM 0+500	Southbound	1	Ninh Hiep IC	6	KM 40+500	Northbound	1	Yen Binh IC
2	KM 16+220	Northbound	1	NH18-IC	7	KM 41+450	Southbound	1	Yen Binh IC
3	KM 17+560	Southbound	1	NH18-IC	8	KM 52+900	Northbound	1	Song Cong IC
4	KM 25+200	Northbound	1	Soc Son IC	9	KM 53+800	Southbound	1	Song Cong IC
5	KM 27+000	Southbound	1	Soc Son IC	10	KM 63+000	Northbound	1	Thai Nguyen IC

Total: 10 pcs

Source: ITS Integration Project (SAPI) Study Team

Figure 3.6 Location Map for Vehicle Detector System



Source: ITS Integration Project (SAPI) Study Team

(4) Basic Specifications for Vehicle Detector System

- **Vehicle Detector Sensor**

Following types of sensor are generally used as the vehicle detector:

- Loop-coil type sensor,
- Ultrasonic type sensor, and
- Image recognition type sensor.

In MOT decision No.2503/BGTVT-KHCN, it is clearly mentioned that it is priority to choose digital IP camera in design of surveillance camera system in expressway combining with traffic detection, traffic volume and traffic flow speed function (VDS).

Accordingly, the image recognition type detector is proposed for the project in consideration of advantages such as:

- Multiple lane/zone detection is applicable,
- Image recognition camera can be located on any places of expressway including bridge section,
- Applicable to identify traffic swerved from lanes,

- Secondary usage for visual judgment is capable, and
- Maintenance work on the pavement can be avoided.

However, it is possibility that image recognition type detector may not be well functioning under the bad weather conditions such as dense fog and heavy rain. Therefore, the detailed specifications of vehicle detector sensor must be further studied in the detailed design stage.

- **Image Recognition Processor**

Image recognition processor shall have following functions;

- Capable of measuring required data for compiling following traffic data, at least:

  Traffic volume (by all lane, by one lane, by vehicle category and by hour),

  Vehicle average speed (for every 1 minute, 15 minutes, 1 hour)

  Time occupancy rate

  Large-sized vehicle traffic (vehicle length)

- To transmit the traffic data to the Road Management Office through fiber optic cable
- Capable of synchronizing its clock to the system master clock

- **Traffic Analysis Processor**

Transmitted data from image recognition processor shall be analyzed, stored, retrieved by traffic analysis processor. Followings are minimum required functions of the server.

- Traffic data reception
- Error checking
- Data accumulation and averaging (Sectional data, Hourly data and Daily data)
- Reporting and display
- Transferring the processed data to the traffic management system server

- **Future Expansion**

The measured data shall be provided to the Northern Regional Main Center through fiber optic cable as required in the future when the Regional Main Center is established.

At the initial stage, it is proposed that the vehicle detectors will be introduced by the policy of one set between ICs. This is for the purpose of i) cost saving and ii) realization of the quantitative measurement of the traffic conditions such as traffic volume. However, in the future when the traffic volume increases and the congestion-prone points become clear, the installation interval can be shortened for more detailed calculation.

2) Weather Monitoring System

(1) Basic Functions of Weather Monitoring System

The weather monitoring system is installed to measure weather conditions on or near the highway. A driving environment on the highway is judged based on the data from the weather roadside equipment. If hazardous weather condition is detected by the system, warning message will be announced road users through the variable message sign. If weather condition is too dangerous for driving, the highway may be closed. The weather roadside equipment consists of various types of sensor to measure required weather data.

Table 3.6 Weather Monitoring Items and Required Sensors

Item	Purpose	Required Sensor	Necessity
Wind Velocity & Wind Direction	To measure and process **Instantaneous and Average Wind Velocity and Direction**	Anemometer	○
Air Temperature	To measure **Air Temperature** for general purpose	Thermometer	○
Road Temperature	To mainly detect **Ice Road**	Road Surface Thermometer	×
Rainfall	To measure and process **Hourly Rain** and **Accumulated Rain**	Rainfall Gauge	○
Visibility	To detect **Dense Fog**	Visibility Meter	○

Source: Consultant of the New NH3 Project

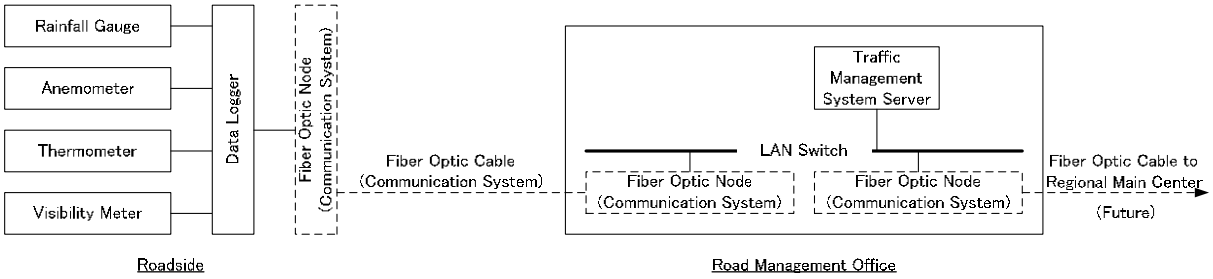
In the project, an anemometer, a thermometer, a rainfall gage and a visibility meter are proposed to be installed for collecting necessary weather information.

According to the JICA draft ITS Standard, weather sensors must be installed every 40km along the expressway network, and the actual weather conditions on the highway may little differ depending on the location. However, the total length of the New NH3 is less than 62 km, and weather sensors will be also provided on the expressway connected with the New NH3 such as NH18 and NH1A. Therefore, meteorological sensors will be placed at one place, beside the New NH3 Road Management Office (KM38+600), in initial stage.

All measured or average data shall be sent to traffic management system server equipped with weather data server function from weather roadside equipment through fiber optic cable network. Transmitted data shall be processed, stored, retrieved in the server and monitored on a display.

(2) Weather Monitoring System Configuration

Figure 3.7 Weather Monitoring System Configuration



Source: ITS Integration Project (SAPI) Study Team

(3) Basic Specifications for Weather Monitoring System

- **Rainfall Gauge**
  - Measuring Range: Measurable min 200 mm/h
  - Sensitivity: 0.5 mm
  - Accuracy : Max ±0.5mm (up to 20mm/h), Max ±3% (more than 20mm/h)
- **Anemometer**
  - Measurement range: Wind velocity 2 - 50 m/sec in units of 0.1 m/sec

    Wind direction16 directions
  - Accuracy: within±3%
- **Thermometer**
  - Measuring range: - 10 to 60 degree centigrade
  - Resolution : 0.1 degree -10 to 60 degree centigrade
  - Accuracy: ±0.2 centigrade (at +20 degree centigrade)
- **Visibility Meter**
  - Measuring Range : Meteorological Optical Range(MOR) 10m - 2,000m
  - Accuracy: ±10% (up to 2,000m)
- **Data Logger**

The data logger shall have following main functions;

- To collect observed data from each sensor
- To convert raw data obtained from each sensor to the format which is able to process statistically.
- To calculate and store average, maximum, minimum values for wind speed, visibility, temperature and accumulated amount of precipitation based on the 5 minutes

observed data

- To transmit the data to the road management office through fiber optic cable upon request/configured setting interval

- **(Traffic Management System Server)**

According to the JICA draft ITS standard, weather data generated by data logger is monitored and stored in the Weather Data Server. In case of the New NH3, such weather data handling functions should be equipped in the Traffic Management System Server considering the number of weather roadside equipment to be monitored and future functional transition to the Northern Regional Main Center. The Traffic Management System Server shall have following minimum weather data handling functions;

- To collect the processed data from data logger at regular interval (at least 5-minute interval)
- To compile the processed data into database and search
- To detect warning weather condition by comparing with the preset threshold and alert with buzzer displayed on screen
- To monitor operating conditions of the sensors and identify the failures when occurs

- **Future Expansion**

The system shall be capable of transmitting the weather data to Weather Data Server installed in the Northern Regional Main Center in future with suitable data set/elements specified in the JICA draft ITS standard.

3) CCTV Monitoring System

(1) Basic Functions of CCTV Monitoring System

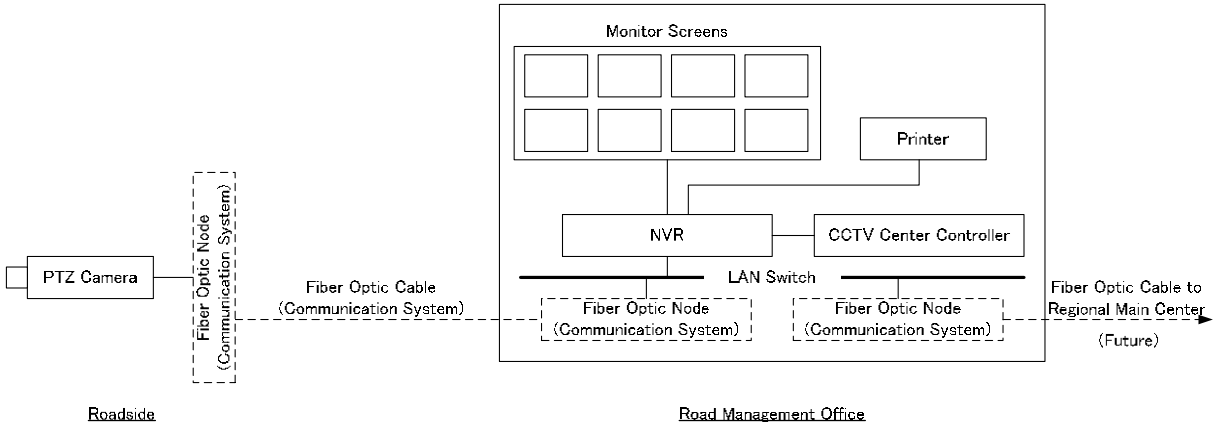
The CCTV monitoring system provides visual image of the road and traffic conditions on the highway around camera location. The system is useful for road operator to confirm visually the situation on the highway. If an incident occurs within the coverage area of camera, confirmation in detail becomes possible and countermeasure such as lane control can be implemented. Hazardous conditions such as low visibility due to fog or heavy rain are also detected by the camera and drivers can be advised to take precautions through the variable message sign.

The CCTV monitoring system consists of CCTV camera at roadside, CCTV center controller, NVR (Network Video Recorder), monitor screens and printer at the Road Management Office. CCTV camera image from roadside shall be transmitted to the Road Management Office through fiber optic cable network. MPEG-4 format shall be applied to digital video encoding protocol to reduce the network traffic of transmission system. PTZ camera, which has zoom and pan-tilt functions to cover wider area and long distance for monitoring whole sections of main carriageway, will be introduced in the Project. A total of 8 sets of monitor screen will be provided in the Road Management Center. Considering the

future expandability to transfer video image on the New NH3 to the Northern Regional Main Center, NVR as a CCTV control and recorder device will be deployed to secure the interoperability and reduce the network traffic.

(2) CCTV Monitoring System Configuration

Figure 3.8 CCTV Monitoring System Configuration



Source: ITS Integration Project (SAPI) Study Team

(3) Arrangement Plan of CCTV Camera Equipment

In the previous ITS basic plan for the New NH3, CCTV camera is proposed to be installed at diverting and merging points near interchange only since;

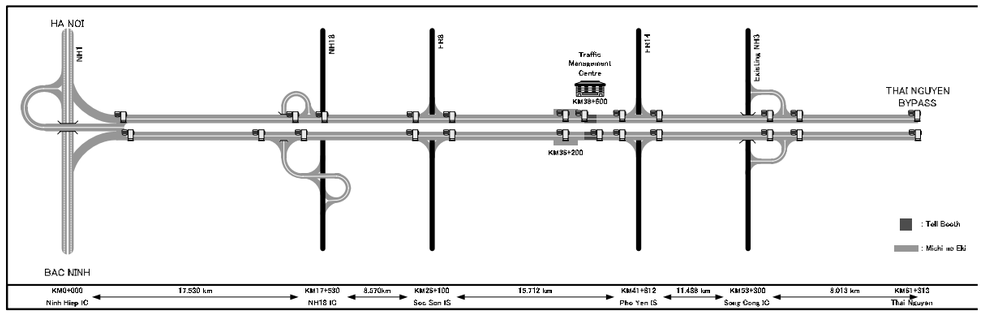
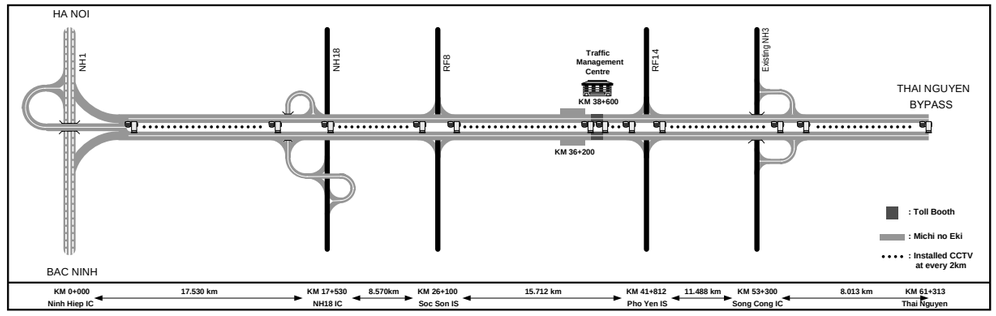
a) The New NH3 doesn't have continuous lighting system. Therefore, it may be possible that CCTV monitoring system could not be effectively working due to lack of required illuminance, even if the CCTV camera is installed at the interval of 2km.

b) Power supply system are planned only to cover surrounding areas of interchanges, toll barrier and michi-no-eki where lighting system and ITS facilities will be placed. In case the CCTV camera is installed at the interval of 2km, additional power supply system will be required. It may results in high construction costs.

On the other hand, CCTV camera arrangement throughout the highway with 2 km interval is proposed in the JICA draft ITS Standard.

Table 3.7 shows the comparison between CCTV arrangements proposed by previous ITS basic plan and JICA draft ITS Standard.

Table 3.7 Comparison Table of CCTV Arrangement

CCTV Arrangement	**At diverting and Merging Points Near Interchanges (Previous ITS Basic Plan Report for the New NH3)**		**2km Interval throughout Highway (JICA Draft ITS Standard)**	
Location Map				
Number of CCTV	24 cameras		44 cameras	
Power Supply Method	- Commercial power supply with UPS and generator backup		- Commercial power supply - UPS and generator backup power supply system is provided to CCTV cameras located near the interchanges and toll barrier and michi-no-eki.	
Operation (Incident Notification)	- Diverting and Merging Points: Normally monitored by CCTV - Through Lane: Based on the report from the site (patrols/users)	△	- Entire Highway: Monitored by CCTV	○
Covering Range	- It is limited to the diverting and merging points	△	- It can cover the entire highway	○
Visibility at Night	- Clear because lighting facilities are located nearby	○	- Visibility at night on the sections between ICs can not be assured because lighting facilities are not located. However, even under such condition, CCTV camera is still effective at identifying severities of incidents by monitoring of vehicle light or tail-lamp	○
Power Interruption	- CCTV can continuously work in case of power interruption because generators are prepared nearby (however it shall be noted that the visibility becomes restricted in case of power interruption at night because the generators are not prepared for lighting facilities.)	○	- Monitoring at midway of interchanges is limited during power interruption. - CCTV located the interchanges and toll barrier and michi-no-eki can continuously work even in case of power failure.	○
Cost	- Construction cost is reasonable	○	- Construction cost becomes higher because of number of cameras and power supply facilities for all cameras. However, costs for power supply system can be minimized for exclusively feeding commercial power to CCTV cameras at midway of the highway without backup power supply.	△
Recommendation	**Average**		**Recommended**	

Source: ITS Integration Project (SAPI) Study Team

As a comparison result, CCTV camera arrangement installed at each 2km interval on main carriageway is recommended with following reasons;

- According to the MOT decision No.2503/BGTVT-KHCN dated 4 May 2011, utilization of IP digital camera with high resolution is more and more popular due to reasonable price and its remarkable advantages in image centralization recording and traffic management.
- Incident notifications on entire highway are possible.
- Even under the conditions in heavy rain, darkness or the night, CCTV camera is still effective at identifying severities of incidents by monitoring of vehicle light or tail-lamp.
- Power supply system can be provided with low construction costs for exclusively feeding commercial power to CCTV cameras located at midway between interchanges without backup power supply.

Proposed location plan of CCTV camera becomes as **Table 3.8** and **Figure 3.9**. The location of CCTV camera is set up by considering the following actual road conditions on the New NH3:

a) Location of toll barrier, interchanges and merging/diversion sections where most attentions for road operation must be paid on the highway,

b) Horizontal and vertical alignment of the highway,

c) Location of flyover or others which will be visual obstacle for CCTV monitoring, and

d) Manhole position to connecting fibre optic cable with CCTV Camera for transmitting CCTV image to Road Management Office.

Total of 44 PTZ cameras including 4 cameras for exclusively monitoring toll barrier and michi-no-eki will be provided in the New NH3 Project.

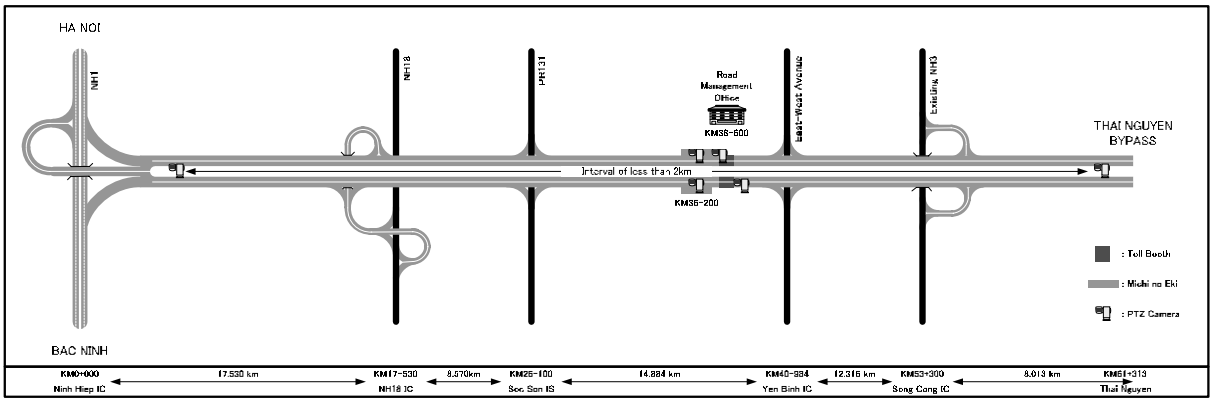
Table 3.8 CCTV Camera Location

No.	Location	Distance (km)	Type	Remarks	No.	Location	Distance (km)	Type	Remarks	No.	Location	Distance (km)	Type	Remarks
1	KM 0+785.0	0.79	PTZ		16	KM 23+350.0	2.00	PTZ		31	KM 40+400.0	1.35	PTZ	Yen Binh IC Monitoring, Yen Binh IC Ramp(km 40+984)
2	KM 2+355.0	1.57	PTZ		17	KM 25+350.0	2.00	PTZ	Soc Son IC Monitoring, Soc Son IC Ramp (km 26+100)	32	KM 41+400.0	1.00	PTZ	Yen Binh IC Monitoring, Pho Yen Flyover (km 41+812)
3	KM 3+925.0	1.57	PTZ	Flyover 01 (km 4+710)	18	KM 26+500.0	1.15	PTZ	Soc Son IC Monitoring, Flyover 07 (km 26+740)	33	KM 42+692.4	1.29	PTZ	
4	KM 5+225.0	1.30	PTZ	Flyover 02 (km 5+740)	19	KM 27+735.6	1.24	PTZ		34	KM 44+453.1	1.76	PTZ	
5	KM 6+410.0	1.19	PTZ		20	KM 29+726.7	1.99	PTZ		35	KM 46+213.9	1.76	PTZ	
6	KM 7+750.0	1.34	PTZ	Flyover 03 (km 8+420)	21	KM 31+717.8	1.99	PTZ		36	KM 47+974.6	1.76	PTZ	Fedder Road 17 Flyover (km 48+885)
7	KM 9+298.5	1.55	PTZ	Flyover 04 (km 10+177)	22	KM 33+708.9	1.99	PTZ		37	KM 49+708.0	1.73	PTZ	
8	KM 10+700.3	1.40	PTZ		23	KM 35+700.0	1.99	PTZ	Service Area Diversion Section	38	KM 51+354.0	1.65	PTZ	
9	KM 11+746.8	1.05	PTZ	Flyover 05 (km 12+270)	24	KM 36+200.0	-	PTZ	Service Area (Northband)	39	KM 53+000.0	1.65	PTZ	Song Cong IC Ramp (km 53+122)
10	KM 12+945.0	1.20	PTZ	Flyover 06 (km 13+620)	25	KM 36+200.0	-	PTZ	Service Area (Southband)	40	KM 53+700.0	0.70	PTZ	
11	KM 14+580.0	1.64	PTZ		26	KM 36+600.0	0.90	PTZ	Service Area Diversion Section, Flyover 08 (km 37+200)	41	KM 55+671.4	1.97	PTZ	
12	KM 16+500.0	1.92	PTZ	NH18 IC Monitoring, NH18 IC Ramp (km 16+850)	27	KM 37+850.0	1.25	PTZ		42	KM 57+642.9	1.97	PTZ	
13	KM 17+350.0	0.85	PTZ	NH18 IC Monitoring	28	KM 38+500.0	-	PTZ	Toll Plaza (km 38+600)	43	KM 59+614.3	1.97	PTZ	Flyover 10 (km 60+600.0)
14	KM 19+350.0	2.00	PTZ		29	KM 38+700.0	-	PTZ	Toll Plaza (km 38+600)	44	KM 61+100.0	1.49	PTZ	Ending Point (km 61+313.2)
15	KM 21+350.0	2.00	PTZ		30	KM 39+052.5	1.20	PTZ	Flyover 09 (km 39+405)					

Note PTZ: Camera with Pan-Tilit-Zoom functions

Source: ITS Integration Project (SAPI) Study Team

Figure 3.9 Location Map for CCTV Monitoring System



Source: ITS Integration Project (SAPI) Study Team

(4) Other Considerations on CCTV Monitoring System

- **Power Supply System**

As mentioned earlier, power supply system in the New NH3 Project is currently proposed only to cover surrounding areas of interchanges, toll barrier and michi-no-eki where lighting system and ITS facilities will be located. Therefore, additional power supply system must be provided to feed commercial power to CCTV camera placed at midway between interchanges, toll barrier and/or michi-no-eki.

