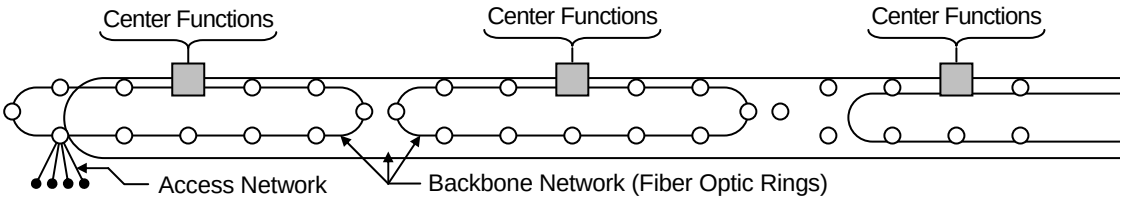
8.3 Communication Network

1) Structure of Communication Network

Communication network consists of the backbone network and the access network as below. The backbone network needs to secure sufficient capacity for additional use in the future, and is required to achieve the excellent stability and the prompt recovery from network trouble as well. Consequently, fiber optic ring is to be adopted for the backbone network and network management is to be included in the center functions.

Figure 8.3.1 Structure of Communication Network



Note: - ▭ : Main-node for the center functions (of the management office or the main center),
- ○ : Sub-node for connecting the roadside equipment,
- ↘ : Roadside equipment.

Source: VITRANSS 2 Study Team

The fiber optic rings tend to be installed by sections of the road and to be operated by the different operators; however, cooperation among them needs to be secured by connecting the main-nodes each other.

The functions for road operation discussed in the foregoing section are to be actualized by the equipment organized hierarchically through the backbone network as shown below. The roadside equipment is connected to the sub-nodes at the node spots and is operated remotely from the management office by the road section. The maintenance offices are to be integrated by the main center for the efficient road operation.

The management office needs to be facilitated by the monitoring equipment for surveillance and the operation vehicles including a patrol car, an ambulance, a tow car and a maintenance car as mentioned in the minimal service requirements in Chapter 4. In addition, it is required that the time to send the operation vehicles to the incident site is to be less than 1 hour from the occurrence of incident, where notification of the occurrence of incident to the road operator is performed within 10 minutes and the average travel speed of the vehicles on the expressway network is more than 60 km/h as shown in the minimal service requirements.

Hence, the intervals of the management office on the expressway network shall be less than 80 km as shown by the calculation below.

$$\textit{Maximum Interval} = 80\ km < ((60–10–5) \times 60 / 60) \times 2$$

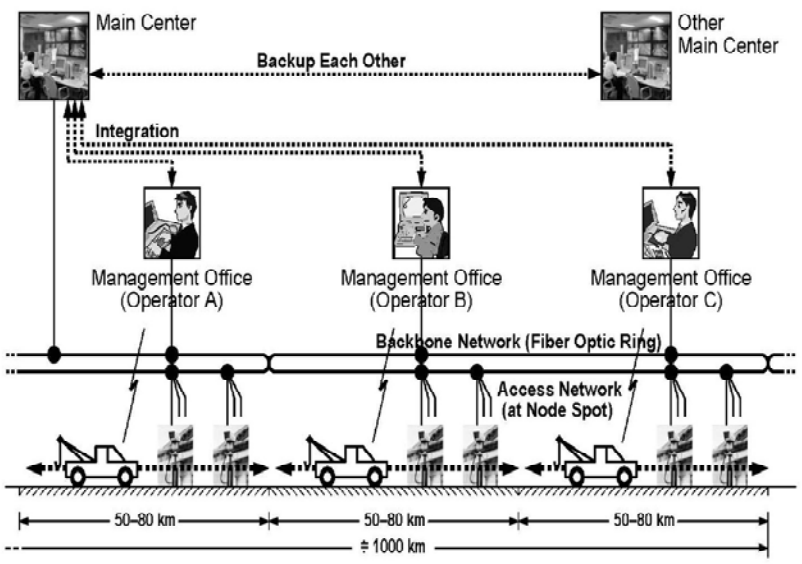
The management offices are to be integrated over the large range on the road network for the following reasons:

(i) Information dissemination beyond the border of the offices to allow the drivers to avoid the influence of incident and the traffic congestion and to reschedule his travel,

(ii) Traffic data analysis over the jurisdictions of the offices to allow the planners to set appropriate priorities to the road improvement projects,

(iii) Cost cutting on construction of the center.