Following three (3) alternatives for supplying power to CCTV camera are considerable;

Alternative-1: Feeding from power supply system at interchange,

Alternative-2: Feeding from newly constructed power supply system for each CCTV camera with backup power supply system, and

Alternative-3: Feeding from newly constructed power supply system for each CCTV camera without backup power supply system.

Comparison of alternatives for power supply system is summarized as table below. Considering the cost effectiveness, alternative-3 is proposed as power supply system to CCTV camera placed at midway.

Table 3.9 Comparison of Power Supply System to CCTV Camera at Midway

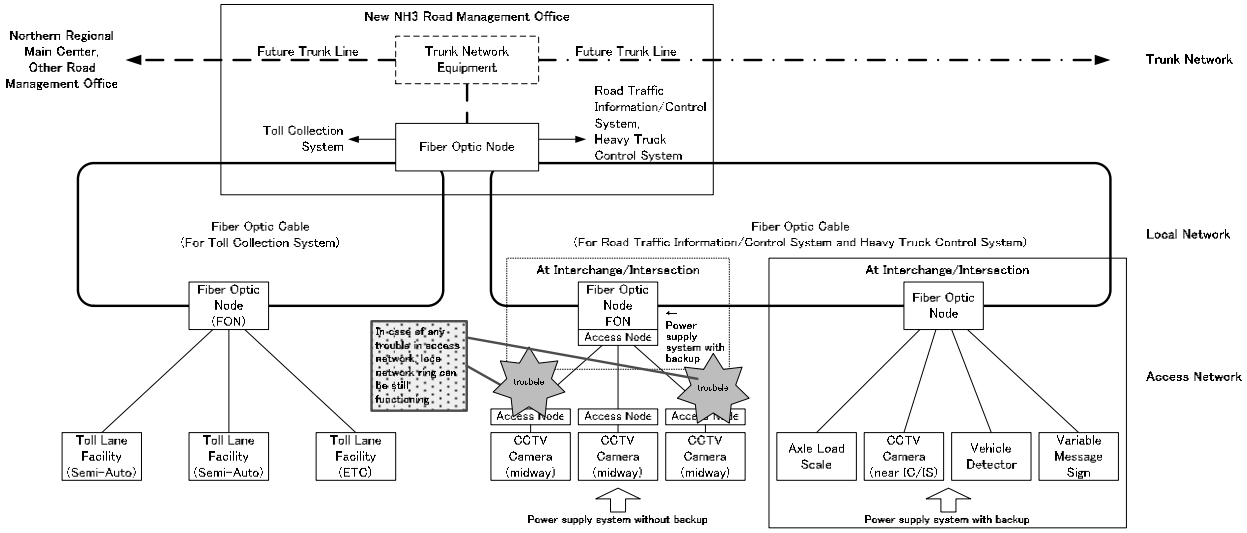
Items \ Alternatives	Alternative-1 Power supply from interchange	Alternative-2 Additional power supply system with backup	Alternative-3 Additional power supply system without backup
1. Outline	Electricity is fed from power supply system with backup (UPS and DEG) installed at interchange.	Electricity is fed from newly constructed power supply system with backup (UPS and DEG) at each CCTV camera location.	Electricity is fed from newly constructed power supply system without backup at each CCTV camera location.
2. Required Equipment	- Power cable and PVC cable from nearest interchange - UPS and DEG at interchanges (increased capacity is required)	- Down step transformer at each camera location - UPS and DEG at each camera location	- Down step transformer at each camera location
3. Advantage	- CCTV monitoring is available even during commercial power interruption	- CCTV monitoring is available even during commercial power interruption	- Construction cost is cheaper than other alternatives
4. Disadvantage	- Voltage drop must be considered due to long distance feeder. - Additional conduit system is necessary along the expressway - Large capacity UPSs and DEGs are required at interchanges	- UPS and DEG is additionally required at each camera location - Construction costs will be quite high	- In case of power failure, CCTV image at midway between interchanges cannot be monitored in Road Management Office.
5. Cost	High	High	Low
Recommendation	Average	Average	Recommended

Source: ITS Integration Project (SAPI) Study Team

- **Communication System**

As well as power supply system, structure and hierarchy of communication system for connecting CCTV camera must be considered to secure the total network reliability. The roadside equipment on the New NH3 such as CCTV camera, VMS, traffic detector is connected by firer optic cable of which network configuration is applied to flattened ring topology. Though Gigabit/10Gigabit Ethernet with Resilient Packet Ring (RPR) having fail-over function, which can guarantee connectivity even if one communication node or fibre optic cable is down, will be employed as communication system of the New NH3, the communication system will not be functioning in case two or more communication node be in failure caused by wide area blackout. Avoiding whole network failure and securing the data transmission reliability, CCTV camera network must be separately configured with other ITS facilities by using access node 1:1 connection with Fibre Optic Node (FON). Following figure illustrates proposed network configuration of the New NH3.

Figure 3.10 Proposed Network Configuration for CCTV Camera



Source: ITS Integration Project (SAPI) Study Team

(5) Basic Specifications for CCTV Monitoring System

- **CCTV Camera**
  - Camera type: PTZ (Pan, Tilt, Zoom) IP digital camera
  - Image device: CCD or CMOS Sensor
  - Video compression: MPEG-4 Part2, Part10, AVS
  - Lowest illuminance: 0.5lx or less
  - Lens: Zoom lens (>20x optical)
  - Camera platform: Panning +/- 170 degrees, Tilting: 100 degrees or more
  - Camera housing: To be equipped (Equivalent to IP66)
- **NVR**

NVR shall have following functions.

- To select any camera image to be displayed on monitor screen
- To receive camera control signal from CCTV center controller and send it to the CCTV camera
- To generate character to indicate camera location over the video image
- To record the video image from any of the camera with suitable storage capacity
- To capture CCTV camera images as still picture
- To encode the video image into suitable format to monitor it on the display panel and monitoring PC

- **CCTV Center Controller**

CCTV center controller shall have various control functions including camera selection, pan-tilt head control, monitor TV control and video control. The operator console shall be of PC type.

- **Monitor Screen**

A total 8 sets of monitoring screen shall be provided at the Road Management Office. The size of the monitor screen shall be 20 inch or larger and LCD type TV shall be adopted.

(6) Future Expansion

The system shall be capable of transmitting the video image data to the Northern Regional Main Center and controlling CCTV camera at roadside from the Regional Main Center via NVR in future.

4) Heavy Truck Control System

Passing heavy vehicles causes damage to the structure and pavement, the vehicle with illegal weight are not allow to use public road as regulated by Circular 07/2010/TT-BGTVT and shall be penalised according to Decree 34/2010/ND-CP. The overload monitoring system shall be introduced in the project to measure the weight of vehicles using the highway in order to control the vehicles and protect the highway.

(1) Arrangement Plan of Axle Load Scale

a) Location

Following four (4) alternatives are set up as axle load scale location applied to the New NH3.

- Alternative-1: All deceleration lanes of interchanges
- Alternative-2: Closely back from toll barrier
- Alternative-3: All acceleration lanes of interchanges
- Alternative-4: Deceleration lanes of interchanges excepting NH1 and NH18

The comparison of alternatives is summarized as **Table 3.10** with following considerable factors;

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

horizontal angle: within 5 degree
vertical angle: within 10 degree

- Necessity of large land acquisition for rejecting overloaded vehicle
- Enforcement of overloaded vehicle on all expressway sections
- Effects of rejecting overloaded vehicles from the expressway
- Cost effectiveness

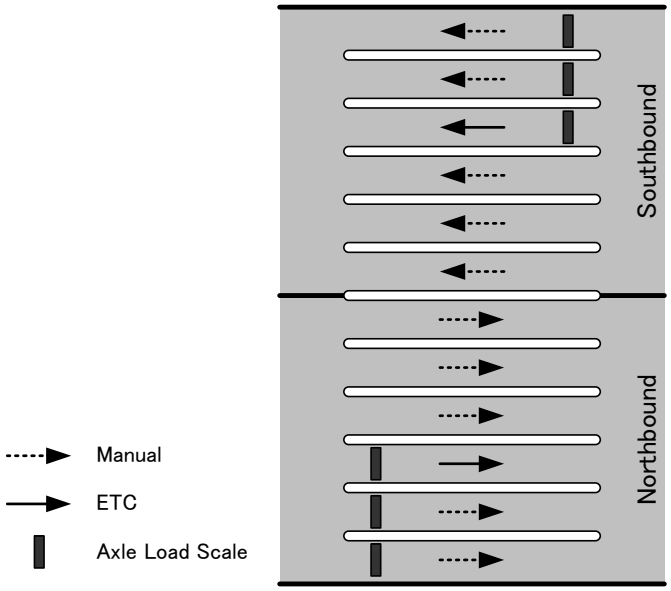
As a study result, the location closely back from toll barrier (Alternative-2) is most recommendable for axle load scale applied to open system considering its advantages such as keeping measuring accuracy, easiness to secure the land for rejecting overloaded vehicle, and cost effectiveness.

b) Proposed Arrangement of Axle Load Scale

An arrangement plan of axle load scale on toll barrier for the New NH3 is set up in accordance with JICA draft ITS Standard.

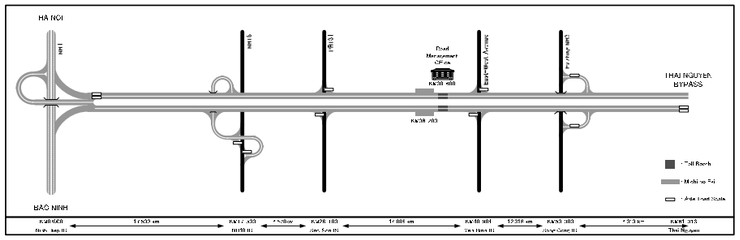
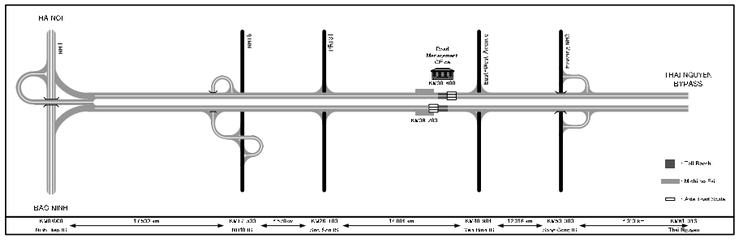
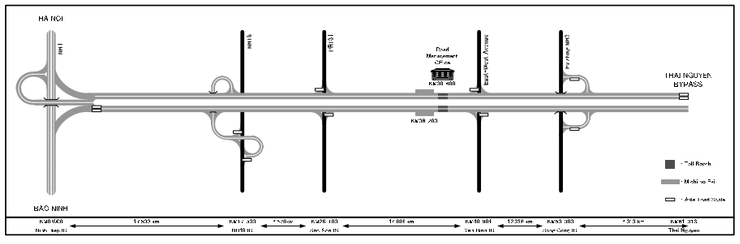
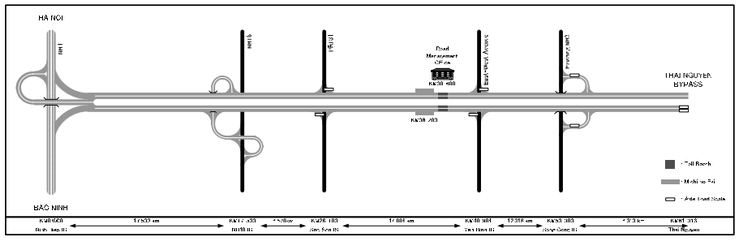
- Axle load scales are installed on three (3) lanes near the roadside of the toll barrier in each direction.
- Vehicles equipped for ETC can be processed at the third lane from the roadside.
- Vehicles not equipped for ETC can be processed at the first or second lanes from the roadside.

Figure 3.11 Arrangement Plan of Axle Load Scale on Toll Barrier



Source: ITS Integration Project (SAPI) Study Team

Table 3.10 Comparison on Axle Load Scale Location

Items / Alternatives	Arrangement Plan	Measuring accuracy: Tire passing track	Measuring accuracy: Driving speed of vehicle	Measuring accuracy: Angle between lane direction and vehicle driving direction	Measuring accuracy: Angles of license-plate number fixing to the vehicle	Necessity of large land acquisition	Enforcement of overloaded vehicle on all expressway sections	Effects of rejecting overloaded vehicles from the expressway	Cost effectiveness: Number of Axle Load Scale	Cost effectiveness: Cost	Recommendation
Alternative-1 All deceleration lanes of interchanges		Difficult (No lane barrier on deceleration lanes)	Over measuring range (Max. 50km/h)	Difficult to keep measuring range (No lane barrier on deceleration lanes)	Difficult to keep measuring range, especially vertical angle	Necessary	Possible	Average	12	High	Not Suitable
Alternative-2 Closely back from toll barrier		Capable	Less than 40km/h	Within 5 degree	Within measuring range	Not Necessary	Possible	High	6	Low	Recommended
Alternative-3 All acceleration lanes of interchanges		Difficult (No lane barrier on acceleration lanes)	Over measuring range (Max. 50km/h)	Difficult to keep measuring range (No lane barrier on acceleration lanes)	Difficult to keep measuring range, especially vertical angle	Necessary	Possible in case axle road scales are installed on all connecting expressways and arterial roads	Average	12	High	Not Suitable
Alternative-4 Deceleration lanes of interchanges excepting NH1 and NH18		Difficult (No lane barrier on deceleration lanes)	Over measuring range (Max. 50km/h)	Difficult to keep measuring range (No lane barrier on deceleration lanes)	Difficult to keep measuring range, especially vertical angle	Necessary	Possible in case axle road scales are installed on NH1 and NH3	Average	8	Average	Not Suitable

Source: ITS Integration Project (SAPI) Study Team

(2) Basic Functions of Heavy Truck Control System

The axle load scale shall be placed at toll barrier on both directions to detect the overweight vehicles. The system shall have the following function;

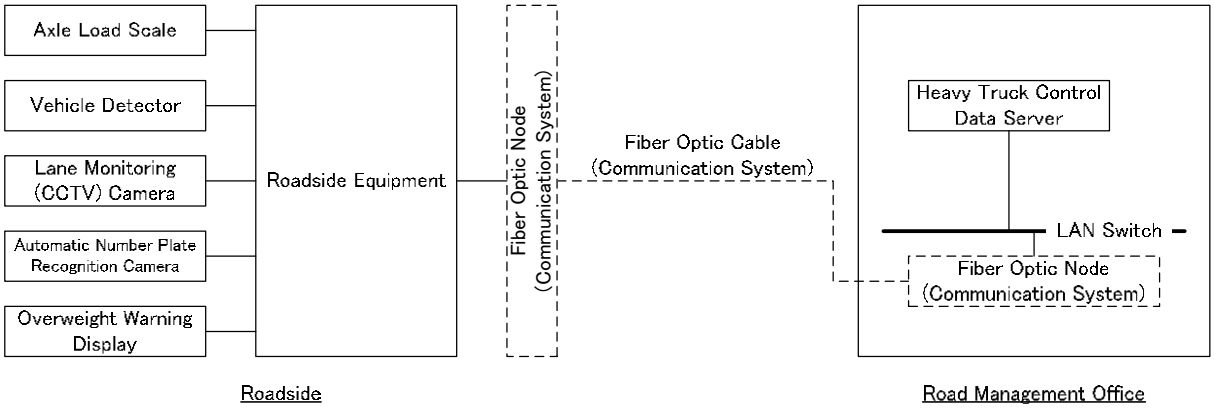
- To measure axle weight of vehicle and calculate total weight automatically,
- If the measured axle weight or total weight of the vehicles exceeds the allowable maximum weight, the lane camera temporally records video image of the passing vehicles,
- If overloaded, the automatic number plate recognition camera memorizes the plate number as well,
- The video image and plate number recorded at roadside are promptly sent to the Road Management Office, and warning alarm and messages are provided to the traffic inspector,
- The system accumulates the records for statistics

The weigh-in-motion (WIM) type axle load scale shall be used for this highway, because of its advantage that the vehicles are not necessary to stop on the sensor so that many vehicles can be measured without causing inconvenience to the traffic flow.

(3) Heavy Truck Control System Configuration

The heavy truck control system consists of axle load scale, vehicle detector, lane monitoring camera, automatic number plate recognition camera (ANPR), overweight warning display and roadside equipment installed at toll barrier, and heavy truck control data server at the Road Management Office.

Figure 3.12 Heavy Truck Control System Configuration



Source: ITS Integration Project (SAPI) Study Team

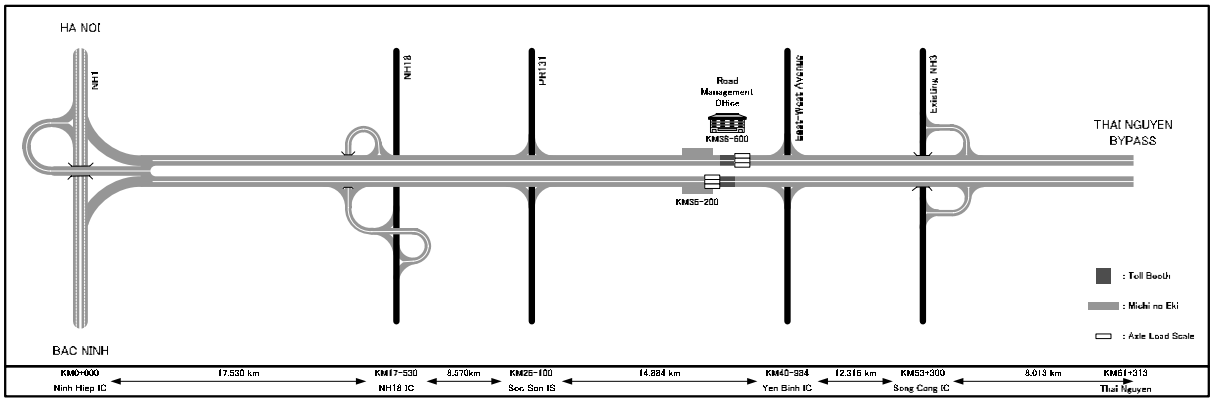
(4) Location of Axle Load Scale

Table 3.11 Axle Load Scale Location

No.	Location	Bound	Number of Lane	Remarks
1	KM 38+600	Northbound	3	Toll Barrier
2	KM 38+600	Southbound	3	Toll Barrier

Source: ITS Integration Project (SAPI) Study Team

Figure 3.13 Location Map for Heavy Truck Control System



Source: ITS Integration Project (SAPI) Study Team

(5) Basic Specifications for Heavy Truck Control System

- **Overall Functions**

Followings are overall functions of the heavy truck control system as minimum;

- Weight measurement
- Vehicle detection
- Axle distance measurement
- Video image monitoring
- Photo taking (Number plate recognition)
- Excess weight detection and alarm
- Error detection and alarm
- Local control operation
- Data transmission to the Road Management Office
- Data recording and operation logging at the Road Management Office
- Operation and malfunction report

- **Measurement**

The heavy truck control system shall be capable of measuring and calculating each axle, total weight, distance between two adjacent axles and vehicle speed. The measurement accuracy shall be within the range of +/- 10% for 95 % of vehicles measured. Allowable vehicle passing speed shall be 20 to 40 km/h.

- **Type of axle load scale**

The sensor of axle load scale shall be piezoelectric sensor.

- **Lane Monitoring Camera and Automatic Number Plate Recognition Camera**

The lane monitoring camera shall be installed to monitor and record the overweight vehicle with color. The automatic number plate recognition camera shall also be used to take photo of the vehicles judged over loaded automatically. Infrared type camera may be used. Signal from the vehicle detector shall be used as timing signal for photo.

- **Future Expansion**

After introduction of closed system access control to the New NH3 in future, the axle load scale shall be additionally installed at each exit tollgate on interchanges in order to detect and enforce the overloaded vehicle strictly.

5) Mobile Radio Communication System

(1) Basic Functions of Mobile Radio Communication System

The mobile communication radio system is to be introduced for voice communication between the Road Management Office and personnel engaged in the highway operation and maintenance who are on the highway or other locations. The system shall cover the entire highway with high quality communication. There are two types of mobile radio communication system to be applied as show in table below.

Table 3.12 Comparison of Mobile Radio Communication System

Type / Item	Use Exclusive Line (VHF or UHF band)	Use Mobile Phone by Telecommunication Carrier
Cover Area	Cover Entire Highway (To be confirmed) ○	Cover Entire Highway ○
One-to-Many Communication	Possible ○	Impossible △
Reliability	High ○	Low △
Frequency Allocation	Required △	Not Requierd ○
Initial Cost	High △	Low ○
Running Cost	Low ○	High △
Recommendation	◎	△

Source: Consultant of the New NH3 Project

In order to provide high reliable communication, it is recommended that an exclusive VHF (Very High Frequency) or UHF (Ultra High Frequency) band will be used as the frequency of mobile radio communication in conformity to existing lows and regulations regarding radio wave transmission in Vietnam. The system can also provide one-to-one and one-to-many communications. Digital transmission technology shall be used for its advantages over the conventional analog type.

(2) Mobile Radio Communication System Configuration

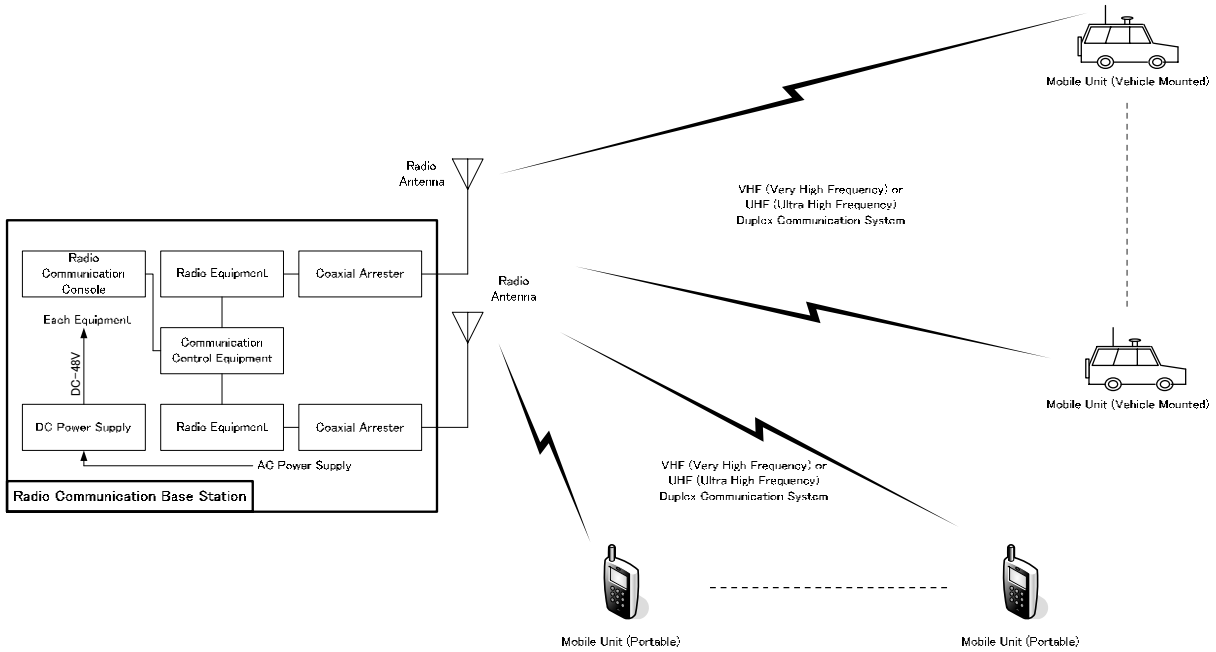
The system will consist of 1 radio communication base station to be installed at the Road Management Office, 20 vehicle mounted mobile units and 20 portable mobile units. Additional base station may be required to cover the entire highway.

Table 3.13 Mobile Radio Communication System Component

No.	System Component	Location	Quantity	Remarks
1	Radio Communication Base Station	Road Management Office	1	Including Control Equipment
2	Mobile Unit (Vehicle Mounted Type)	-	20	
3	Mobile Unit (Portable Type)	-	20	

Source: Consultant of the New NH3 Project

Figure 3.14 Mobile Radio Communication System Configuration



Source: Consultant of the New NH3 Project

(3) Basic Specifications for Mobile Radio Communication System

- **Overall functions**

Followings are overall functions and requirements of the mobile radio communication system as minimum;

- Quality of communication indicated by S/N ratio measured with standard modulation shall be better than 25 dB. The standard modulation is defined as shift of 1.75 kHz against the input signal of 1 kHz.
- One-to-one, one-to-many communications shall be possible.
- ID data shall be automatically transmitted every time call is made.
- Mobile units both vehicle mounted type and portable type shall be equipped with

GPS and the system has a vehicle tracking function.

- Portable units shall be rain proof.

- **Radio Communication Base Station**

The radio communication base station consists of radio equipment (transmitter and receiver), antenna, coaxial arrester, communication control equipment and radio communication console. Two sets of transmitter and receiver shall be installed as hot standby system.

The radio communication console equipped with microphone shall have such functions as to select and communicate with any mobile unit or mobile unit group to be preset, select transmitter and receiver (No.1/No.2) to be used, track vehicle location, and log operation record through the communication control equipment. The yagi-type antenna will be used to transmit the radio effectively. The coaxial arrester shall be installed to protect the equipment from lightning surge. The power supply to the each equipment shall be made from DC power supply with battery having enough capacity to supply power until the emergency generator starts.

- **Mobile Unit**

Both vehicle mounted type and portable type mobile units with battery charger shall be provided. The mobile unit shall be of compact size and light in weight in consideration of the usability.

6) Variable Message Sign System

(1) Basic Functions of Variable Message Sign System

The variable message sign (VMS) system is introduced to provide highway users with road and traffic condition information such as accident, weather condition, congestion in order to assist highway users driving. Generally, following types of VSM are existed.

Table 3.14 Types of Variable Message Sign (VMS)

Item	Objective	Necessity
VMS for Ingress	● To inform the road, traffic and weather conditions on highway to drivers who intend to use the highway in advance and allow them to determine whether to use the highway.	○
VMS for Egress	● To promptly inform road closure to drivers who are on highway, when highway is closed due to an accident or other reasons and have them exit from the interchange. ● To inform drivers of the road conditions on highway ahead of them and advise them to drive carefully.	○
Toll Gate & Barrier VMS	● To inform drivers of the road conditions on highway ahead of them.	△ (Future)
Travel Time VMS	● To inform travel time from VMS point to major destinations.	△ (Future)
Graphic Information VMS	● To inform congestion on highway to make drivers select most suitable route.	△ (Future)

Source: Consultant of the New NH3 Project

In consideration of the level of user services, VMS only for ingress and egress would be introduced in the initial stage, since the VMS is much expensive facility. Therefore, other types of VMS such as the travel time display and graphic information display shall be installed in future.

Message indication of variable message sign can be changed by the signal from VMS center controller in the Road Management Office through fiber optic cable network. Three message composition methods shall be provided; (1) manual input, (2) combination of preset words, and (3) selection of preset message for the system. In case the manual input, any text message input (but the length of message is limited) by the operator through keyboard of operator console will be displayed on the VMS board. In case the combination of preset words, frequently words or phrase such as “accident”, “strong wind”, “construction work” will be preset in the VMS central controller and operator chooses these words to compose a message. Preset message selection method allows the operator easily to select one of the preset messages which is predefined and stored in VMS central controller. All messages indicated on VMS shall be in both English and Vietnamese. Followings are example of the message.

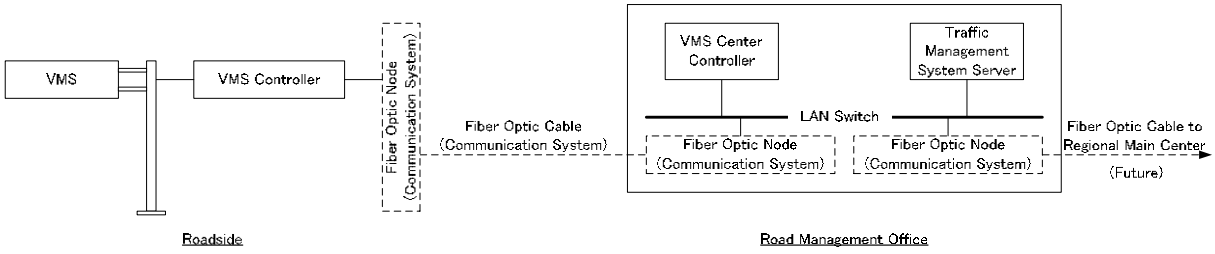
Table 3.15 The Example of Message on VMS

Location	Incident	Action
From here	Accident	Closed
____km ahead	Construction work	Slow down
____interchange	Congestion	Be careful
Right / Left lane	Men at work	Exit
Tunnel	Stalled vehicle	Use right / left lane
Bridge	Fallen Object	Keep distance
Ha Noi	Rain	Turn on light
Thai Nguyen	Heavy rain	
NH 18	Strong wind	
FR 17	Fog	
	Heavy Fog	
	Fire	
	Slow moving vehicle	

Source: Consultant of the New NH3 Project

(2) VMS System Configuration

Figure 3.15 VMS System Configuration



Source: ITS Integration Project (SAPI) Study Team

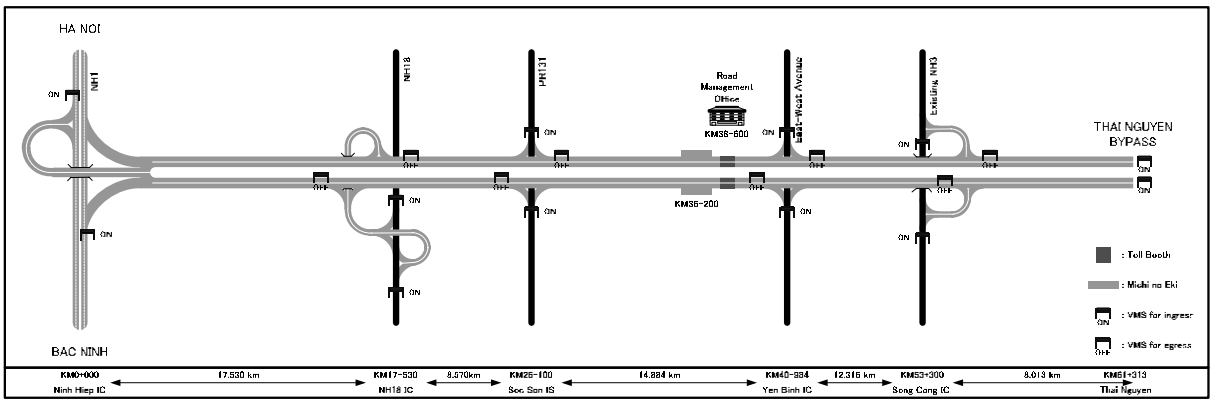
(3) Location of Variable Message Sign Board

Table 3.16 Variable Message Sign Board Location

No.	Location	Bound	Remarks	No.	Location	Bound	Remarks
1	NH1	From east side	Ninh Hiep IC Entrance	11	KM 40+500	Northbound	Yen Binh IC Exit
2	NH1	From west side	Ninh Hiep IC Entrance	12	FR14	From east side	Yen Binh IC Entrance
3	KM 16+220	Northbound	NH18IC Exit	13	FR14	From west side	Yen Binh IC Entrance
4	NH18	From east side	NH18 IC Entrance	14	KM 41+500	Southbound	Yen Binh IC Exit
5	NH18	From west side	NH18 IC Entrance	15	KM 52+900	Northbound	Song Cong IC Exit
6	KM 17+560	Southbound	NH18 IC Exit	16	Existing NH3	From north side	Song Cong IC Entrance
7	KM 25+200	Northbound	Soc Son IC Exit	17	Existing NH3	From south side	Song Cong IC Entrance
8	FR8	From east side	Soc Son IC Entrance	18	KM 53+800	Southbound	Song Cong IC Exit
9	FR8	From west side	Soc Son IC Entrance	19	Existing NH3	From north side	Thai Nguyen IC Entrance
10	KM 27+ 0	Southbound	Soc Son IC Exit	20	Existing NH3	From south side	Thai Nguyen IC Entrance

Source: Consultant of the New NH3 Project

Figure 3.16 Location Map for VMS System



Source: Consultant of the New NH3 Project

(4) Basic Specifications for VMS System

- **Variable Message Sign (VMS)**

High Intensity LED (Light Emitting Diode) shall be used as lighting source in consideration of efficiency and small power consumption. A display panel shall be of unit construction using LED matrix unit. The display panel shall indicate 2lines or more and each line shall be capable of indicating 24 characters. Character height shall be more than 450mm and width shall comply with the standard of 22-TCN-331-05 Road Signs on Highway.

- **VMS Controller**

Followings are minimum requirements of VMS controller installed in the VMS:

- To receive display data from VMS center controller and send back the operating status data,
- To control VMS display based on the display data sent from VMS center controller,

- To monitor operating conditions of VMS, and
- To control VMS manually at the site.

- **VMS Center Controller**

VMS center controller consists of data server, data input device, monitor screen, printer and backup media drive, and shall have following functions:

- To compose message by three method, manual input, combination of preset words, and selection of preset message,
- To have interface with operator through data input device,
- To convert text and symbol message to be displayed on VMS into dot image data to control LED display matrix,
- To communicate with VMS controller unit at roadside for message data and operating status data transmission,
- To display and store operating status and issue alarm in case of abnormal condition,
- To record operation log.

- **Future Expansion**

The functions of VMS center controller will be handed over to the Northern Regional Main Center when it is established. The VMS center controller at the New NH3 Road Management Office will be used as the standby system for the case of the system failure at the Northern Regional Main Center.

7) Traffic Management System

(1) Basic Functions of Traffic Management System

The proposed traffic information/control system consists of many system components. The traffic management system manages the total system, encourages data exchange between the systems in order to realize fully their functions and achieve the overall objectives of the traffic information/control system. The system shall have the following basic functions;

- To manage and integrate all information regarding road and traffic conditions, incidents and highway operation
- To manage the all information related to operation status of each system component
- To display and share the information mentioned above among the operators
- To process, store and record the necessary data for effective highway operation
- To disseminate the information converted appropriate data to the operators in the Road Management Office or other places

- To synchronize all clocks used among each system

The traffic management system consists of traffic management system server, facility management server, display panel, etc. installed at the Road Management Office.

The traffic management system server is central equipment of the traffic management system and to collect, process, store, record and display the information regarding road and traffic conditions, incidents and highway operation. The facility management server is to monitor the operation status of the each system facility.

The display panel and controller are used for a purpose of sharing the traffic information among the personnel at the Road Management Office. The equipment shows the information on the current traffic condition, facility operation status and any other information on the image of highway map on the screen.

(2) Traffic Management System Components

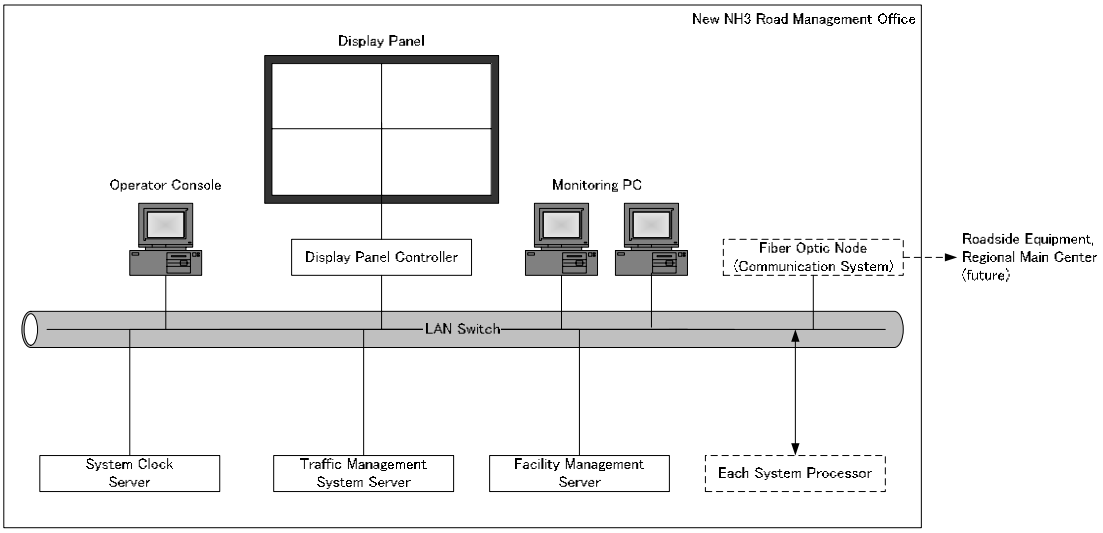
Table 3.17 System Components of Traffic Management System

No.	System Component	Quantity	Remarks
1	Traffic Management System Server	1	
2	Facility Management Server	1	
3	Display Panel	1	
4	Display Panel Controller	1	
5	System Clock Server	1	
6	Operator Console	1	
7	Monitoring PC	2	

Source: ITS Integration Project (SAPI) Study Team

(3) Traffic Management System Configuration

Figure 3.17 Traffic Management System Configuration



Source: ITS Integration Project (SAPI) Study Team

(4) Basic Specifications for Traffic Management System

- **Traffic Management System Server**

The traffic monitoring system server is central equipment of the traffic management system and shall have the following main functions;

[Incident Management]

This function is to manage the information of all incidents and events related to highway operation as listed below.

- Traffic congestion or incident near off-ramp (vehicle detector system)
- Abnormal weather condition (weather monitoring system)
- Audio information (mobile radio communication system / Internal telephone system)
- Incident information input by operators themselves
- Other incident and event information

The purpose of the function is to share the incident and event information with other staff engaged in the highway and to make record of these incidents. The incident information can be input, updated or deleted by the operators through operator console.

[Provision of Incident Information]

The server shall have a function to distribute the incident information to the driver through variable message sign via VSM system on the basis of the operator's instruction by the operator console.

[Database Management]

The server must handle a large amount of information such as the data listed below.

- Traffic data (traffic volume, vehicle average speed, time occupancy rate, large-sized vehicle traffic)
- Weather data (air temperature, instantaneous wind velocity and direction, average wind velocity and direction, rainfall gauge, visibility)
- VMS display message
- GPS location data of mobile radio communication unit
- Statistic data (daily, monthly, annual data)
- Incident and event information input by operators themselves
- Other data

The server shall have function to process, store and record these data efficiently and

uniformity.

[Display Function]

This function is to display current or passed traffic information, individual system window, etc. on the display panel, operator console and monitoring PCs.

[Information Dissemination]

In order to share the information all staffs engaged in the highway, information dissemination function shall be equipped on the server. All data shall be converted Web data or equivalent so that the information shall be monitored by the display panel, operator console or the monitoring PCs.

[Reporting]

The server shall have a reporting function in which various daily, monthly and annual reports can be prepared with color laser printer. The report will be produced in two modes. In automatic mode, reports will be printed automatically at the timing specified for each report. In manual mode, report is printed when the operator requests it. All reports will be in Vietnamese.

Database management software and highly reliable external storage device shall be introduced for the traffic management system server.

- **Facility Management Server**

The facility management server shall be provided to monitor the operational condition of facilities on the highway. The server shall monitor the operation status of the following component systems;

- Vehicle Detector System
- Weather Monitoring System
- CCTV Monitoring System
- Mobile Radio Communication System
- Variable Message Sign System
- Traffic Management System
- Power Supply System

The role of the server is to consolidate the system operation status monitoring function undertaken by each system component, present the status to operators and record the system operation. In case any abnormality or malfunction is detected, the server shall issue an alarm together with information regarding type and location of the failure so that remedial action can be taken smoothly.

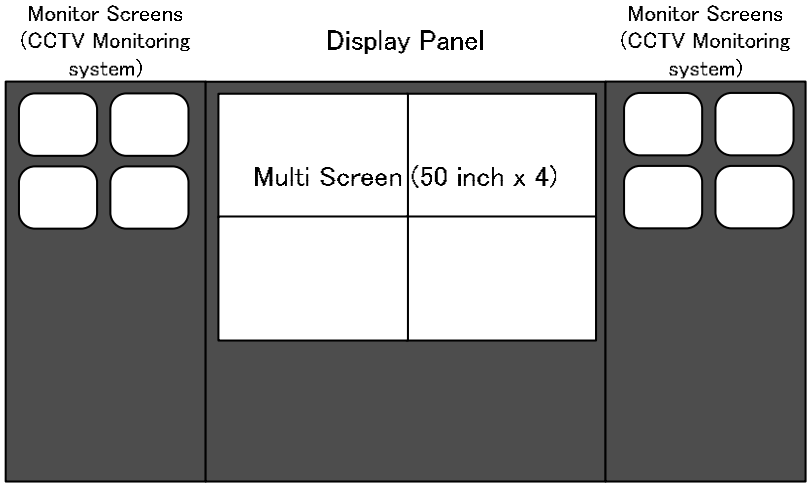
- **Display Panel & Controller**

Display panel and controller are used for a purpose of sharing the traffic information among the personnel at the Road Management Office. The equipment shows the information on the current traffic condition, facility operation status and any other information on the image of highway map on the screen.

The display panel shall be multi screen type and large enough to cover the entire highway. The display shall be comprised of 4 multi screens or more. The size of 1 screen shall be 50 inch or more. Liquid crystal display (LCD) shall be used for the multi screen display in consideration of its image quality, lifecycle time, cost merit, versatility.

The display panel controller shall have functions to control display on the display panel by obtaining the data from traffic management system server or facility management server. The display panel controller shall be PC type. Figure below shows the reference layout image of the display panel.

Figure 3.18 Reference Layout of Display Panel



Source: Consultant of the New NH3 Project

To confirm the traffic information individually, monitoring PCs will be introduced. The monitoring PC provides necessary information for highway operation and management through the servers.

- **System Clock Server**

Each system component will be equipped with a clock system for its operation. These clocks shall be synchronized to collect and process the data correctly. A system clock server will be provided to the traffic management system as a reference clock. All clocks in the system component shall be synchronized with the clock provided by the server using network time protocol (NTP) or simple network time protocol (SNTP).

- **Operator Console**

Operator console will be used to provide the information to operator individually at the Road Management Office. It shows various kind of information in text and graphic. The operator console shall consist of at least 2 sets of personal computer with 20 inch or more

LCD monitor.

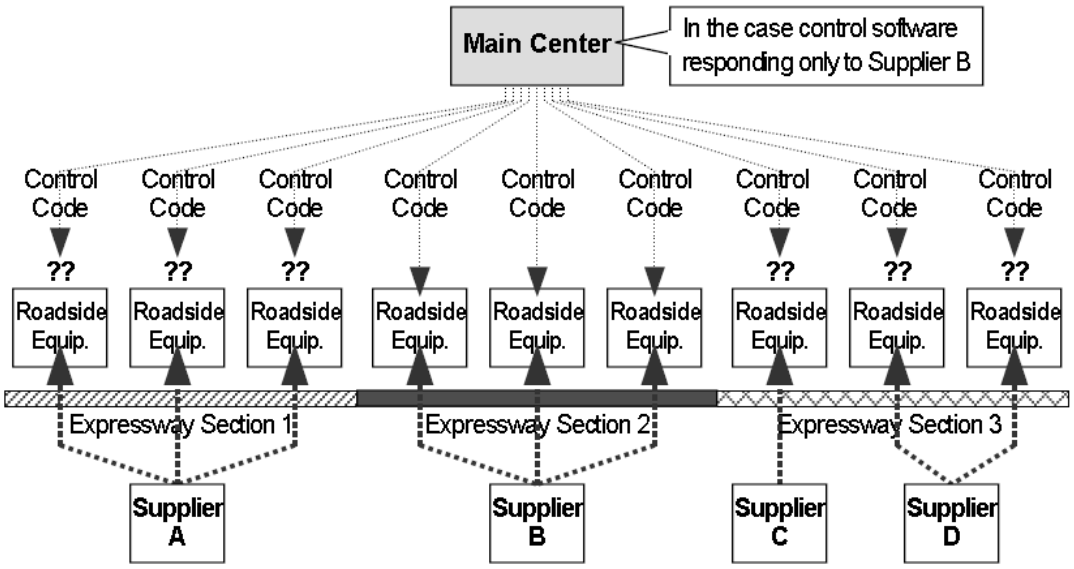
8) Considerations on Future Expandability and Compatibility with the Northern Regional Main Center

As mentioned earlier, the traffic information/control system of the New NH3 to be introduced in Phase-1 will be expanded to connect to the Northern Regional Main Center in Phase-2, accordingly the system must have following future expandability and compatibility with the Regional Main Center.