Figure 8.3.2 Hierarchical Structure on Backbone Network



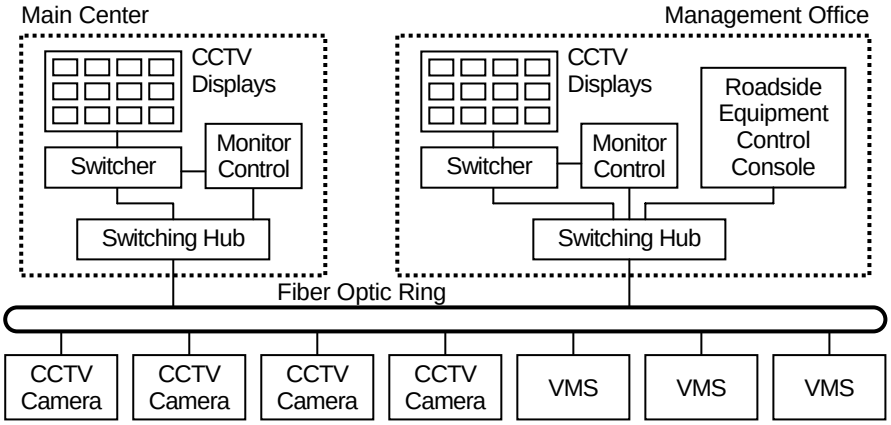
	Node Spot					
	Interchange	Barrier Tollgate	Rest Area	Junction	Lighting Station	Tunnel
Manual Toll Collection	✓	✓				
Touch&Go	✓	✓				
ETC	✓	✓				
CCTV	✓	✓	✓	✓	✓	✓
Vehicle Detection	✓	✓	✓	✓	(✓)	
Weather Sensing	✓	✓	✓			
VMS/SGM	✓	✓		✓	(✓)	✓
Emergency Telephone				✓	✓	✓
Radio Communication				(✓)	(✓)	(✓)
Wired Communication	✓	✓	✓	✓	✓	✓
Lightening	✓	✓	✓	✓	✓	✓
Power Equipment	✓	✓	✓	✓	✓	✓
Tunnel Equipment						✓

Source: VITRANSS 2 Study Team

The main center fulfils the role of integration and its appropriate jurisdictional range is assumed around 1000km in the Master Plan.

Video image and message sign are the major data that affects the structure of communication network. CCTV camera and VSM at roadside are to be controlled remotely from the center. Video images shall be put up on the many sets of colour displays in the center, being selected automatically by turns by a switcher under normal conditions or being selected manually in case of an incident. Video images shall be put up on the colour displays in the main center as well. The roadside equipment control is conducted at the management office in the 1st stage of ITS introduction; however, that shall be transfer to the main centers for realizing more integrated form of the traffic information/control in the later stage.