(1) Integration of Roadside Equipment Control

ITS consists of various system components including roadside equipment, road management office system and the regional main center system. The traffic control and monitoring is to be conducted by controlling the roadside equipment and actual equipment control will be made through control codes transmitted from the road management office and the Regional Main Center. On the other hand, implementation of roadside equipment including the New NH3 is conducted in construction projects of individual road sections, thus, unification of the control code must be considered.

Figure 3.19 Control Codes Incompatible among Different Suppliers



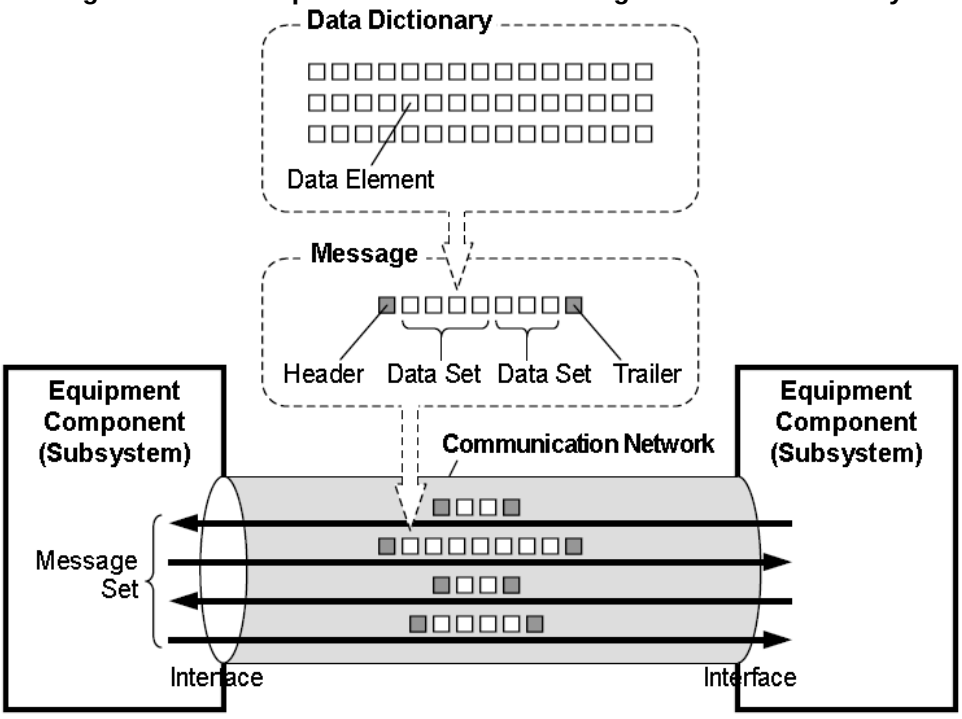
Source: ITS Standards & Operation Plan Study Team

The ITS packages to be unified such control codes among whole packages are CCTV monitoring and VMS system. As for the CCTV monitoring system, NVR (Network Video Recorder) is one of useful integration tools for controlling CCTV cameras procured by different suppliers. Since detailed specifications of NVR are currently being studied by the JICA SAPI project, NVR and CCTV camera to be introduced in the New NH3 must meet the system requirements specified in the SAPI project. On the other hand, there is no effective integration tool and standard for controlling VMSs at this moment. Thus, for VMS implementation in the New NH3 Project, the supplier will be requested to disclose the control code in order to incorporate the VMS control function on the New NH3 into VMS control software in the Northern Regional Main Center.

(2) Message/ Data Interoperability

Although other ITS roadside equipment except CCTV monitoring and VMS system need not particular control codes, the message and data of all roadside equipment to be exchanged with the centralized equipment installed in road management office and the Regional Main Center must be unified in accordance with ISO/IEC 11179.

Figure 3.20 Conceptual Illustration of Message List/ Data Dictionary



Source: ITS Standards & Operation Plan Study Team

For securing interoperability of ITS message/data exchange, the draft message/data standards which specify the message list and data dictionary have been developed in the JICA previous study and further details are being studied in the JICA SAPI project. The ITS facilities in the New NH3 must have conformity with the message/data standards

(3) Expandability of Communication Network

A network structure of the communication on the New NH3 will be separately configured with three (3) hierarchy, trunk network, local network and access network. The trunk network connecting with the Northern Regional Main Center will be introduced in later stage when the Regional Main Center is constructed. Therefore, the network equipment in the New NH3 shall be only equipped with the network interface between the network equipment to be installed in future for connecting the Northern Regional Main Center such as LAN port, etc. at initial stage.

However, the fiber optic cable shall have enough capacity for future connection even the location plan of the Northern Regional Main Center is not yet fixed, in order to avoid double constructions of the cable. Required fiber optic cable core for connecting with the Regional Main Center is estimated of 8 cores or more.

4. Toll Collection System

4.1 Overview

Generally, the toll collection system for a toll road can have a variety of configurations, depending upon:

- Toll rate principles such as the flat rate, segmental flat rate and traveled-distance dependent rate;
- Physical feature of the highway, whether it constitutes a network, or a singular highway with a single or multiple section(s);
- Number and distribution of tollgates;
- Classification of toll-charged vehicles;
- Toll charging principle, closed system or open system;
- Type and location of the highway, whether it is urban or rural;
- Toll collection method to be adopted, whether automatically by modern electronic equipment or manually with labor-collective manpower, etc.

In Vietnam, the toll collection is implemented based on the national policy stipulated by the "Circular Regulation on Collection, Payment, Management and Use of Road Toll (No.90/2004/TT-BTC)", and the locations of tollgates on national highways and provincial roads are determined by the Ministry of Finance (MOF) and the provincial people's committee, respectively. Therefore the toll collection configuration for the New NH3 shall be specified mostly in conformity with the government regulations.

Thus, the policy of the toll collection for the New NH3 is set as follows;

Table 4.1 Policy for Toll Collection for the New NH3

Component	Existing Plan	Remarks
1. Toll Charging Principle	Open system	
2. Toll Rate Principle	Flat rate by vehicle class	
3. Tollgate	Only one barrier-type tollgate jointly for the both traffic directions across the main carriageway on one represented section	Location: KM38+600
4. Number of Toll Lanes	6 lanes in one direction	
5. Vehicle Classification	As specified by MOF	
6. Toll Collection Method	One-stop bar-cord system and non-stop ETC	

Source: Consultant of the New NH3 Project

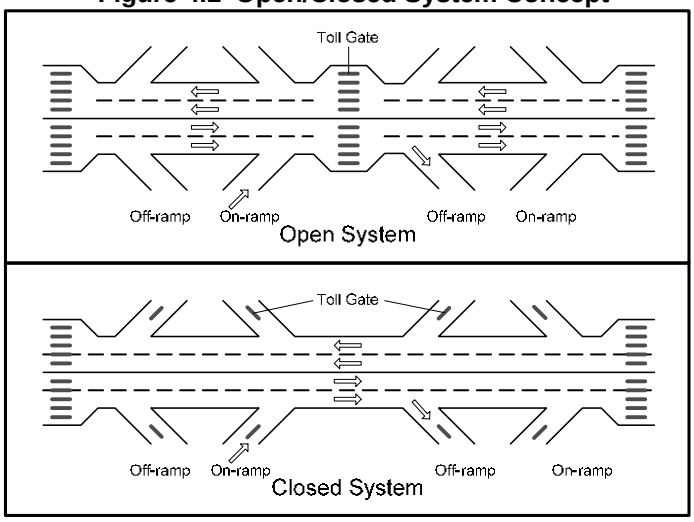
4.2 Tariff Rate System

1) Toll Charging Principle (Open/Closed System)

In general, there are two types of toll collection system, open system and closed system. In open system, there is 1 tollgate in each or represented toll section and toll is collected at the tollgate. The tollgate is constructed on mainline or entry/exit ramps in the section. Fixed tariff rate system such as flat tariff and sectional tariff system are basically applied for the open system.

In closed system, tollgate is installed at both entry and exit ramps. Typical toll collection process is that a ticket is issued at entry ramp and the toll is made payment, which depends on vehicle path, driving distance and vehicle classifications, at exit ramp together with the ticket. Distance based tariff system or any other tariff system can flexibly be adopted for the closed system. The concept of open and closed system is shown in **Figure 4.1** below.

Figure 4.1 Open/Closed System Concept



Source: Consultant of the New NH3 Project

The comparison of each charging system is summarized as **Table 4.2** below.

Table 4.2 Comparison of Open/Closed System

	Open System	Closed System
1.Toll Arrangement	Tollgate at each toll section (on Main line or ON/OFF-Ramp)	Tollgate at both On and OFF-Ramp
2.Tariff Rate	Flat tariff or Sectional tariff	Distance based or flexible tariff rate system
3.Toll Collection	Impossible to be secured toll tariff collection	Possible to be secured toll tariff collection due to fully access control
4.Number of transactions	Variable (1 to multiple) depending on distance traveled	At entrance to take ticket and at exit ramp to pay toll
5.Access control	Impossible to prevent illegal entry and to control when accident, congestion and disaster occurs.	Strict access control possible
6.Congestion at tollgate	Congestion may occur at mainline tollgate	Congestion occurs, but limited at ramps
7.Additional interchange	Additional toll gate is required on mainline or toll free section is created	Additional toll gate is required at ON and OFF-Ramp of new interchange
8.Conformity with regulations	Conformity with existing Vietnamese regulation	Not yet stipulated in Vietnamese regulation
9.Applicable road network	Suitable for single and short expressway network	Suitable for large and long expressway network

Source: Consultant of the New NH3 Project

The open system is applied to the New NH3 in conformity with the circular (No.90/2004/TT-BTC) at the time of road opening.

However, the closed system has following advantages comparing with the open system;

- Various tariff rate system can be adopted
- Strict toll collection is possible
- Traffic controls such as prevention of illegal entry are possible
- Congestion on mainline can be avoided

Therefore, transition to the closed system from the open system shall be considered in the future.

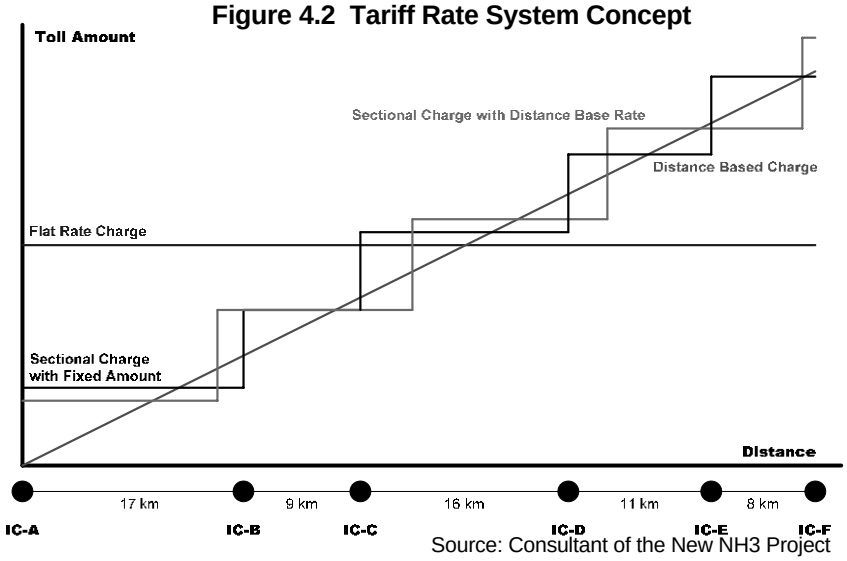
2) Toll Rate Principle

Following toll rate principles are existed in the highway toll collection system.

- Flat rate
- Sectional rate with fixed amount
- Sectional rate (distance base rate)
- Distance based rate

The concept of each toll rate is shown in **Figure 4.2** below.

Figure 4.2 Tariff Rate System Concept



Source: Consultant of the New NH3 Project

According to the Circular (90/2004/TT-BTC), the flat rate is only stipulated as toll rate principle and currently other toll rates are not applied in Vietnamese highway. Thus, the flat rates by vehicle class will be introduced to the New NH3 at the initial stage. After the highway extension or transition to the closed system, the sectional rate or the distance based rate may be adopted in future. Therefore, toll collection system shall have such future expandability for toll rate system.

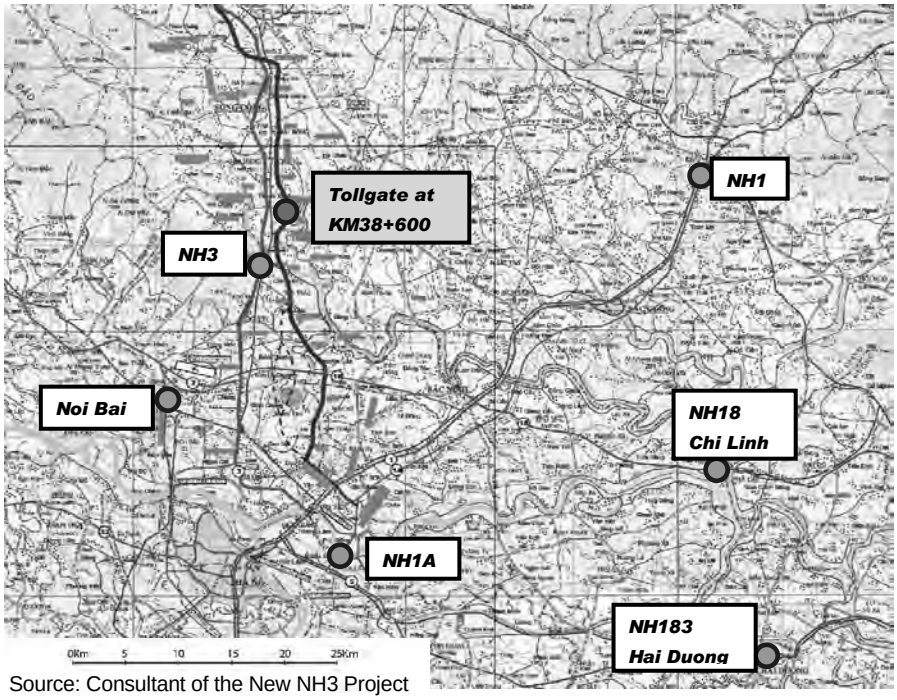
4.3 Location of Tollgate

1) Location

It was proposed that a barrier-type, two-directional tollgate located at KM 38+600 will be provided on the New NH3 by the previous consultant's proposal from following reasons.

- According to the Circular (No.90/2004/TT-BTC), the distance between each tollgate shall be basically more than 60-70km. Geographically, the proposed tollgate is located at approximately 60km away from the nearest NH1A tollgate.

Figure 4.3 Existing Tollgate Location Plan



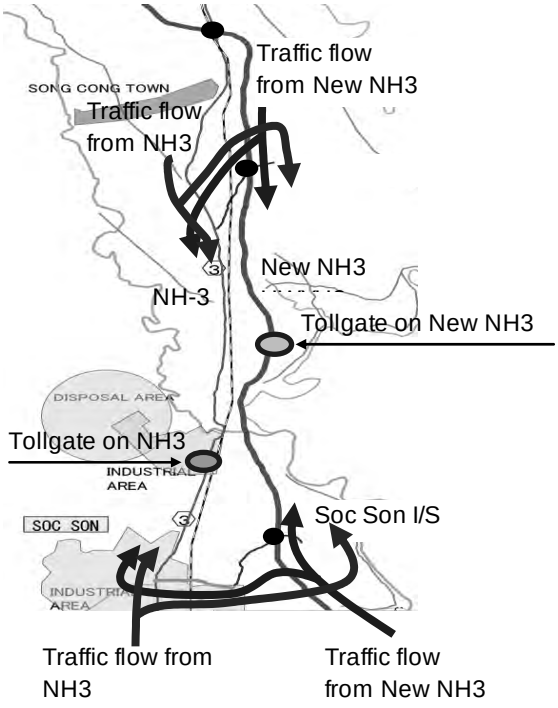
Source: Consultant of the New NH3 Project

- When operation of the New NH3 starts, the possible traffic flow from/to Hanoi area at Soc Son are estimated as shown in right figure. The tollgate on the existing NH3 is located between Soc Son and Yen Binh. For tolling fairness, the tollgate on the New NH3 shall be also located between Soc Son I/C and Yen Binh I/C.

- The exact location was determined, based on the consideration from various aspects of physical design, construction and social conditions.

This concept is kept in this ITS basic plan, and any changes from previous proposed tollgate location are not made.

Figure 4.4 Possible Traffic Flow



Source: Consultant of the New NH3 Project

2) Required Number of Lane

The required number of lanes at the tollgate is theoretically dependent upon the incoming traffic volume and the average service time at the gate for the required service level (the average number of waiting vehicles per lane). Usually, the design hourly traffic volume for the target year (vehicles per hour) and the empirically known average service time for each toll collection type (seconds per vehicle) are used to obtain the required number of lanes for the target service level (vehicles per lane). The number of lanes is obtained by the following computations, of which concept is equal to the JICA draft ITS Standard as well;

Table 4.3 Required Number of Lanes in One Direction at Tollgate

Service Level = Average Queue Length (vehicles per lane)	Service Time (seconds per vehicle)	Toll Collection Method	Design Hourly Traffic Volume (vehicles per hour)							
			1,440	1,620	1,800	1,980	2,160	2,340	2,520	2,700
1.0	4.5	ETC	2	3	3	3	3	3	4	4
	6	Dsitance base rate (Enter)	4	4	4	4	5	5	5	6
	8	Flat rate	4	5	5	5	6	6	7	7
	14	Dsitance based rate (Exit)	7	7	8	9	10	10	11	12
3.0	6	Dsitance base rate (Enter)	3	3	4	4	4	5	5	5
	8	Flat rariff	4	4	5	5	6	6	6	7
	14	Dsitance base rate (Exit)	6	7	8	8	9	10	11	11

Source: Design Manual Vol. 4, Japan Highway Public Corporation

Generally, as the 30th highest hourly traffic volume is supposed to be the target traffic level, the design hourly traffic volume (DHV) is calculated by;

$$DHV = ADT \times K \times D$$

Where, DHV: Design hourly traffic volume in one direction (vehicles per hour),

ADT: Annual average daily traffic in both directions (vehicles per day),

K: Ratio of the annual 30th highest hourly traffic volume in both directions to ADT, and

D: Ratio of the heavier directional traffic volume to the total of bidirectional traffic volumes during the 30th highest hour.

For the New NH3 which is located in the suburban area of Hanoi, these values are tentatively selected as K = 0.12 and D = 0.60.

According to the traffic forecast demand updated on August 2009 by the consultants which is almost same as low diversion scenario forecast by SAPROF Study, the future traffic demand on the Soc Son I/S - Yen Binh I/C section was estimated as follows;

Table 4.4 Future Traffic Demand on Soc Son I/S – Yen Binh I/C section

Stage	ADT Forecast Soc Son I/S - Yen Binh I/C (PCU)		
	On the Existing NH3	On the New NH3	Total Traffic
2006 (Actual)	9,600	-	9,600
2010	13,600	-	13,600
2013	5,100	11,900	17,000
2015	5,900	13,900	19,800
2020	8,600	20,100	28,700
2025	12,200	28,400	40,600
2030	15,000	42,500	57,500
2035	15,000	66,300	81,300

Source: Consultant of the New NH3 Project

If the target year is set to be 2035 for planning of the tollgate for the New NH3, the forecast ADT will turn out to be 66,300 vehicles a day. However, these volumes include that of motorbikes which are actually exempted from paying a toll on the road in Vietnam, and, generally, even not allowed to drive on expressways. Since an actual traffic demand forecast on the New NH3 in 2035 shows the composition of motorbikes as dominant as approximately 58 % of the total automobiles, the ADT to be applied to the tollgate plan should be reduced to 50 % of these volumes.

Thus, the design hourly traffic volume in one direction is calculated as;

DHV = 66,300 x 0.5 x 0.12 x 0.6 = 2,387 (vehicles per hour)

The average service time for the flat toll rate system is empirically around 8.0 seconds per vehicle. Then, if the service level is set as the average queue length of 1.0 vehicle per lane, the required number of lanes in one direction at the toll gate results in 6 to 7 lanes. Thus, the number of toll lanes shall be set 6 lanes in each direction, and the non-stop ETC system would be introduced on each 1 lane to cope with future growing traffic volumes in this project.

4.4 Vehicle Classification

Vehicle classification for the highway payment shall basically follow the requirements of MOF circular mentioned early. The classification of vehicle is defined in accordance with the number of seats and type of vehicle as shown in **Table 4.5** below.

Table 4.5 Vehicle Classification

Ordinal Number	The Categories of the Vehicle	Applicable for the Project
1	Two wheelers, three wheelers, mopeds and the like	
2	Lambretta, rudimentary trucks, tractors	
3	Cars of under 12 seats, trucks of a tonnage of under 2 tons and mass transit buses	O
4	Cars of between 12 and 30 seats, trucks of a tonnage of between 2 tons and under 4 tons	O
5	Cars of 31 seats or more; trucks of a tonnage of between 4 and under 10 tons	O
6	Trucks of a tonnage of between 10 and under 18 tons and 20ft-container lorries	O
7	Trucks of a tonnage of 18 tons or over and 40 ft-container lorries	O

Source: 90/2004/TT-BTC, MOF, VN

4.5 Toll Collection Method

The toll collection method is basically divided into three types, i.e. manual, semi-automatic and automatic, and each toll collection method is generally defined as follows;

[Manual Toll Collection]

The manual toll collection is to manually collect toll with cash and ticket by the tollgate staffs.

[Semi-Automatic Toll Collection]

In the semi-automatic toll collection, the toll payment is made by IC card without cash transaction and tollgate staffs.

[Automatic Toll Collection (ETC)]

The automatic (electronic) toll collection (ETC) allows drivers to automatically pay toll without stopping the vehicle on the tollgate by utilizing wireless communications between On-board Unit and road side antenna.

In Vietnam, however, the semi-automatic toll collection system may be defined as;

- To realize one-stop toll payment and transaction with barcode ticket system*
- To have automatic toll audit and recording functions with post-classification check equipped with CCTV camera and IR camera for vehicle license plate recognition
- To have toll data processing functions with computing system

* Uniquely, the “two-stop” method, by which a user vehicle stops twice both at the ticket hut at the roadside upstream of the tollgate to buy a toll ticket and at the tollgate to give the ticket to the toll attendant for a single toll payment, is being dominantly adopted in Vietnam. A barcode ticket system realizes one-stop toll collection using pre-printing barcode ticket in both toll payment and transaction.

For the New NH3, it is proposed that the toll collection system should be equipped with above functions, that is said as “semi-automatic toll collection system” in Vietnam, so that a more modernized one-stop toll payment is realized.

Additionally, introduction of the automatic toll collection system for 1 lane in each direction is proposed to provide high level toll collection service to the drives and cope with future growing traffic volumes.

4.6 Basic Functions and Specifications

1) Semi-automatic Toll Collection System

(1) System Component

Semi-automatic toll collection facilities at the tollgate for the New NH3 shall follow the basic

standard “TCCS 01/2008/VRA” and will be composed of following equipment.

[Lane Equipment]

- Vehicle Detector: used for counting vehicle number and closing the barrier automatically after vehicles pass the tollgate
- Toll Transaction Equipment: to collect the toll charge by using barcode ticket system, process toll transaction data and transmit it to toll office system
- Lane Control Equipment: including lane control panel, automatic lane barrier, traffic sign and alarm horn and lamp to let drivers stop at the toll lane for payment or prevent to enter the closed lanes
- Inspection equipment: including lane camera, lane VMS and automatic number plate recognition camera (ANPR) to monitor passing vehicle, read its number plate, and provide necessary information such as toll fare and lane situation to the drivers
- Others: UPS, manual lane barrier and indication lamp

[Toll office]

- Toll office Equipment: including various servers, computers, monitors, storages, etc. to acquire, monitor and store all toll transaction data from tollgate

[Others]

- Network, power supply, overall camera, internal telephone, others

Table 4.6 Semi-Automatic Toll Collection System Component

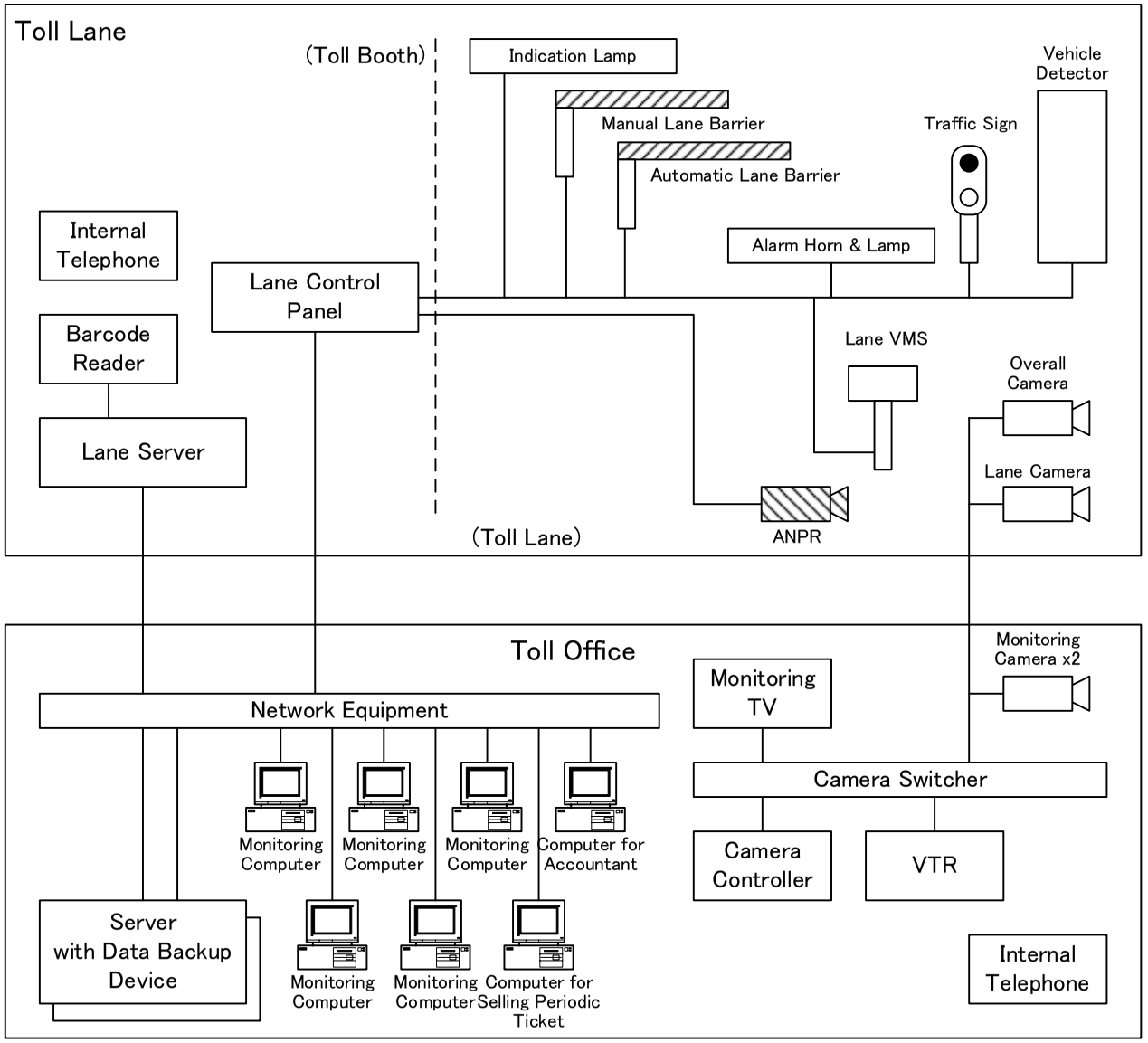
No.	System Component			Quantity		Remarks
				Toll lane	Toll Office	
(1)	Lane Equipment	Vehicle Detector	Vehicle Detector	10		
(2)		Toll Transaction Equipment	Lane Server	10		
(3)			Barcode Reader	10		
(4)		Lane Control Equipment	Lane Control Panel	10		
(5)			Automatic Lane Barrier	10		
(6)			Traffic Sign	10		
(7)			Alarm Horn and Lamp	10		
(8)		Inspection Equipment	Lane Camera	10		CCD color camera
(9)			Lane VMS	10		LED type
(10)			Automatic License Number Plate Recognition Camera (ANPR)	10		Infra-Red camera
(11)		Others	Manual Lane Barrier	10		
(12)			Indication Lamp	10		
(13)	Toll office	Toll Office Equipment	Server		1	with data backup device
(14)			Monitoring Computer		5	with barcode reader
(15)			Computer for selling periodic ticket		1	with barcode reader
(16)			Computer for accountant		1	with barcode reader
(17)			Monitoring TV		1	
(18)			Camera Switcher		1	
(19)			Camera Controller		1	
(20)			Monitoring Camera		2	
(21)			VTR		1	
(22)	Others	Others	Overall camera	2		
(23)			Internal Telephone	10	3	
(24)			Power Supply Equipment	1	1	UPS, etc.
(25)			Network Equipment	1	1	Including network cable
(26)			Others	1	1	Lighting Arrester, etc.

Source: Consultant of the New NH3 Project

(2) System Configuration

A configuration of semi-automatic toll collection system (barcode ticket system) is illustrated as figure below.

Figure 4.5 Proposed Configuration of Semi-automatic Toll Collection System (Barcode Ticket System)



Source: Consultant of the New NH3 Project

(3) System Requirement

a) Vehicle Detector

The vehicle detector is used for counting number of vehicle and closing the barrier automatically after vehicle pass the tollgate. The vehicle detector shall be controlled by computer system.

b) Toll Transaction Equipment

- **Lane Server**

The lane server shall display the necessary information for toll transaction such as toll transaction data and barcode reader data. The computer can also be input required data made through a barcode reader and keyboard by toll staff.

- **Barcode Reader**

The barcode ticket system will be adopted as the toll ticket for the project. A single trip ticket, a round trip ticket, a monthly ticket, quarterly ticket will be utilized for the barcode ticket system. The barcode ticket shall be recoded on following information together with pre-printing receipt.

- Code of local tax bureau
- Code of toll station
- Type of ticket (Single trip, round trip, monthly, quarterly)
- Type of vehicle
- Year of issue
- Issue number
- Ticket number

The barcode reader shall have a function scanning all required information above from the barcode ticket.

c) Lane Control Equipment

- **Lane Control Panel**

The lane control panel shall be capable of connecting all control equipment of toll lane to computer network. The control panel should have separate switch for manual barrier open/close in emergency case. The control panel also have a separate vehicle auto-counter and shall be able to store data of at least 2 weeks.

- **Automatic Lane Barrier and Manual Lane Barrier**

Two types of barrier, the automatic lane barrier and the manual lane barrier, are provided to let the driver stop at the toll lane or prevent to enter the toll lane. The automatic lane

barrier shall be used for control the “Stop” and “Go” of the vehicle. When the driver makes toll payment at tollgate, automatic lane barrier shall be opened automatically based on a signal from lane control panel. The manual lane barrier shall be placed around the edge of the toll island to indicate the toll lane is available or not.

- **Traffic Sign**

The traffic sign is a traffic signal with a red “Stop” and green “Go” light, and located at the vehicle departure side of each toll lane to control passage. The green “Go” light indicates that the toll ticket was issued or the toll fee was paid and the driver is free to move on.

- **Alarm Horn and Lamp**

The alarm horn and lamp are used for warning the violation driver and calling for the support from toll security in enforcement of violation vehicle. This equipment is controlled by lane computer in special situation.

d) Inspection Equipment

- **Lane Camera**

The lane camera is used to observe the condition of toll collection on the lane. The video image shall be recorded by toll office system. The lane camera shall be located where it is possible to observe the vehicle fully when the driver stops at the toll booth. A CCD color camera shall be used as the lane camera.

- **Lane VMS**

The lane VMS is used to show the toll fare, vehicle classification registered by the toll staffs, toll charge and other information related toll transaction and lane situation. The toll fare display shall be placed where a driver can see it when he stops at the toll booth.

- **Automatic License Number Plate Recognition Camera (ANPR)**

At toll plaza of high traffic volume, ANPR is installed for speed up the passing of vehicle. ANPR is used for reading vehicle number plate and checking the ticket database. If vehicle have monthly or quarterly ticket and this ticket is still validated, the barrier shall be opened automatically.

e) Other Lane Equipment

- **Indication Lamp**

The indication lamp is mounted on the toll canopy above the each toll lane and shall indicate whether the lane is opened or closed to the driver.

f) Toll Office Equipment

The toll office equipment will be provided in the toll office building. The toll office equipment consists of server, monitoring computer, computers for selling periodic ticket and accountant, monitoring TV, camera switcher and controller, monitoring camera and VTR. Main functions of the system are:

- Transaction data acquisition/store from lane equipment and provision of real time monitoring through visual displays in the toll office,
- Data processing and toll office management via visual display units, printer terminals, auxiliary memory media and data transfer facilities, and
- Camera monitoring, controlling and recording.

Two units of the database server for backup purpose and seven (7) units of computer will be introduced in the toll office building.

g) Others

- **Overall Camera**

The overall camera shall be of PTZ camera and used for monitoring overall location of toll barrier.

- **Internal Telephone**

The internal telephone is used for communication between toll lanes and toll office in case of emergency.

- **Others**

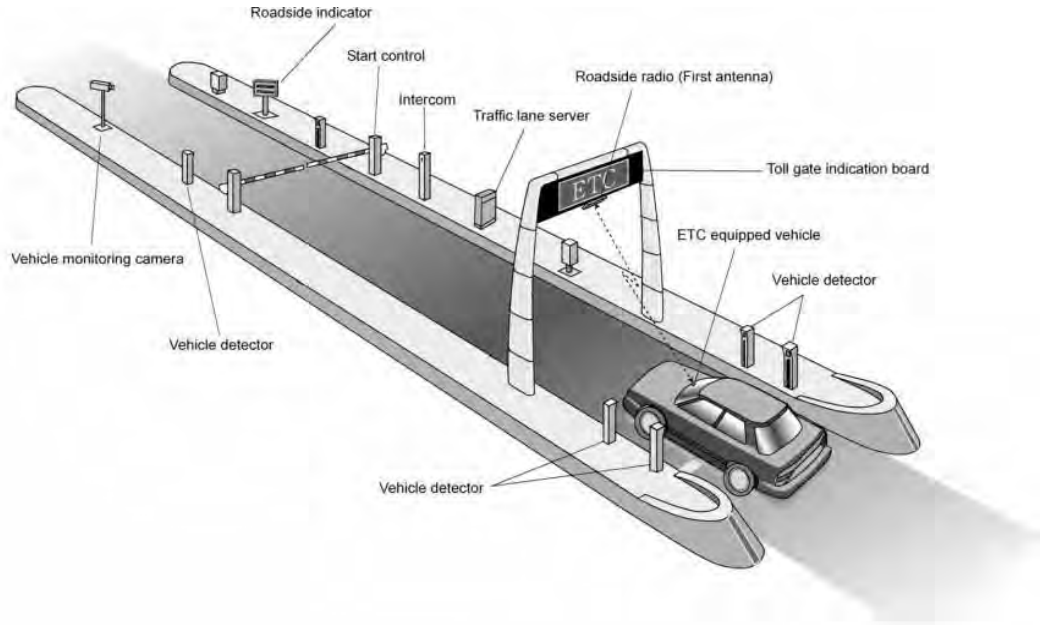
Other required facilities such as power supply equipment (UPS), network equipment, etc. shall be provided in the system.

2) Automatic Toll Collection (ETC) System

(1) General

The ETC realizes automatic toll transaction by utilizing wireless communications between On-board Unit (OBU) and road side antenna as typically show in Figure 4.6 below.

Figure 4.6 ETC Operation Image



Source: Consultant of the New NH3 Project

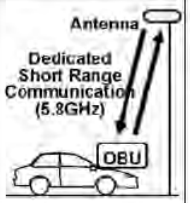
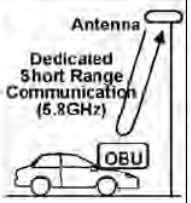
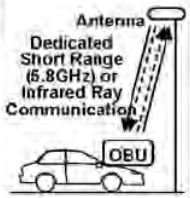
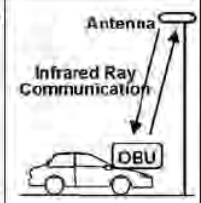
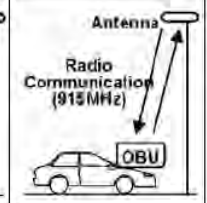
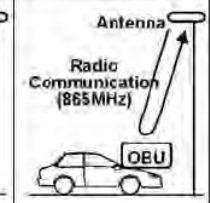
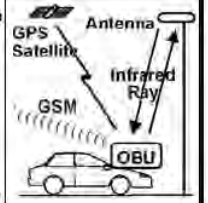
Basic toll collection procedures under the ETC system will be as follows;

- A driver who intends to use the ETC system installs and set up the OBU on his vehicle. The driver also has to purchase the IC card for prepayment.
- When the approaching vehicle equipped the OBU to the tollgate, communications are made between the OBU and the road side antenna.
- The validities of the OBU and IC card inserted into the OBU are checked through the communications, firstly. If the communications are made successfully, vehicle classification recorded into OBU is read through the communications and the toll is automatically calculated and withdrawn from the remaining deposit of IC card. Then, automatic lane barrier will be automatically opened.
- Information including vehicle number, passing date and time, toll charge, reaming deposit of IC card, etc. are transferred and recorded into the toll office system.

(2) Type of the Road-to-Vehicle Communication Method for ETC

There are various kinds of road-to-vehicle communication method for ETC in the world. According to the JICA draft ITS Standard, each type of ETC has its advantages and disadvantages as shown in table below;

Table 4.7 Comparison on Road-to-Vehicle Communications for ETC

	Active-DSRC	Passive-DSRC	DSRC/IR	IR	RF-Tag (Active)	RF-Tag (Passive)	GPS/GSM/IR
Outline							
Actual Use in Toll Collection	Many experiences	Many experiences	Many experiences	Many experiences	Many experiences	Few	None
Shared Use among Different Operators	Many experiences	Many experiences	A few experiences	Not shared	Not shared	Not shared	Not shared
Shared Suppliers in Actual Road Operation	12 (in Japan)	3 (in France)	7 (in Korea)	Not shared	Not shared	Not shared	Not shared
Recommendation in On-going Project in Vietnam	HCMC–Long Thanh –Dau Giay	HCMC–Trung Luong, Can Tho Bridge	None	None	Not Applicable (Conflict with GSM)	Cau Gie–Ninh Binh	None
Accuracy of Communicatior	High (99.9999%)	No regulation	Lowering by Sunlight	Lowering by Sunlight	Relatively low	Relatively low	No regulation
Vehicle Deceleration	Not necessary	Not necessary	Not necessary	Necessary	Not necessary	Not necessary	Not necessary
2-piece Type OBU	Many experiences	For trial	Many experiences	Many experiences	No experience	No experience	No experience
Prepaid-Balance-in-Card	Capable	For trial	Capable	Capable	Not capable	Not capable	Not capable
Combined Use of ETC and Touch&Go	Capable	For trial	Capable	Capable	Capable	Capable	Not capable
Applicability to ERP **	Applicable	Applicable	Not applicable	Not applicable	Applicable	Applicable	Applicable
OBU Cost	Average	Low (1-piece type)	Average	Average	Low (1-piece type)	Very low (1-piece type)	High (1-piece type)
Roadside Equipment Cost	Low	Average	High	Average	Low	Low	Very low
International Standard	Established	Established	Established	Patented	Established	Established	None
Grading	Competitive	Competitive	Not suitable	Not suitable	Not suitable	To be followed up	Not suitable

Note, **: ERP (Electronic Road Pricing) by multi-lane free-flow, OBU: OBU is including Tag in this table

Source: ITS Standards & Operation Plan Study Team

In consideration of following advantages, the Active-DSRC type would be recommended.

- High accuracy and reliability with high communication capacity (Applicability to multi-lane free-flow in future)
- Applicability for shared use by different operator
- Capability of 2-piece type OBU (IC card can be used as the multimodal card)
- Capability of prepayment method
- Conformity of DSRC and IC card specifications with international standards

However, ETC standard in Vietnam is under the preparation by DOST (Department of Science and Technology) of MOT and the final decision has not been made yet at the time of preparation of this basic plan. Therefore, the type of the ETC system for the project is to be determined by the final decision of the DOST when it is made.

(3) System Component

Automatic toll collection system for the New NH3 will be composed of the following equipment.

Table 4.8 Automatic Toll Collection System Components

No.	System Component			Quantity			Remarks
				Toll lane	Toll Office	User	
(1)	Lane Equipment	Vehicle Detector	Vehicle Detector	2			
(2)		Toll Transaction Equipment	Roadside Antenna	2			
(3)			On-Board Unit			50,000	
(4)			IC Card			300,000	
(5)			Entry Card Issuer	2			
(6)			Lane Server	2			
(7)		Lane Control Equipment	Roadside Controller	2			
(8)			Automatic Lane Barrier	2			
(9)			Traffic Sign	2			
(10)			Alarm Horn and Lamp	2			
(11)		Inspection Equipment	Lane Camera	2			CCD color camera
(12)			Lane VMS	2			LED type
(13)			Automatic License Number Plate Recognition Camera (ANPR)	2			Infra-Red camera
(14)		Others	Manual Lane Barrier	2			
(15)			Indication Lamp	2			
(16)	Toll office	Toll Office Equipment	Toll Management Server		1		
(17)			IC Card / OBU Registration Terminal		2		
(18)			IC Card Reader/Writer		5		
(19)	Others	Others	Internal Telephone	2			
(20)			Power Supply Equipment	1	1		UPS, etc.
(21)			Network Equipment	1	1		Including network cable
(22)			Others	1	1		Lighting Arrester, etc.

Source: Consultant of the New NH3 Project

In addition to the semi-automatic toll collection equipment, roadside antenna will be installed at tollgate to communicate with the OBU. For early wide spreading of ETC system, a total of 50,000 OBU and 300,000 IC cards are proposed to be provided in the project. In the toll office, toll management server, IC card/OBU registration terminal and IC card reader/writer will be placed to handle the ETC transaction data.