Figure 8.3.3 Roadside Equipment Monitoring/Control in the 1st Stage

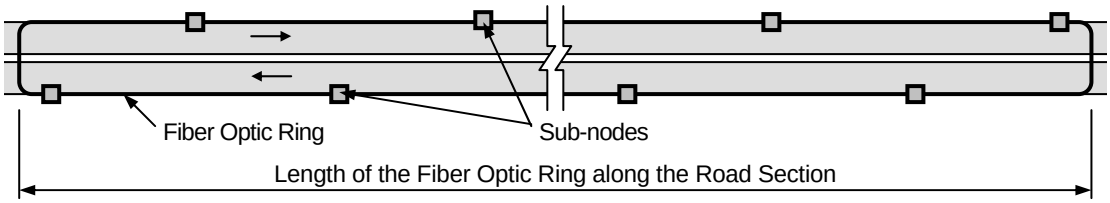


Note, **: Roadside equipment control is to be transfer to the main center in the later stage
Source: VITRANSS 2 Study Team

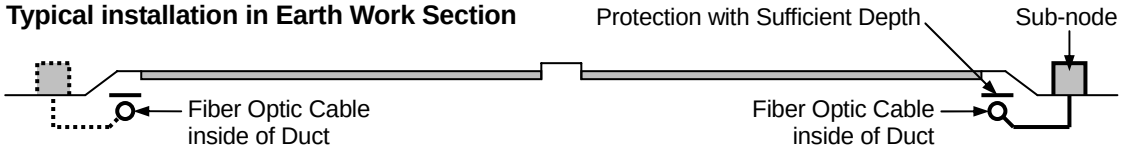
2) Installation of Fiber Optic Cable

The fiber optic cable is to be installed along the road keeping adequate distance between up-line and down-line as shown below for securing physical stability and redundancy.

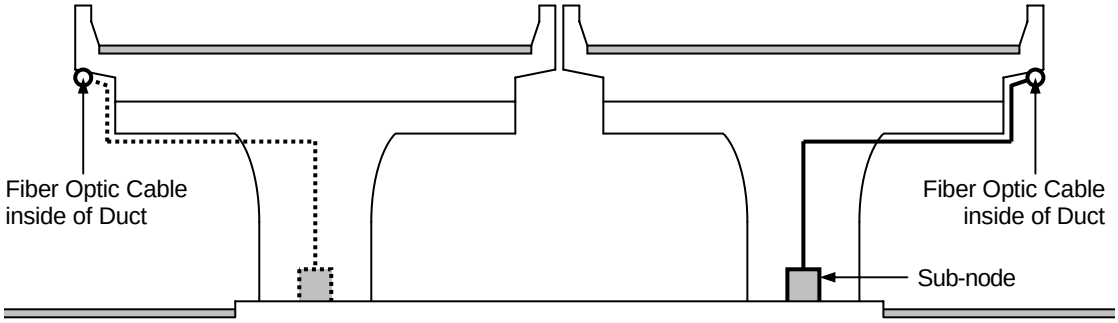
Figure 8.3.4 Typical Arrangement of Main Ring and Sub-nodes



Typical installation in Earth Work Section



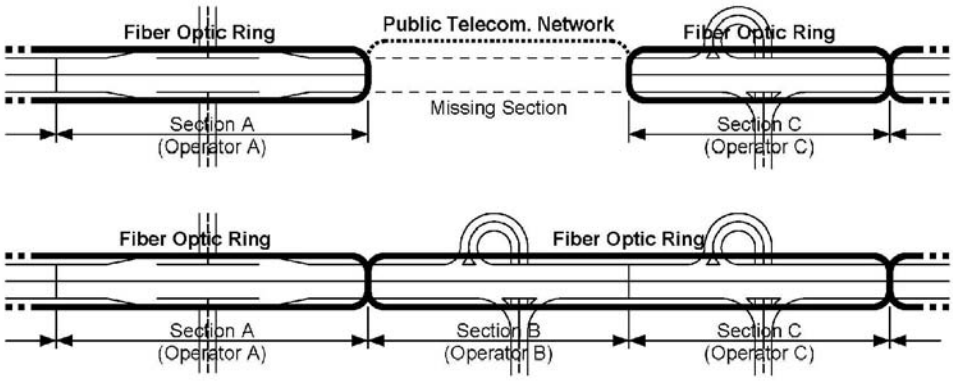
Typical installation in Viaduct Section



Source: VITRANSS 2 Study Team

In addition, the fiber optic cable of backbone network is to be installed by sections of the road. For the missing section, the public telecommunication network is to be used as a complement in the first stage as shown below; then, the fiber optic cable is to be installed to form the linked loops after filling a blank of the road section.