(4) Issues for Introduction of Automatic Toll Collection System

For the operation of the automatic toll collection system, the integrated framework which becomes beyond the scope of the individual projects including the ITS development for the New NH3 are required as follows.

a) IC-Card Operation

The scheme of the IC-card operation for issuance, charging, re-charging and distribution of the invalidated IC-card needs to be established. The possible case as example is:

i) A bank becomes in charge of IC-card issuance with deposit and centrally controls the accumulated data regarding the IC-card in the head of office of the bank,

ii) IC-card, commonly used by the different road operators or multipurpose usage, is issued/re-charged in the branches of the bank and toll offices along the expressways/highways, or any other places,

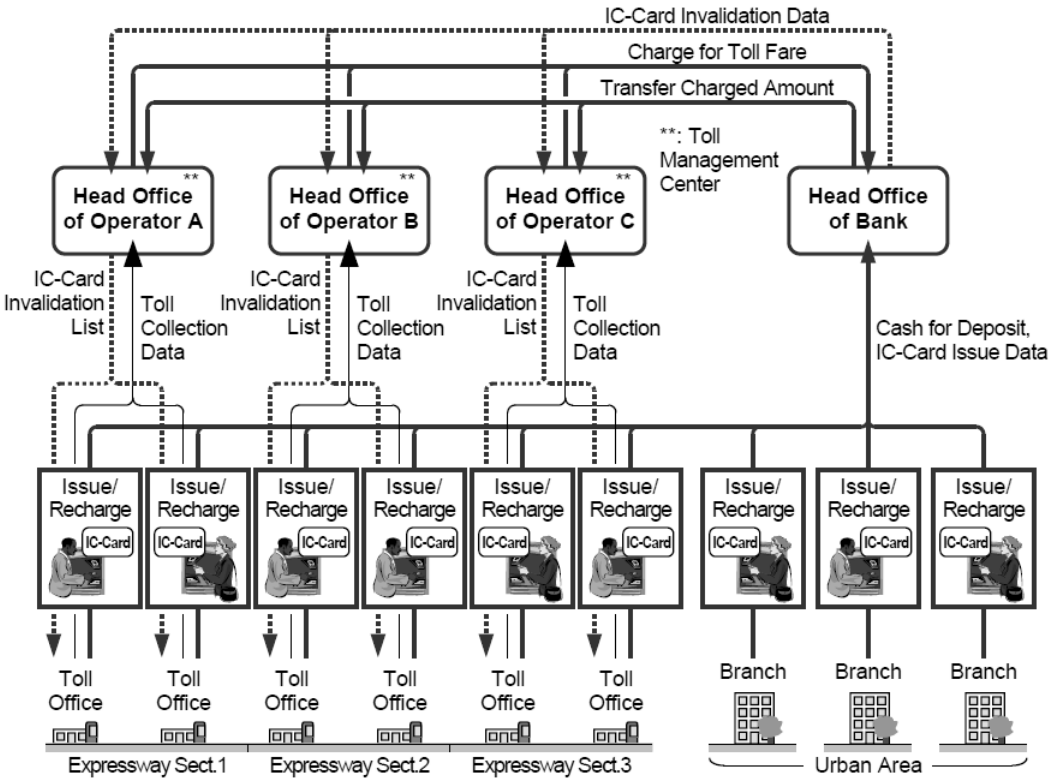
iii) The data of toll fare is transferred from the road operators to the bank and the charged amount to the road operator's bank account,

iv) IC-card invalidation list, which is the information of the invalidated IC-card for any reasons, is generated by the bank and transferred to the road operators for checking the passage of the vehicle at toll gate,

v) The detailed specification of the IC-card system is determined by higher level and the individual projects including the New NH3 follow the determined specification for the design.

The figure below shows the conceptual framework of the IC-card operation.

Figure 4.7 Framework of IC-Card Operation



Source: ITS Standards & Operation Plan Study Team

b) OBU Operation

The scheme of the OBU operation for registration, management, and distribution of the invalidated OBU list needs to be established. The possible case as example is:

i) Newly established OBU registration center becomes in charge of OBU registration and management,

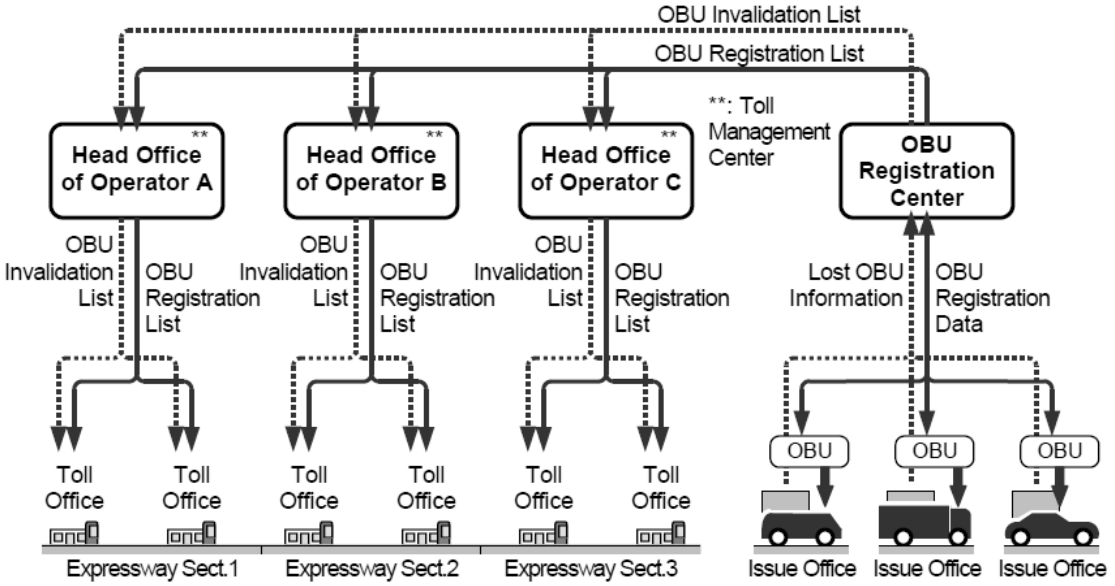
ii) The center compiles the OBU registration list upon issuance of the OBU and transfers to the toll offices through the head offices of the road operators,

iii) The center generates the lost/invalidated OBU list to the toll offices through the head offices of the road operators,

iv) The detailed specification of the OBU is determined by higher level and the individual projects including the New NH3 follow the determined specification for the design.

The figure below shows the conceptual framework of the OBU operation.

Figure 4.8 Framework of OBU Operation

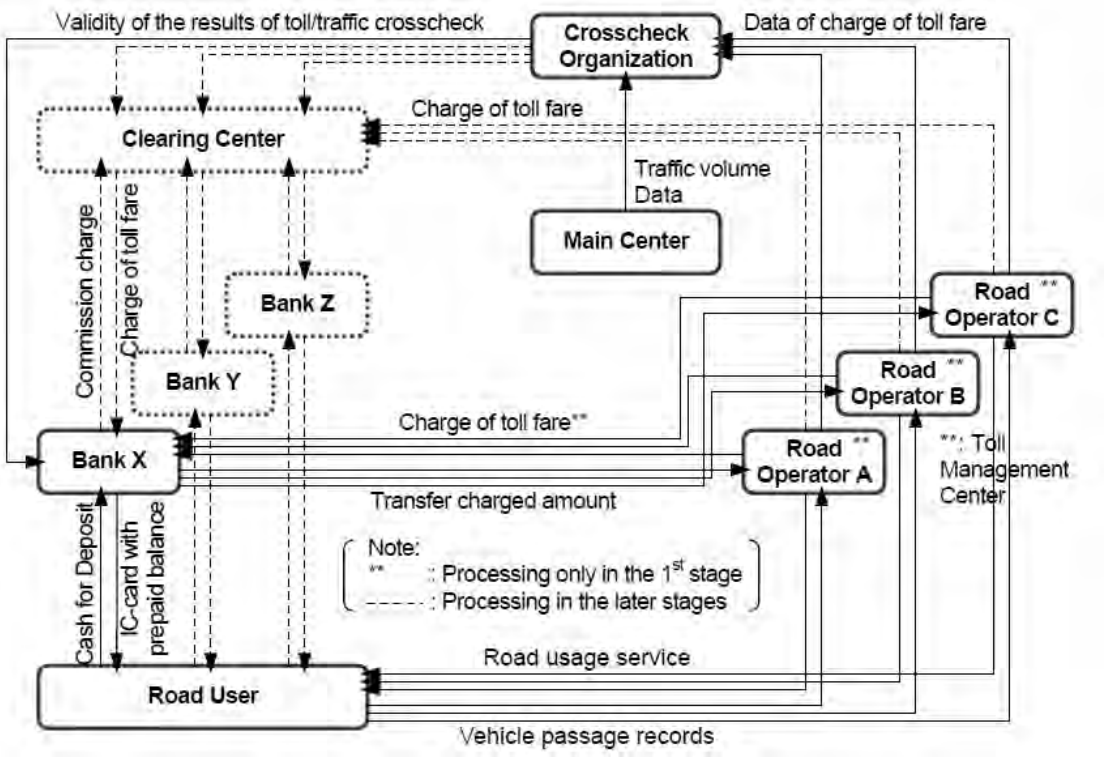


Source: ITS Standards & Operation Plan Study Team

c) Toll Settlement Framework

The scheme of the toll settlement needs to be established. The figure below shows the conceptual framework of the toll settlement based on the concept of the JICA draft ITS Standard. In this case, i) the data of the charged toll fare is transmitted from the road operators to the bank, clearing center in later stage, through the cross check organization, and ii) the charged toll fare is transferred to the road operators. The clearing scheme is particularly important for the distance proportional tariff system across the different road operators' sections while the flat rate is to be applied to the New NH3. However in relation with the IC-card operation, the entire settlement scheme shall be prepared.

Figure 4.9 Framework of Toll Settlement



Source: ITS Standards & Operation Plan Study Team

Under the condition where such above scheme has not been established yet at the time of the preparation of the basic plan, the components of the automatic toll collection system described above are tentatively proposed on the assumption that the IC-card and OBU are issued/registered at the toll office, which shall become a part of the above entire system in the future.

5. Communication System

5.1 Network Configuration

The traffic information/control system and the toll collection system consist of various facilities such as vehicle detector, CCTV camera, variable message sign and toll collection facilities along the roadside. These roadside facilities are connected with the centre equipment installed at the Road Management Office. Additionally, the Road Management Office in the New NH3 shall transfer the traffic data to the Northern Regional Main Center in future.

The communication system is required to provide the data transmission and voice communication services. IP (Internet Protocol) based transmission system will be adopted for flexibility, expandability and cost effective construction of the system, and considering the technical trends in all over the world.

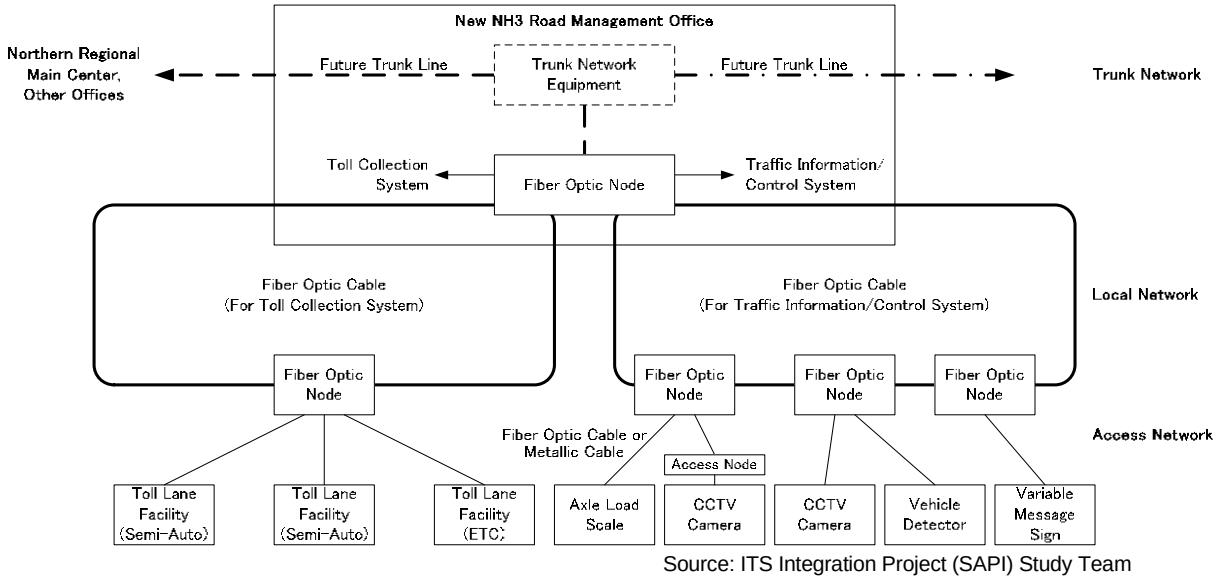
1) Network Structure and Node Location

A network structure of the communication system will be separated by three (3) hierarchy, trunk network, local network and access network.

The trunk network will be introduced to connect with the Northern Regional Main Center and other Road Management Offices when the expressway is extended. Therefore, the equipment for the trunk network will not be installed under the project, however, the communication system must have a function of such future connectivity.

Transmission nodes for local network (FON: Fiber Optic Node) will be placed to link between the Road Management Office and Michi-no-eki or other main connection points. The network topology of the local network shall be configured a flattened ring structure to guarantee connectivity even if one node or communication cable fail to operate. Access network will be established to connect between FON and roadside facilities. The concept of the network structure and hierarchy is shown in **Figure 5.1**.

Figure 5.1 Network Structure and Hierarchy



Source: ITS Integration Project (SAPI) Study Team

All communication cable shall be fiber optic cable having enough number of cores except the metallic cable to be used to directly connect roadside facilities and FON in order to realize high capacity data transmission. The location of the FON is summarized as **Table 5.1** below.

Table 5.1 Location of the Fiber Optic Node (FON)

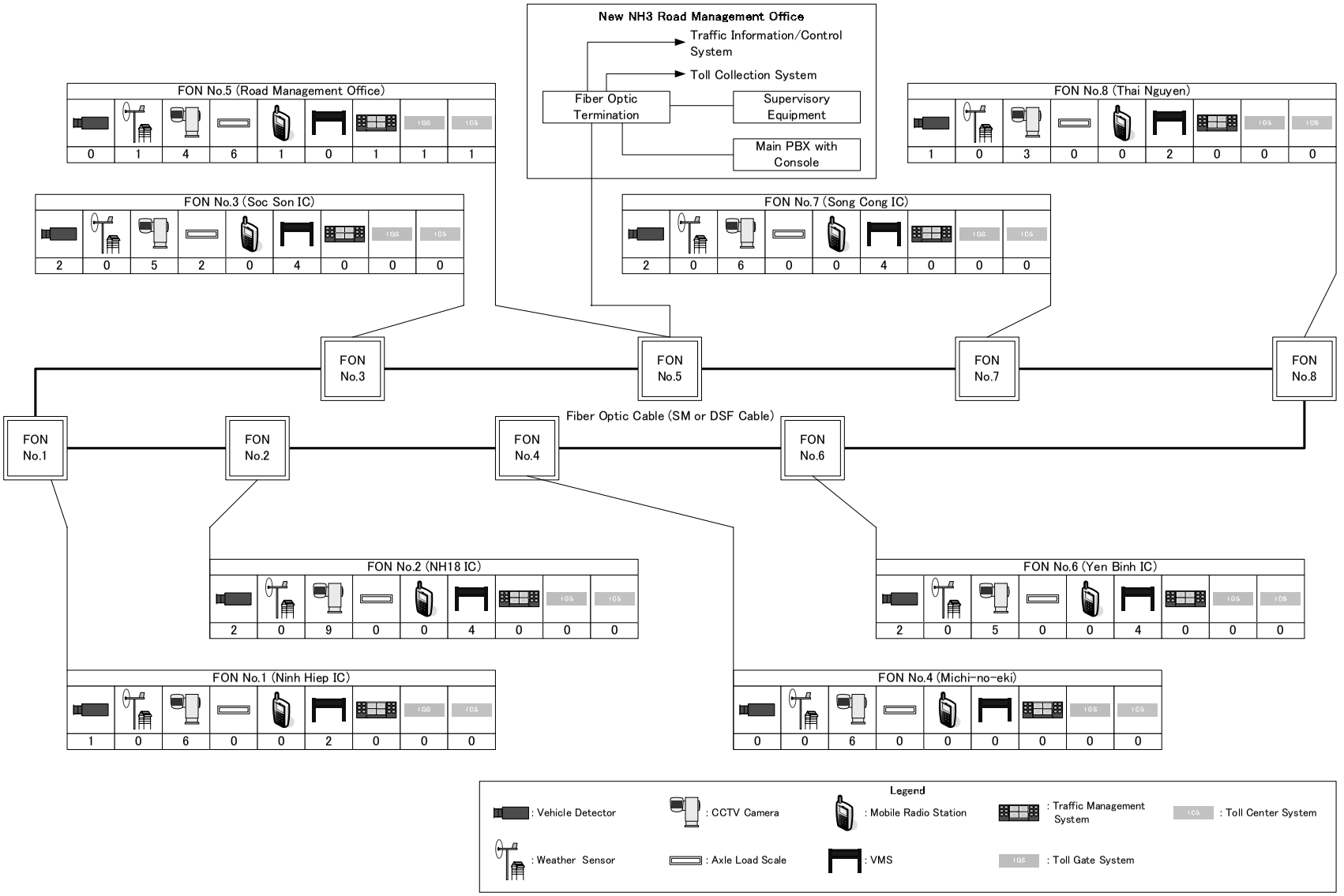
No.	Location	Quantity	Remarks
1	Ninh Hiep IC	1	KM0+000
2	NH18 IC	1	KM 17+530
3	Soc Son IC	1	KM 26+100
4	Michi-no-eki	1	KM 36+200
5	Road Management Office	1	KM 38+600
6	Yen Binh IC	1	KM 40+984
7	Song Cong IC	1	KM 53+300
8	Thai Nguyen	1	KM 61+313

Source: Consultant of the New NH3 Project

2) Network Configuration

Proposed network configuration of the communication system is illustrated as **Figure 5.2**.

Figure 5.2 Network Configuration



Source: ITS Integration Project (SAPI) Study Team

5.2 Basic Functions and Specifications

1) Fiber Optic System

The fiber optic system shall have highly reliability and provide secure communications for real time signals such as voice, video, traffic management data and toll collection data to connect fiber optic cable with Internet Protocol.

(1) Fiber Optic Node (FON)

The FON shall have enough capacity and interface, quality of services (QoS) control function, fail-over function and any other required functions. Followings are reference specifications of the FON.

a. Standards:	Gigabit/10Gigabit Ethernet
b. Capacity:	1 Gbps or more
c. Interface:	Fiber Optic Interface: 8 core or more
	LAN Interface: 20 ports or more
d. Applied Topology:	Ring, Star
e. Fail-Over Function:	Resilient Packet Ring (RPR)
f. Transmission Distance:	60km or more
g. Changeover Time:	50msec or less
h. Network Management:	SNMP or equivalent
i. Reliability:	1×10^{-6} or better

(2) Access Node

Access node has a function to convert electrical signal to optic signal to connect roadside equipment with the FON. Followings are basic requirements of the access node.

a. Input/Output:	10Base-T/100Base-TX
	Single Mode (SM) Fiber Optic Cable
b. Number of Core:	2 C or less

2) Communication Cable

The type of cable for the communication system will be as stipulated below table.

Table 5.2 Type of Communication Cable

Application	Type	No. of Cores	Remarks
1. Trunk Network	Fiber Optic Cable	8C	In future
2. Local Network	Fiber Optic Cable	8C	
3. Access Network	Fiber Optic Cable, Ethernet Cable or Others	30C or more	
4. Inside buildings	Ethernet Cable or Others	-	

Source: ITS Integration Project (SAPI) Study Team

Fiber optic cable installed along the highway is estimated of 46 cores. To meet the future demand, 100C Single Mode (SM) fiber optic cable is proposed to be installed.

(1) Fiber Optic Termination

Fiber optic termination will be installed in the Road Management Office, Michi-no-eki or other fiber optic connection points and used to connect fiber optic cable with the ITS and the toll collection equipment by using suitable connectors smoothly.

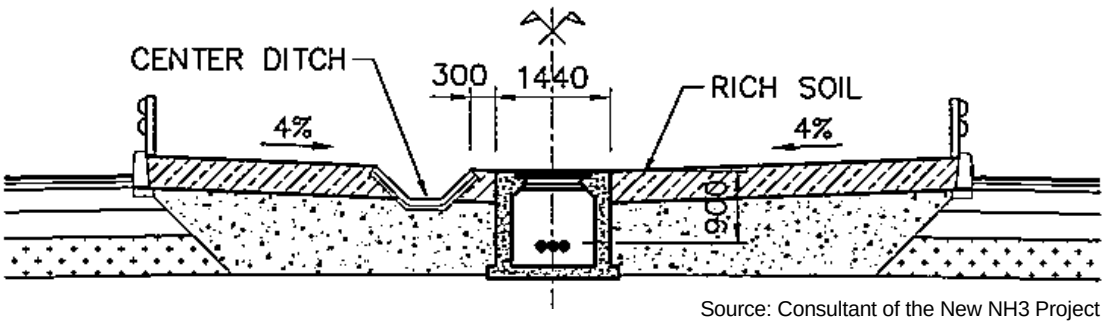
a. Splicing Number of Core: 100C or more

b. Connector: SC or FC Connector

(2) Conduit Plan

Cable conduit system for the communication system includes underground pipe, pipe attached to bridge or viaduct, hand-hole, pull box, cable rack and associated accessories necessary for cable installation. Typical section of conduit at grade-section is illustrated as figure below.