Figure 8.3.5 Stepwise Installation of Fiber Optic Cable



Source: VITRANSS 2 Study Team

3) Transmission Method

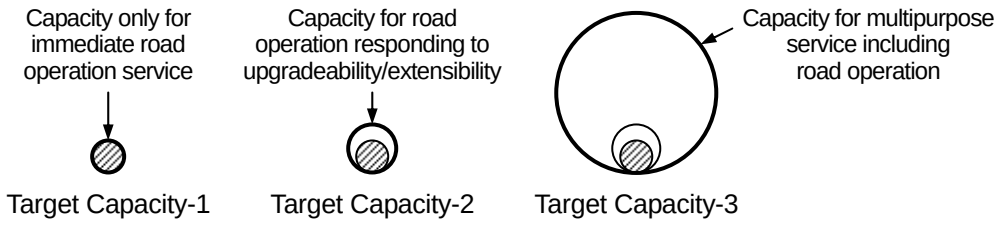
The most suitable transmission method is to be reasoned out from the target capacity of the communication network depending on the scope of the service provided through it. Three typical concepts below can be proposed for the target capacity of the communication network for road operation.

(i) Target capacity-1: only for the immediate road operation service

(ii) Target capacity-2: for the road operation service responding to upgradeability / extensibility

(iii) Target capacity-3: for the multipurpose service including the road operation.

Figure 8.3.6 Target Capacity of Communication Network for Road Operation



Source: VITRANSS 2 Study Team

If the concept of target capacity-2 is adopted in Vietnam, SDH is to be recommended as the most suitable transmission method. However, the communication system is to be used for broader purpose to achieve efficient road operation and to get profits by administrating the organization of communication system operation (→ To be referred to Figure 8.2.4). For that reason, IP over SDH/DWDM and IP over TDM/DWDM are recommended as the most suitable transmission method as shown in the table below. That can realize the concept of target capacity-3.

Table 8.3.1 Comparison of Transmission Methods

	IP over ATM	IP over G-Ethernet	IP over SDH	IP over ATM/DWDM	IP over SDH/DWDM	IP over TDM/DWDM
Stability	Average	Average	High	Average	Average	High
Capacity	0.15～0.6Gbps	1～10Gbps	0.5～10Gbps	～1Tbps	～60Gbps	～1Tbps
Additional Services**	Not sufficient	Not sufficient	Not sufficient	Sufficient	Sufficient	Sufficient
Track Records in Vietnam	--	--	--	--	Adopted by Viettel***	Adopted by VNPT***
Compatibility	Low	High	High	High	Low	High
Implementation Cost	High	Average	High	Highest	Highest	Highest
Grading	Not Suitable	Comparable	Comparable	Not Suitable	Recommended	Recommended

Source: VITRANSS 2 Study Team
Note
**: leasing of lines is one of the simple additional services using the remaining capacity of communication network
***: See Section 6.9.

8.4 Arrangement and Cooperation of the Centers

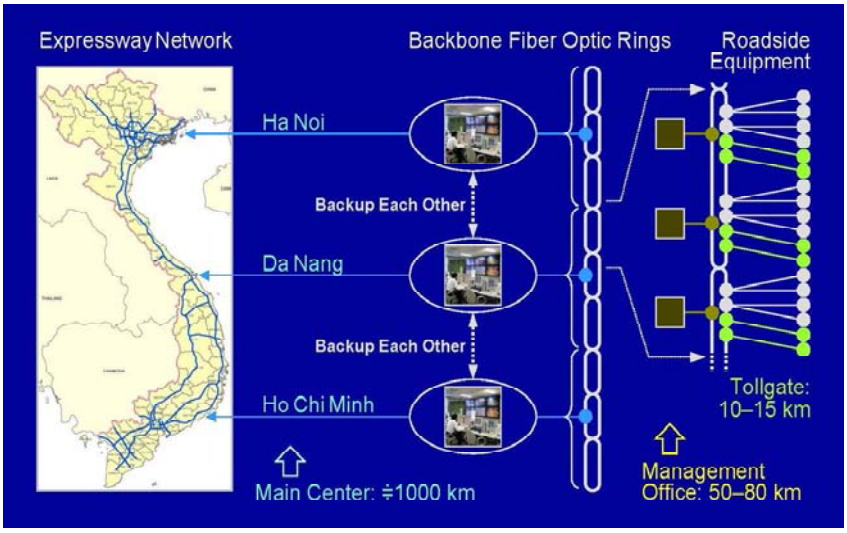
For the following reason, three main centers in Ha Noi, Da Nang and Ho Chi Minh are to be implemented for the inter-city expressway network over the entire country.

(i) Communication network and roadside equipment of ITS is to be installed stepwise from around Ha Noi, Da Nang and Ho Chi Minh, keeping pace with expressway construction

(ii) Data traffic for operating ITS is to concentrate around Ha Noi and Ho Chi Minh where the expressways will be constructed at high density

(iii) The appropriate jurisdictional range of the main center is assumed around 1000km, and it will become larger as the advancement of technology in the future.

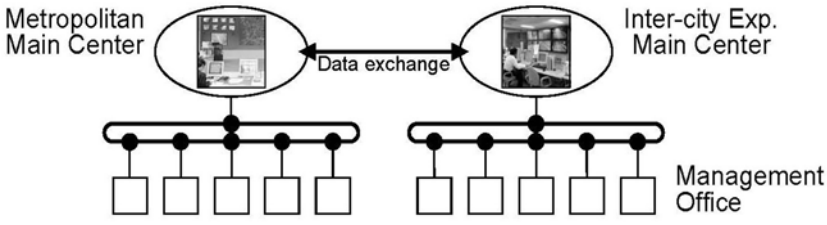
Figure 8.4.1 Arrangement of the Main Centers



Source: VITRANSS 2 Study Team

Traffic information and other road services need to be provided to the users continuously on the road network; accordingly, traffic data is to be exchanged between the main centers for the inter-city expressways and for the arteries/expressways in the metropolitan area.

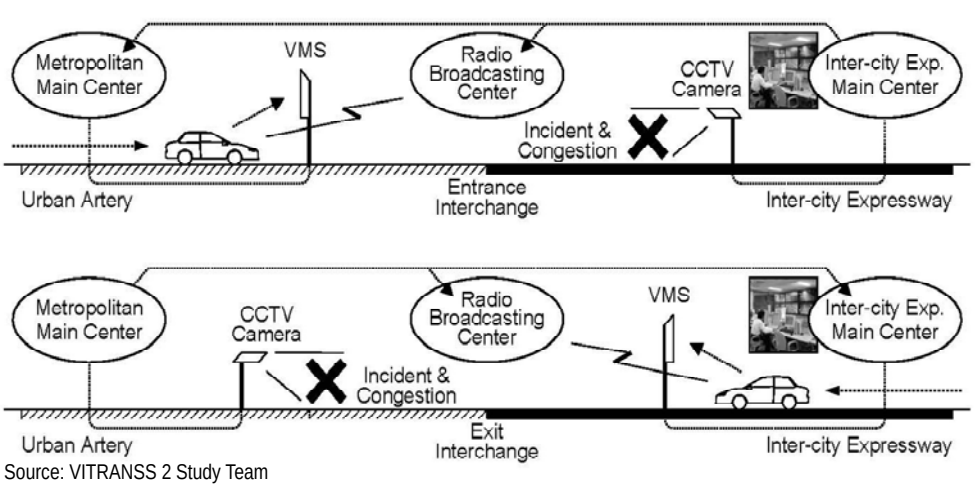
Figure 8.4.2 Cooperation between Two Centers in a Metropolitan Area



Source: VITRANSS 2 Study Team

Information of incidents and traffic congestion on the inter-city expressways needs to be provided to the drivers on the urban arteries in advance of coming up to the entrance interchange for avoidance of their influence. Similarly, information of the event on the urban arteries is to be provided to the drivers on the inter-city expressways in advance.