Figure 5.3 Typical Section of Conduit Installation



Source: Consultant of the New NH3 Project

Table below shows the comparison of conduit installation method at both sides and median of highway. By considering the following advantages, conduit for the optic fiber cable shall be basically installed at the median of the highway:

i) According to the Technical Specification issued by MIC (Outside Plant Communication - Technical Specification TCN 68-254:2006), the conduit shall be installed preferentially in the median,

ii) The conduit installed in the median is not impacted by vehicles load or bad weather issue such as heavy rain, slope erosion, etc,

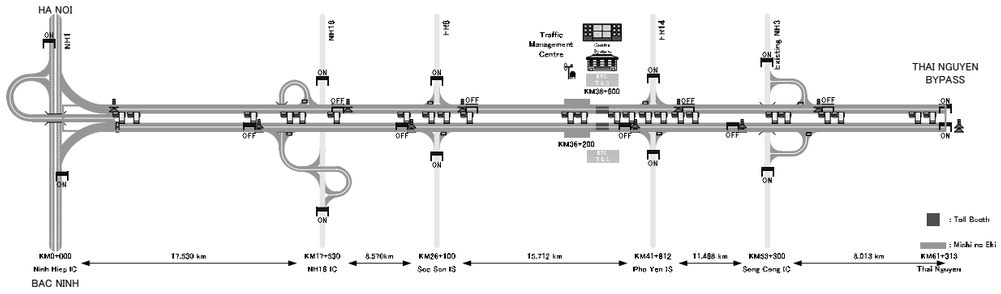
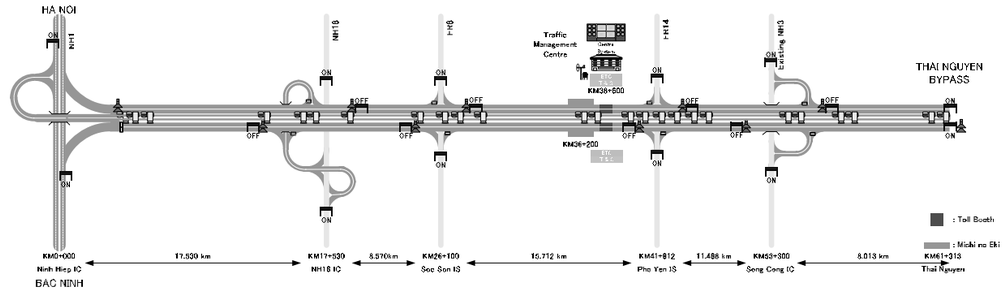
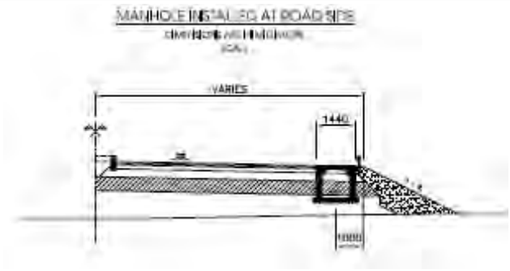
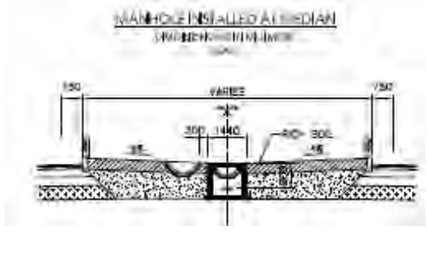
iii) Since almost all of the facilities are located in the center, the crossing conduit can be reduced,

iv) Construction cost is cheaper since the length of the conduit becomes half length compared to installing at both sides,

v) The possibility that the handhole cover and cable are stolen becomes lower, and

vi) More flexibility for the installation of CCTV camera at the median of highway through the lane can be achieved.

Table 5.3 Comparison Table of Conduit Installation Method at Both Sides and at Median of Highway

Prerequisite	Following design policies are applied; (1) CCTV camera will be installed at **median of highway**. (2) Supporting structure is **gantry type structure**.			
Installation Method	Conduit on both sides of highway		Conduit on median of highway	
Summary	Conduit will be installed along both side of the highway (under emergency lane).		Conduit will be installed to median of the highway.	
Location Map				
Sectional Drawing				
Crossing conduit	- Almost all of the facilities are located in the center, a lot of crossing conduits are required.	△	**- Almost all of the facilities are located in the center, crossing pipe can be reduced.**	○
Network reliability	- **Even incase the optic fiber cable is disconnected, the communication network can communicate through another route (Network Reliability is high).**	○	- In case the fiber is broken, there is a possibility of disconnection the fiber is passing 1route. (Reliability is not high).	△
Maintenance	- In case of fiber optic cable / power cable maintenance or additional ITS facilities are installed in future, traffic control will be required.	△	- In case of fiber optic cable / power cable maintenance or additional ITS facilities are installed in future, traffic control may not be required.	○
Cost	- Construction cost is higher since the length of excavation is double length compared to installing to median of highway. (60km×2route)	△	**- Construction cost is cheaper since the length of cable is half length compared to installing at both sides. (60km×1route)**	○
Risk against violence	- There are possibilities of accident if handhole cover is stolen.	△	- There are few possibilities that handhole cover will be stolen. Even if the cover was stolen, it may not affect the highway traffic.	○
ITS facility expansion	- Since almost all of the facilities are located in the center, additional crossing conduit works will be needed.	△	- No additional crossing conduit works will be needed.	○
Other issue	- Avoiding the approach slab of bridge.		- Avoiding sky-light for box-culvert (width: 1m).	
Recommendation	**Average**		**Recommended**	

Source: Consultant of the New NH3 Project

3) Network Supervisory Equipment

The communication system shall be equipped with a supervisory function which continuously monitors the system operation and issues an alarm in case malfunction. Supervisory equipment shall have the following functions;

- Management of occurrence
- Registration and modification of network system configuration
- Testing of equipment and circuit
- Logging of equipment operation and cable
- Changeover between primary and backup routes

4) Internal Telephone System

Internal telephone system over VoIP technology will be provided for voice communication between the personnel at the offices. The system will be also connected to the public switched telephone network for the communication with public. The system will consist of IP telephone sets and an IP based private branch exchange (IP-PBX) at the Road Management Office. IP-PBX will control centrally all telephone sets.

IP-PBX shall have the capacity to handle the number of telephone sets shown below.

Table 5.4 Number of Internal Telephone

Location	No. of Telephone Sets		Remarks
	Proposed	Future Demand	
1. Road Management Office	50	100	
2. Service Area	10 x 2	20 x 2	
3. Toll Barrier	12 x 2	12 x 2	
Total	94	164	

Source: Consultant of the New NH3 Project

The capacity of IP-PBX shall be of minimum 200 ports. The system must also have the capacity of 20 PSTN lines.

6. Electrical Facility

6.1 General

The power supply system for the New NH3 is planed to be fed from high voltage distribution line of 22 kV to supply road lighting with commercial power. However, lighting system of the New NH3 will be handed over and managed by local authority, while ITS facilities will be managed by DRVN. Thus, power supply system for lighting system and ITS facilities should be separately installed to clarify its demarcation. Also, ITS and toll collection facility must operate even during power interruption of high voltage distribution line and maintenance work of power supply equipment. Therefore, in this report, the power load demand for the ITS and the toll collection facility and required back-up power supply facilities such as Diesel Engine Generator (DEG) and Uninterruptible Power Supply (UPS) are clarified.

6.2 Power Supply for ITS Facilities

Almost all of ITS facilities except CCTV camera located at midway between interchanges will be located at Road Management Office, service area and interchanges. Supplying the power for the facilities needs to be considered to maintain the operation of equipments in normal condition (commercial power supply) and emergency condition (commercial power black-out) and to save initial cost as well as maintenance cost.

The table below shows required power supply points for the ITS and the toll collection facility, and their estimated demand load. The power supply facility will be required at the Road Management Office, the michi-no-eki and each interchange.

Table 6.1 Power Supply Points and Estimated Demand Load

No.	Station No.	Power Supply Points	Estimated Demand Load (kVA)	Required DEG Capacity (kVA)	Required UPS Capacity (kVA)
1	KM 0+000	Ninh Hiep IC	20 kVA	20 kVA	20 kVA
2	KM 17+530	NH18 IC	40 kVA	40 kVA	40 kVA
3	KM 26+100	Soc Son IC	40 kVA	40 kVA	40 kVA
4	KM 36+200	Michi-no-eki	10 kVA	10 kVA	10 kVA
5	KM 38+600	Road Management Office	200 kVA	100 kVA	80 kVA
6	KM 40+984	Yen Binh IC	40 kVA	40 kVA	40 kVA
7	KM 53+300	Song Cong IC	40 kVA	40 kVA	40 kVA
8	KM 61+313	Thai Nguyen IC	20 kVA	20 kVA	20 kVA

Source: ITS Integration Project (SAPI) Study Team

Apart from those power supply facilities, step down transformers with small capacity for feeding to CCTV camera will be required.

6.3 Diesel Engine Generator (DEG)

1) Capacity of the DEG

The Diesel Engine Generator (DEG) must operate during commercial power interruption. It is costly if the generator covers all loads of the system. Thus, loads for the DEG must be

selected to reduce the required capacity of the generator. The conditions to calculate loads for power supply by engine generator are as follows;

- Traffic management and toll collection equipment: 100 %
  (including A/C for equipment)
- Communication equipment: 100 %
  (including A/C for equipment)
- Lighting for tollbooth: 100 %
- Measuring equipment in toll plaza: 100 %
- Lighting and outlet for buildings: 50 %
- Air conditioner for tollbooth: 100 %
- Water supply and sewerage: 100 %
- Auxiliary power for engine generator: 100 %

2) Fuel Tank Capacity

Fuel tank capacity is calculated based on the following parameters:

- Generator operation duration: 24 hours
- Required oil tank capacity calculation formula:

  $Q=b \times Le/\varphi$

  Where, Q: Hourly fuel consumption (litter/h)

  b: Fuel consumption rate per horsepower (0.231-0.299kg/psh)

  Le: Engine power (PS)

  φ: Fuel oil specific gravity

  (Heavy oil: 0.84kg/litter, light diesel oil: 0.83kg/litter)

3) Basic Specifications

Type	Indoor, 4 cycle engine, Electrical Governor, Brushless exciter
Number of phase	3
Rated capacity (kVA)	10, 20, 40, 100 kVA (see **Table 6.1**)
Rated voltage (V)	400
Rated speed (rpm)	1500
Rated frequency (Hz)	50
Other equipment included	490 litters fuel tank (steel) for the road management office

6.4 Uninterruptible Power Supply (UPS)

To compensate for a short time power cut off during power changeover duration from commercial power to emergency generator power, Uninterruptible Power Supply (UPS) must be provided.

1) Compensation time of UPS

Generally, compensation time of UPS is decided by the expected power interruption period. Power supply system in the Project will have a DEG, it will take around 30 seconds until the DEG generates normal voltage after commercial power interruption. However, considering possible starting trouble of the DEG, the power interruption period is selected as 10 minutes.

2) Basic Specifications

Type	
- Capacity	10, 20, 40, 80 kVA (see **Table 6.1**)
- Compensation period	10 minutes
- Rating	Continuous duty
- Cooling system	Forced air-cooling
- System	Synchronized AC line (By-pass)
- Rectifier/Charger	Full wave rectifier
- Inverter	Transistor bridge
AC Input	
- Phase & Wiring	single phase 2 wires
- Rated voltage	220V
- Voltage variation range	Within $\pm$ 10%
- Rated frequency	50 Hz
- Frequency variation range	Within $\pm$ 5%

7. Cost Estimate

The cost for the ITS and the toll collection system are estimated as rough order basis with following conditions:

- Cost is on 2011 basis.
  - ROM (Rough Order Magnitude) cost information from major international manufacturers
  - Past projects contract price information
- Consultant's internal cost estimation data
- Not including contingencies and government tax.
- Not including costs for creation of new organization and site preparation (building), etc.

The cost for the ITS and the toll collection system are estimated as around 607.9 billion combined VND which including 23.4 million USD and 120 billion VND as shown in **Table 7.1** and **Table 7.2**.

The unit price information and cost estimate for the New NH3 will be further updated during detailed design stage to harmonize with ITS cost data for other expressways estimated by the JICA SAPI project.

Table 7.1 Summary of Cost Estimate for ITS and Toll Collection System in USD

No.	Item	Unit	Quantity	Amount (USD)	Amount (VND)	Total Combine (VND)
1	Traffic Information/Control System			9,988,761	26454278918	232,302,673,643
1.1	Vehicle Detector System	lot	1	201,383	2677169233	6,827,269,932
1.2	Weather Monitoring System	lot	1	96,957	222010973.2	2,220,109,732
1.3	CCTV Monitoring System	lot	1	617,340	1774004564	14,496,140,360
1.4	Heavy Truck Control System	lot	1	824,479	1887873656	18,878,736,558
1.5	Mobile Radio Communication System	lot	1	319,962	431661103.1	7,025,441,956
1.6	Variable Message Sign System	lot	1	3,334,554	7635386521	76,353,865,214
1.7	Traffic Management System	lot	1	3,028,567	11826172867	74,238,873,731
1.8	Training, Others	lot	1	1,565,520	0	32,262,236,160
2	Toll Collection System			10,286,688	12038392279	224,026,462,787
2.1	Semi-Automatic Toll Collection System	lot	1	654,998	1945975933	15,444,171,832
2.2	Electronic Toll Collection (ETC) System	lot	1	8,615,290	10092416345	187,636,319,754
2.3	Training, Others	lot	1	1,016,400	0	20,945,971,200
3	Communication System			2,853,136	21393086077	80,190,519,113
3.1	Fiber Optic System	lot	1	2,214,839	20527778084	66,171,190,171
3.2	Internal Telephone Others	lot	1	235,697	865307993.1	5,722,548,142
3.3	Training, Others	lot	1	402,600	0	8,296,780,800
4	Electrical Facility			546,202	38919507465	50,175,645,700
4.1	Electrical Facility	lot	1	148,882	38919507465	41,987,675,140
4.2	Others	lot	1	397,320	0	8,187,970,560
5	Power Supply			0	21202578567	21,202,578,567
5.1	Transformer	lot	1	0	9523579112	9,523,579,112
5.2	Power Line	lot	1	0	11678999456	11,678,999,456
Total				**23,674,788**	**120,007,843,306**	**607,897,879,809**

Source: ITS Integration Project (SAPI) Study Team

Table 7.2 Cost Estimate for ITS and Toll Collection System in USD

No.	Item	Description	Unit	Quantity	Unit Price (USD)	Unit Price (VND)	Amount (USD)	Amount (VND)
1	**Traffic Information/Control System**						**9,988,761**	**26,454,278,918**
1.1	**Vehicle Detector System**						**201,383**	**2,677,169,233**
1.1.1	**Roadside Equipment**						**48,150**	**2,326,299,733**
(1)	Vehicle Detector	CCTV Camera	set	**10**	1,170	2,679,040	11,700	26,790,400
(2)	Image Recognition Processor		set	**10**	3,645	8,346,240	36,450	83,462,400
(3)	Traffic Detector Pole, Others		lot	**10**		221,604,693	0	2,216,046,933
1.1.2	**Center Equipment**						**153,233**	**350,869,500**
(1)	Traffic Analysis Processor		set	**1**	153,233	350,869,500	153,233	350,869,500
1.2	**Weather Monitoring System**						**96,957**	**222,010,973**
1.2.1	**Outside Equipment**						**96,957**	**222,010,973**
(1)	Anemometer	Aero-vane type	set	**1**	23,590	54,016,123	23,590	54,016,123
(2)	Thermometer	Platinum resistance thermometer	set	**1**			Inc. above	0
(3)	Rainfall Gauge	Tipping bucket type	set	**1**			Inc. above	0
(4)	Visibility Meter	Light wave scattering type	set	**1**	38,016	87,048,192	38,016	87,048,192
(5)	Data Logger		set	**1**	35,351	80,946,658	35,351	80,946,658
1.3	**CCTV Monitoring Subsystem**						**617,340**	**1,774,004,564**
1.3.1	**Roadside Equipment**						**361,931**	**1,177,841,832**
(1)	CCTV Camera	PTZ camera with pole 10m	set	**44**	8,226	18,835,053	361,931	828,742,312
(2)	CCTV Camera Foundation		each	**44**		7,934,080	0	349,099,520
1.3.2	**Center Equipment**						**255,408**	**596,162,732**
(1)	NVR		set	**1**	675	1,545,600	675	1,545,600
(2)	CCTV Center Controller		set	**1**	235,697	539,693,350	235,697	539,693,350
(3)	Monitor Screen	LCD 20inch or larger	set	**8**	2,380	5,448,673	19,037	43,589,382
(4)	Printer		set	**1**		11,334,400	0	11,334,400
1.4	**Heavy Truck Control System**						**824,479**	**1,887,873,656**
1.4.1	**Roadside Equipment**						**470,968**	**1,078,412,518**
(1)	Axle Load Scale		set	**6**	45,615	104,447,526	273,688	626,685,158
(2)	Vehicle Detector	Inductive loop detector or equivalent	set	**6**	1,803	4,127,782	10,816	24,766,694
(3)	Lane Monitoring Camera	IP camera	set	**6**	9,900	22,668,800	59,400	136,012,800
(4)	Automatic Number Plate Recognition Camera	Infrared type	set	**6**	9,900	22,668,800	59,400	136,012,800
(5)	Overweight Warning Display	LED type or equivalent	set	**6**	2,250	5,152,000	13,500	30,912,000
(6)	Roadside Panel		set	**1**	54,164	124,023,066	54,164	124,023,066
1.4.2	**Center Equipment**						**353,511**	**809,461,137**
(1)	Heavy Truck Control Data Server	Video/Data multiplexer, Capture overlay unit, etc.	set	**1**	353,511	809,461,137	353,511	809,461,137
1.5	**Mobile Radio Communication System**						**319,962**	**431,661,103**
1.5.1	**Center Equipment**						**188,517**	**431,661,103**
(1)	Radio Equipment	VHF or UHF band	set	**1**	188,517	431,661,103	188,517	431,661,103
(2)	Communication Control Equipment		set	**1**			Inc. above	0
(3)	Radio Communication Console	Inc. Microphone	set	**1**			Inc. above	0
(4)	Radio Antenna	Yagi type antenna	set	**2**			Inc. above	0
(5)	Coaxial Arrester & Cable		set	**1**			Inc. above	0
1.5.2	**Mobile Equipment**						**131,446**	**0**
(1)	Mobile Unit	Vehicle Mounted	set	**20**	3,928		78,566	0
(2)	Mobile Unit	Portable	set	**20**	2,644		52,879	0
1.6	**Variable Message Sign Subsystem**						**3,334,554**	**7,635,386,521**
1.6.1	**Roadside Equipment**						**3,122,447**	**7,149,709,295**
(1)	Variable Message Sign Board	High intensity LED	set	**20**	117,882	269,922,842	2,357,634	5,398,456,842
(2)	VMS Controller		set	**20**	29,436	67,402,503	588,725	1,348,050,063
(3)	VMS Support Gate Type incl. Foundation			**20**	8,804	20,160,119	176,088	403,202,389
1.6.2	**Center Equipment**						**212,107**	**485,677,226**
(1)	VMS Center Controller		set	**1**	212,107	485,677,226	212,107	485,677,226
1.7	**Traffic Management System**						**3,028,567**	**11,826,172,867**
(1)	Traffic Management System Server		set	**1**	1,414,111	3,237,999,604	1,414,111	3,237,999,604
(2)	Facility Management Server		set	**1**	1,178,414	2,698,306,254	1,178,414	2,698,306,254
(3)	Display Panel & Controller	50 inch LCD x 4 multi screen	set	**1**	282,809	647,569,182	282,809	647,569,182
(4)	System Clock Server	NTP or SNTP	set	**1**	94,292	215,906,719	94,292	215,906,719
(5)	Operator Console		set	**1**	58,941	134,962,781	58,941	134,962,781
(6)	Monitoring PC		set	**2**		135,441,546	0	270,883,092
(7)	LAN Network Facilities		set	**1**		540,161,234	0	540,161,234
(8)	Furniture	PCs, Air conditioning system, Fire fighting system, etc.	lot	**1**		4,080,384,000	0	4,080,384,000
1.8	**Training, Others**						**1,565,520**	**0**
1.8.1	**Training**		lot	**1**	290,400		**290,400**	**0**
1.8.2	**Spare parts, Maintenance equipment**		lot	**1**	708,840		**708,840**	**0**
1.7.3	**Others**	**Commissioning Test, Manuals, Others**	lot	**1**	566,280		**566,280**	**0**
1. Traffic Management System Total							**9,988,761**	**26,454,278,918**

Source: ITS Integration Project (SAPI) Study Team

2	**Toll Collection System**						**10,286,688**	**12,038,392,279**
2.1	**Semiautomatic Toll Collection System (Barcode Ticket System)**						**654,998**	**1,945,975,933**
2.1.1	**Toll Lane**						**337,178**	**869,448,223**
(1)	Traffic Sign		set	**10**	1,360	3,114,693	13,603	31,146,931
(2)	Indication Lamp		set	**10**	1,105	2,529,838	11,048	25,298,381
(3)	Automatic License Number Plate Recognition Camera (ANPR)	Infrared type	set	**10**	4,759	10,897,346	47,591	108,973,455
(4)	Lane Camera	CCD color camera	set	**10**	1,699	3,889,966	16,988	38,899,661
(5)	Vehicle Detector	Inductive loop detector or equivalent	set	**10**	934	2,138,121	9,338	21,381,212
(6)	Lane VMS	LED type or equivalent	set	**10**	2,719	6,226,666	27,193	62,266,660
(7)	Automatic Lane Barrier		set	**10**	7,733	17,706,146	77,327	177,061,463
(8)	Manual Lane Barrier		set	**10**	765	1,751,845	7,651	17,518,449
(9)	Alarm Horn and Lamp		set	**10**	84	193,138	843	1,931,382
(10)	Lane Control Panel		set	**10**	5,950	13,623,042	59,495	136,230,420
(11)	Lane Server		set	**10**	4,334	9,923,494	43,338	99,234,939
(12)	Barcode Reader		set	**10**	662	1,515,183	6,617	15,151,826
(13)	Internal Telephone		set	**10**		3,889,966	0	38,899,661
(14)	Overall Camera		set	**2**	1,699	3,889,966	3,398	7,779,932
(15)	Toll Booth Facilities	UPS, Air Conditioner, Exhaust Gas Diffuser, etc.	set	**10**	1,275	2,918,835	12,747	29,188,347
(16)	LAN Network Facilities		set	**10**		5,848,550	0	58,485,504
2.1.2	**Toll Office**						**317,820**	**1,076,527,711**
(1)	Server		set	**1**	288,929	661,582,581	288,929	661,582,581
(2)	Monitoring Camera	Inspection Data Management	set	**2**	1,699	3,889,966	3,398	7,779,932
(3)	Camera Monitoring Equipment	Monitoring TV, Switcher, Controller, VTR, etc.	set	**1**	25,493	58,373,974	25,493	58,373,974
(4)	Monitoring Computer		set	**5**		40,885,448	0	204,427,238
(5)	Computer for selling periodic ticket		set	**1**		40,885,448	0	40,885,448
(6)	Computer for accounting	With printer	set	**1**		70,073,795	0	70,073,795
(7)	Internal Telephone		set	**3**		4,651,638	0	13,954,913
(8)	LAN Network Facilities		set	**1**		19,449,830	0	19,449,830
2.2	**Electronic Toll Collection (ETC) System**						**8,615,290**	**10,092,416,345**
2.2.1	**Toll Lane**						**68,830**	**1,809,236,825**
(1)	Traffic Sign		set	**2**	1,360	3,114,693	2,721	6,229,386
(2)	Indication Lamp		set	**2**	1,105	2,529,838	2,210	5,059,676
(3)	Automatic License Number Plate Recognition Camera (ANPR)	Infrared type	set	**2**	4,759	10,897,346	9,518	21,794,691
(4)	Lane Camera	CCD color camera	set	**2**	1,699	3,889,966	3,398	7,779,932
(5)	Vehicle Detector	Inductive loop detector or equivalent	set	**2**	934	2,138,121	1,868	4,276,242
(6)	Lane VMS	LED type or equivalent	set	**2**	2,719	6,226,666	5,439	12,453,332
(7)	Automatic Lane Barrier		set	**2**	7,733	17,706,146	15,465	35,412,293
(8)	Manual Lane Barrier		set	**2**	765	1,751,845	1,530	3,503,690
(9)	Alarm Horn and Lamp		set	**2**	84	193,138	169	386,276
(10)	Roadside Controller		set	**2**	5,950	13,623,042	11,899	27,246,084
(11)	Entrance Card Issuer		set	**2**	1,699	3,889,966	3,398	7,779,932
(12)	Lane Server		set	**2**	4,334	9,923,494	8,668	19,846,988
(13)	Internal Telephone		set	**2**		3,889,966	0	7,779,932
(14)	Toll Booth Facilities	UPS, Air Conditioner, Exhaust Gas Diffuser, etc.	set	**2**	1,275	2,918,835	2,549	5,837,669
(15)	LAN Network Facilities		set	**2**		5,848,550	0	11,697,101
(16)	Roadside Antenna		set	**2**		816,076,800	0	1,632,153,600
2.2.2	**Toll Office**						**8,546,460**	**8,283,179,520**
(1)	Toll Management Server		set	**1**	3,564,000	8,160,768,000	3,564,000	8,160,768,000
(2)	IC Card / OBU Registration Terminal		set	**2**	20,196	46,244,352	40,392	92,488,704
(3)	IC Card Reader / Writer		set	**5**	2,614	5,984,563	13,068	29,922,816
(4)	IC Card		set	**300,000**	1.25		375,000	0
(5)	On Board Unit		set	**50,000**	91		4,554,000	0
2.3	**Training, Others**						**1,016,400**	**0**
2.3.1	**Training**		lot	**1**	158,400		**158,400**	**0**
2.3.2	**Spare parts, Maintenance equipment**		lot	**1**	476,520		**476,520**	**0**
2.3.3	**Others**	**Commissioning Test, Manuals, Others**	lot	**1**	381,480		**381,480**	**0**
2. Toll Collection System Total							**10,286,688**	**12,038,392,279**