Figure 8.4.3 Necessity of Data Exchange between Main Centers



Source: VITRANSS 2 Study Team

8.5 Stepwise Implementation of ITS

Stepwise implementation of ITS is compiled based on the foregoing discussion and the road map shown in Section 3.10.

1) Traffic Information/Control

The centers and roadside equipment for traffic information/control shall be implemented stepwise according to the time schedule proposed below.

Figure 8.5.1 Stepwise Implementation Schedule for Traffic Information/Control

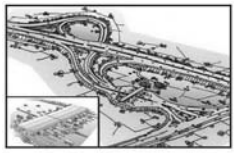
	1st Stage 2015	2nd Stage 2020	3rd Stage 2030
Center	• Traffic information center • Toll management center • Traffic police operation center • Ambulance service center • TV/Radio broadcasting center • Information service center	   • DSRC probe data center • GPS/WL probe data center • Cargo-truck operation center • Inter-city bus operation center	• Road pricing operation center
Roadside Equipment	• Emergency telephone (at every km on the expressway, tunnel section) • CCTV camera (at merging section, exit diverging section, tollgate, tunnel section, incident-prone section, congestion-prone section) • Vehicle detector (at exit diverging section, merging section, tollgate, congestion-prone section) • Weather sensor (at every interchange) • VMS (short of exit diverging point, entrance point, tollgate, relevant spot)		• CCTV camera (at 1 km spacing points in incident-prone section) • SGM (short of junction)
In-vehicle Equipment	• Radio terminal (in the patrol car)	• On-board sensor (in cargo-truck, inter-city bus)	

Source: VITRANSS 2 Study Team, pictures from Southern Vietnam Expressway FS by JETRO

2) Non-stop Toll Collection

The centers and roadside equipment for non-stop toll collection shall be implemented stepwise according to the time schedule proposed below.

Figure 8.5.2 Stepwise Implementation Schedule for Non-stop Toll Collection

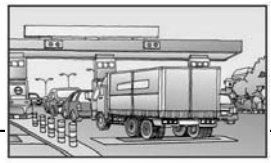
	1st Stage 2015	2nd Stage 2020	3rd Stage 2030
Center	• OBU registration center • Toll management center • Toll/traffic integration center • Traffic information/control center • Prepayment service center	• Clearing center	
Roadside Equipment	• Toll collection (at every tollgate) • DSRC antenna (at every tollgate) • License plate scanner (at every tollgate) • Treadle (at every tollgate) • Lane control (at every tollgate) • CCTV monitoring (at every tollgate) • IC-card recharge terminal (at every tollgate)		 
In-vehicle Equipment	• OBU (2-piece type)		
Mobile Equipment	• IC-card		
In-door Equipment	• IC-card recharge terminal (in the bank)		

Source: VITRANSS 2 Study Team, pictures from Southern Vietnam Expressway FS by JETRO

3) Heavy Truck Control

The centers and roadside equipment for heavy truck control shall be implemented stepwise according to the time schedule proposed below.