Source: ITS Integration Project (SAPI) Study Team

3	**Communication System**						**2,853,136**	**21,393,086,077**
3.1	**Fiber Optic System**						**2,214,839**	**20,527,778,084**
(1)	Fiber Optic Node	Gigabit/10Gigabit Ethernet	set	**8**	35,351	80,946,658	282,811	647,573,262
(2)	Access Node	Media Converter	set	**160**	2,285	5,231,052	365,524	836,968,366
(3)	Fiber Optic Cable	SM-100C	km	**124**	10,605	24,283,725	1,315,054	3,011,181,939
(4)	Fiber Optic Termination		set	**8**	5,915	13,544,155	47,320	108,353,237
(5)	Closure		set	**132**	653	1,496,141	86,249	197,490,586
(6)	PVC Pipe	φ110	km	**186**		66,945,500	0	12,478,641,230
(7)	Manhole	1.44m x 1.6m, H=1.35m	pc	**478**		6,229,386	0	2,977,646,623
(8)	Supervisory Equipment		set	**1**	117,882	269,922,842	117,882	269,922,842
3.2	**Internal Telephone Others**						**235,697**	**865,307,993**
(1)	Main PBX	IP-PBX with Console	set	**1**	235,697	539,693,350	235,697	539,693,350
(2)	Telephone Set	IP-TEL	set	**70**		4,651,638	0	325,614,643
3.3	**Training, Others**						**402,600**	**0**
3.3.1	**Training**		lot	**1**	79,200		**79,200**	**0**
3.3.2	**Spare parts, Maintenance equipment**		lot	**1**	179,520		**179,520**	**0**
3.3.3	**Others**	**Commissioning Test, Manuals, Others**	lot	**1**	143,880		**143,880**	**0**
3. Communication System Total							**2,853,136**	**21,393,086,077**
4	**Electrical Facility**						**546,202**	**38,919,507,465**
4.1	**Electrical Facility**						**148,882**	**38,919,507,465**
(1)	Diesel Engine Generator	400V 3-phase, 10kVA with Fuel Tank	set	**1**	11,000	245,410,000	11,000	245,410,000
(2)	Diesel Engine Generator	400V 3-phase, 20kVA with Fuel Tank	set	**2**	11,000	297,693,000	22,000	595,386,000
(3)	Diesel Engine Generator	400V 3-phase, 40kVA with Fuel Tank	set	**4**	11,000	655,160,000	44,000	2,620,640,000
(4)	Diesel Engine Generator	400V 3-phase, 100kVA with Fuel Tank	set	**1**	11,000	984,500,000	11,000	984,500,000
(5)	UPS	3-phase 400V, 10kVA	set	**1**		458,585,600	0	458,585,600
(6)	UPS	3-phase 400V, 20kVA	set	**2**		458,585,600	0	917,171,200
(7)	UPS	3-phase 400V, 40kVA	set	**4**		641,681,700	0	2,566,726,800
(8)	UPS	3-phase 400V, 80kVA	set	**1**		1,452,011,000	0	1,452,011,000
(9)	DC Power Supply (3 kVA)	3 kVA	set	**1**	60,882		60,882	0
(10)	Low Voltage Cable	600V XLPE Insulated PVC Sheathed Cable	km	**44**		660,888,111	0	29,079,076,865
4.2	**Others**						**397,320**	**0**
4.2.1	**Spare parts, Maintenance equipment**		lot	**1**	220,440		**220,440**	**0**
4.2.2	**Others**	**Commissioning Test, Manuals, Others**	lot	**1**	176,880		**176,880**	**0**
4. Electrical Facility Total							**546,202**	**38,919,507,465**
5	**Power Supply**						**0**	**21,202,578,567**
5.1	**Transformer**						**0**	**9,523,579,112**
(1)	Transformer 22KV/0.4KV	100KVA-22KV/0.4KV	set	**7**		944,830,416	0	6,613,812,913
(2)	Transformer 22KV/0.4KV	50KVA-22KV/0.4KV	set	**4**		727,441,550	0	2,909,766,199
5.2	**Power line**						**0**	**11,678,999,456**
(1)	Power line 22KV	Connecting from Transformer to Power Company Substation	km	**33**		353,909,074	0	11,678,999,456
5. Power Supply Total							**0**	**21,202,578,567**

Total		**23,674,788**	**120,007,843,306**

Source: ITS Integration Project (SAPI) Study Team

8. Implementation Schedule

Table 8.1 shows the revised ITS implementation schedule including detailed design, bidding and construction stage together with proposed consultant manning schedule. The ITS implementation plan was reviewed on the basis of the following conditions.

[Detailed Design Stage]

i) Detailed design work will be immediately commenced from the begging of December 2011 after the authorization of revised ITS basic plan for the New NH3 by MOT.

ii) A total of five (5) months will be needed for detailed design including preparation of drawings, P/Q document, bidding document and cost estimates.

iii) In the early phase of detailed design stage, P/Q document will be prepared to minimize the total time period of bidding process.

[Bidding Stage]

i) P/Q announcement will be made in the beginning of March 2012 and prequalification period requires 45 days.

ii) After prequalification, P/Q evaluation and the approval of P/Q evaluation report by PMU2, bidding announcement will be made in the beginning of July 2012. The bidding period needs 60 days.

iii) After bid open, processes for bid evaluation and clarification, price negotiation and concurrence from MOT and JICA are required.

[Construction Stage]

i) The construction work will be commenced from March of 2013 after bidding process.

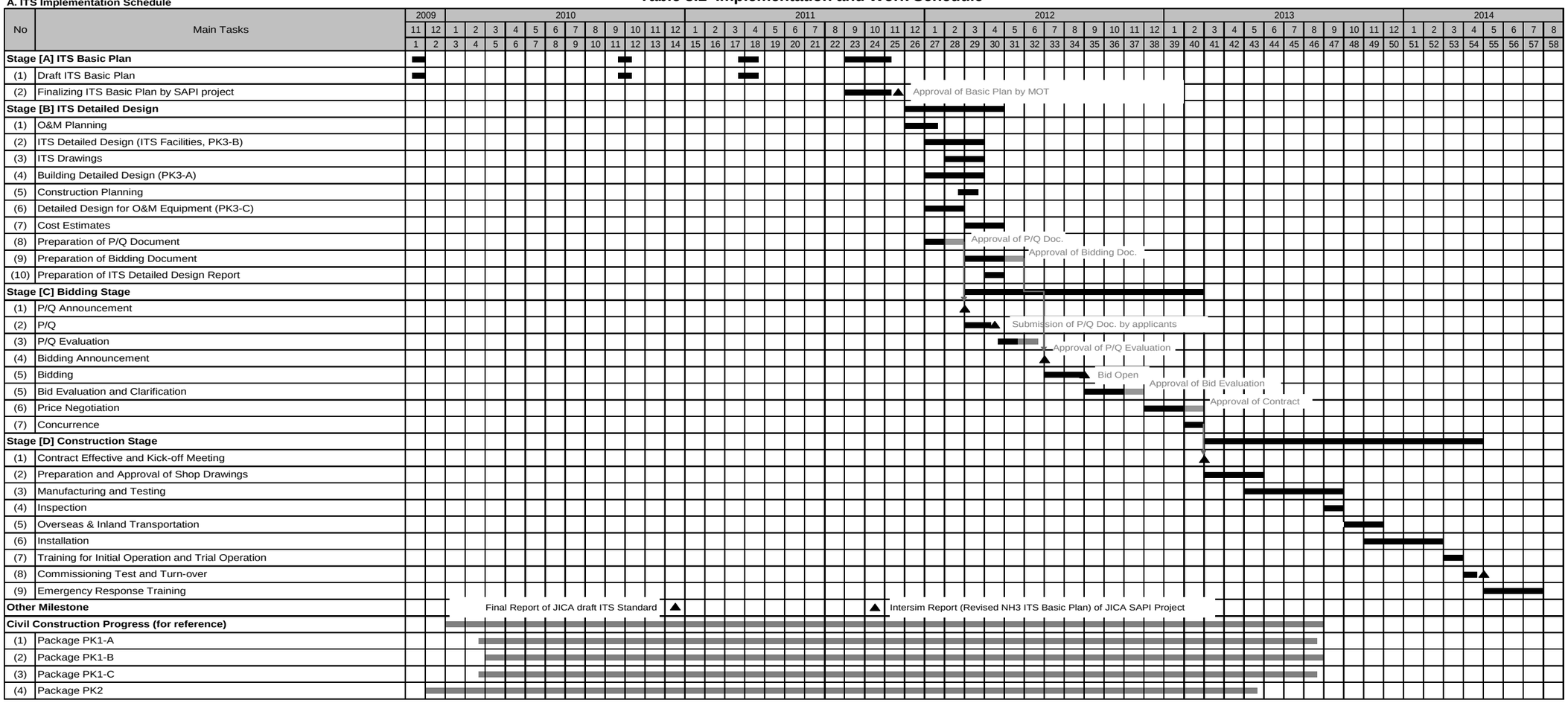
ii) A period of construction stage will be total of 14.5 months including the works for preparation of shop drawing (3months), manufacturing and testing (5months), factory inspection (1month), overseas and inland transportation (2months), equipment installation (4months), and training and trial operation (1month).

Finally, the turn over of ITS facilities will be expected in the middle of April 2014.

Table 8.1 Implementation and Work Schedule

A. ITS Implementation Schedule

No	Main Tasks
Stage [A] ITS Basic Plan	
(1)	Draft ITS Basic Plan
(2)	Finalizing ITS Basic Plan by SAPI project
Stage [B] ITS Detailed Design	
(1)	O&M Planning
(2)	ITS Detailed Design (ITS Facilities, PK3-B)
(3)	ITS Drawings
(4)	Building Detailed Design (PK3-A)
(5)	Construction Planning
(6)	Detailed Design for O&M Equipment (PK3-C)
(7)	Cost Estimates
(8)	Preparation of P/Q Document
(9)	Preparation of Bidding Document
(10)	Preparation of ITS Detailed Design Report
Stage [C] Bidding Stage	
(1)	P/Q Announcement
(2)	P/Q
(3)	P/Q Evaluation
(4)	Bidding Announcement
(5)	Bidding
(5)	Bid Evaluation and Clarification
(6)	Price Negotiation
(7)	Concurrence
Stage [D] Construction Stage	
(1)	Contract Effective and Kick-off Meeting
(2)	Preparation and Approval of Shop Drawings
(3)	Manufacturing and Testing
(4)	Inspection
(5)	Overseas & Inland Transportation
(6)	Installation
(7)	Training for Initial Operation and Trial Operation
(8)	Commissioning Test and Turn-over
(9)	Emergency Response Training
Other Milestone	
Civil Construction Progress (for reference)	
(1)	Package PK1-A
(2)	Package PK1-B
(3)	Package PK1-C
(4)	Package PK2



B. Consultant Manning Schedule (ITS)

No	Position	M/M
Expatriate Engineer		
1	ITS Specialist	19.0
2	Traffic Control and Management Specialist	7.3
3	Toll Facility Specialist	6.0
4	O&M Specialist	7.3
5	Document Specialist	1.0
	Total	40.6
Local Engineer		
1	ITS Engineer (for PK3-B)	25.0
2	Traffic Control and Management Engineer (for PK3-B)	12.0
3	Toll Facility Engineer (for PK3-B)	9.0
4	Electrical Engineer (for PK3-B)	7.0
5	Capital Construction Engineer (for PK3-A, Michi no Eki)	6.0
6	Capital Construction Engineer (for PK3-A, Toll Plaza & ROM)	12.0
7	O&M Specialist (for PK3-B, C)	9.0
8	Cost Estimator 1 (for PK3-A)	2.0
9	Cost Estimator 2 (for PK3-B and PK3-C)	2.0
10	Document Specialist	2.0
	Total	86.0
Local Supporting Staff		
1	Cad Operator 1 (for PK3-A)	3.0
2	Cad Operator 2 (for PK3-B)	3.0
3	Secretary	25.7
4	Translator	19.7
	Total	51.4

Source: ITS Integration Project (SAPI) Study Team

Annex-1 Comparison between New NH3 ITS Basic Plan and Vietnamese Regulation

ITS Facilities	ITS Basic Plan for the New NH3	Vietnamese Regulation	
CCTV Camera	Digital IP Camera with pan-tilt and zoom functions (PTZ Camera)	Digital IP Camera with pan-tilt and zoom functions (PTZ Camera)	MOT Decision 2530/BGTVT-KHCN
Vehicle Detection	Image recognition type detector	Image recognition type detector (traffic detection, traffic volume and traffic flow speed (VDS) function)	MOT Decision 2530/BGTVT-KHCN
Mobile Radio Communication	Mobile radio communication using exclusive frequency (VHF or UHF) will be used for road management.	Not specified	
Variable Message Sign (VMS)	High Intensity LED type VMS	Not specified	
Weather Monitoring	Rainfall gauge, Anemometer, Thermometer, Visibility Meter	Not specified	
Traffic Management System	- Traffic Management System Server - Facility Management Server - Display Panel with Controller - System Clock Server - Operator Console and Monitoring PC	Not specified	
Toll Collection System	(1) Toll Charging Principle (Access Control) Open System	(1)Toll Charging Principle (Access Control) Open System	MOF Circular No.90/2004/TT-BTC
	(2) Toll Rate Principle Flat tariff system	(2)Toll Rate Principle Flat tariff system	MOF Circular No.90/2004/TT-BTC
	(3) Semi-automatic Toll Collection Barcode ticket system	(3) Semi-automatic Toll Collection Barcode ticket system	TCCS 01: 2008/VRA
	(4) Type of ETC System (Road-to-vehicle communication for ETC) **Active DSRC (5.8GHz) type**	(4) Type of ETC System (Road-to-vehicle communication for ETC) **Passive RFID (860-960MHz) type**	MOT Decision 2530/BGTVT-KHCN
	Main reason of not following MOT's Decision:		

ITS Facilities	ITS Basic Plan for the New NH3	Vietnamese Regulation	
	- High accuracy of communication - Proven standard for nationwide ETC.	- Relative low accuracy of communication - Not enough past records for nationwide ETC. (Passive RFID type ETC is applied to only 3 expressways in USA and toll tariff system of those expressways is basically flat rate tariff system. The systems are to be used as individual expressway toll collection system and not used as nationwide ETC system (It is normally said that RF-ID system requires heavy work load of center system and not suitable nationwide ETC).).	
Heavy Truck Control System	- Axle load scale - Vehicle detector - Lane monitoring camera - Automatic number plate recognition camera (ANPR) - Overweight warning display - Roadside equipment	Not specified	
Power Supply System	- Down-step transformer - Diesel engine generator - Uninterruptible power supply (UPS)	Not specified	

Annex-2 Relevant Standard

The following table lists the tentative candidate standards as temporary base. It shall be noted that the standards to be applied will be further investigated during the detail design stage according to the result of SAPI project, and some standards might be altered/added/deleted to be in line with the policy of the Vietnamese government.

1) Referential Standard for Data Exchange between Systems

Reference	Descriptions
ISO 14813:2009	Reference model architecture for the ITS sector
ISO 14817:2002	Transport information and control systems – Requirements for ITS/TICS central data registry and ITS/TICS data dictionaries
ISO 14827-1:2005	Transport information and control systems – Data interfaces between centers for transport information and control system – Part1: message definition requirements
ISO 14827-2:2005	Transport information and control systems – Data interfaces between centers for transport information and control systems – Part 2: DATEX-ASN
ISO 15784-1:2008	Intelligent transport systems (ITS) – Data exchange involving roadside modules communication Part1: General principles and documentation framework of application profiles
ISO 15784-3:2008	Intelligent transport systems (ITS) – Data exchange involving roadside modules communication --- Part3: Application profile-data exchange (AP-DATEX)

2) Toll Collection

Reference	Descriptions
TCCS 01: 2008/VRA	Specification for the one-stop toll station with barcodes receipts
ISO/IEC 11179	Information technology – specification and standardization of data elements
ITU-R M.1453	DSRC at 5.8GHz (Physical Layer)
ISO 15628	DSRC Applications
ISO 14906	Application Interface Definition for DSRC
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

3) Database

Reference	Descriptions
Database	Structured Query Language (SQL)

4) Communication

Reference	Descriptions
Ethernet	• 8802-3: 2000 (ISO/IEC) (ANSI/IEEE Std 802.3 2000 Edition): Information Technology – Telecommunications and information exchange between systems – Local and Metropolitan area networks – Specific equipment --- Part3: Carrier sence multiple access with collision detection (CAMA/CD) access method and physical layer specifications.
Fast Ethernet	• IEEE 802.3u-1995 IEEE Standards for Local and metropolitan area networks: Supplement to Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications: Media access control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100Mb/s Operation, Type 100BaseT (Clauses 21-30) (ANSI) • EIA/TIA568B (AT and T-258A) Commercial Building Telecommunications Wiring Standard, 1991
Gigabit Ethernet	• IEEE 802.3ab : Physical coding sublayer (PCS), physical medium attachment (PMA) sublayer and baseband medium, type 1000BASE-T • IEEE 802.3z : Media Access Control(MAC) Parameters, Physical Layer, Repeater and Management Parameters for 1000 Mb/s Operation
FTP	• RFC 959 File Transfer Protocol, J. Postel, J.K. Reynolds, Oct-01-1985 • RFC 1350 The TFTP Protocol (Revision 2), K. Sollins, July 1992 (TFTP)
HTTP	• RFC 1945 Hypertext Transfer Protocol -- HTTP/1.0. R. Fielding, H. Frystyk, T. Berners-Lee, May 1996 • RFC 2068 Hypertext Transfer Protocol -- HTTP/1.1. R. Fielding, J. Gettys, J. Mogul, H. Frystyk, T. Berners-Lee, January 1997 (Status: PROPOSED STANDARD) • RFC 2616 Hypertext Transfer Protocol /1.1 June 1999 • RFC 2617 HTTP Authentication: Basic and Digest Access Authentication, June 1999
IP	• RFC 791 Internet Protocol. J. Postel. Sep-01-1981
PPP	• RFC 1661 The Point-to-Point Protocol (PPP), W. Simpson, July 1994
SNMP	• RFC 1157 Simple Network Management Protocol (SNMP), J.D. Case, M. Fedor, M.L.Schoffstall, C. Davin, May-01-1990

Reference	Descriptions
TCP	• RFC 793 Transmission Control Protocol. J. Postel. Sep-01-1981
UDP	• RFC 768 User Datagram Protocol. J. Postel. Aug-28-1980
MPEG4	• ISO/IEC 144916-1:1999 Information technology – Coding of audio visual objects – Part 1: Systems • ISO/IEC 144916-2:1999 Information technology -- Coding of audio-visual objects -- Part 2: Visual • ISO/IEC 144916-2:1999 Information technology -- Coding of audio-visual objects -- Part 3: Audio • ISO/IEC 14496-10:2003: Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding
FOC	• ITU-T G 652: Characteristics of a single-mode optical fibre and cable • ITU-T G 655: Characteristic of a non-zero dispersion-shifted single-mode optical fibre and cable

5) Conduit and Manhole

Reference	Descriptions
TCN 68 - 254: 2006	Outside Plant Communication – Technical Specification
TCN 68 - 153: 1995	Cable duct and cable connection box – Technical Standard
TCN 68 - 144: 1995	Rigid Polyvinyl pipe for underground cables – Technical Standard
TC.VNPT - 06:2003	PVC-U pipe for underground cables – Technical Standard
TCN 68 - 178: 1999	Code of Practice for the construction of optical fiber – Communication system
22 TCN - 331 - 05	Sign Board for Expressway
JEAC8001-2005	Japan Electricity Association