Figure 8.5.3 Stepwise Implementation Schedule for Heavy Truck Control

	1st Stage 2015	2nd Stage 2020	3rd Stage 2030
Center	• Heavy truck control center	• DSRC probe data center • GPS/WL probe data center • Cargo-truck operation center	
Roadside Equipment	• Axle scale (at every exit tollgate) • License plate scanner (at every exit tollgate) • Vehicle detector (at every exit tollgate)	• DSRC antenna (at junction)	
In-vehicle Equipment		• On-board sensor (in cargo-truck)	

Source: VITRANSS 2 Study Team, pictures from Southern Vietnam Expressway FS by JETRO

4) Centers and Communication Network

(1) Required Conditions in the 1st Stage

The inter-city expressway network will be constructed by sections from around the three major cities: Ha Noi, Da Nang and Ho Chi Minh. Fiber optic communication network and the management offices will be implemented keeping pace with the expressway construction. The main centers will be constructed separately around these major cities in the 1st stage; accordingly, the backup scheme of the main centers needs to be established respectively around each major city.

(2) Required Conditions in the 2nd Stage

The inter-city expressway main center and the metropolitan main center are to be established separately in the 2nd stage. The reason is the large difference between road networks in inter-city rural areas and those in the metropolitan areas. That should include the following factors:

(i) Daily traffic volume and frequency of congestion

(ii) Affected traffic volume in case of traffic accident

(iii) Easiness of identifying the location of incident site

(iv) Availability of alternate route/interchange in case of traffic accident and congestion

(v) Effectiveness of the installation of ITS/ETC equipment.

The difference is the common characteristic of many Asian countries.

The communication networks of these two main centers need to provide shared interface to the road users and on-board equipment, and the information/data of ITS needs to be exchanged between these main centers.

(3) Stepwise Implementation

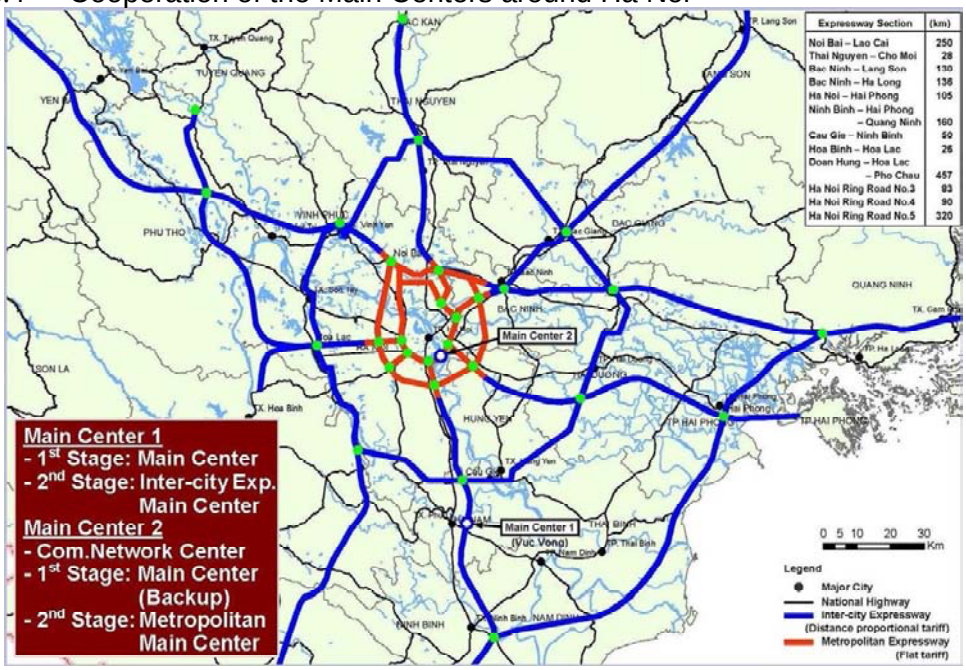
Stepwise implementation of the main center is proposed as following and as shown in the figures in the next page.

(a) **In the 1st Stage:** a couple of the main centers are to be constructed around the major city to backup each other.

(b) **In the 2nd Stage:** a center around the major city is to function as the inter-city expressway main center and another is to function as the metropolitan main center for urban expressways/ arteries.

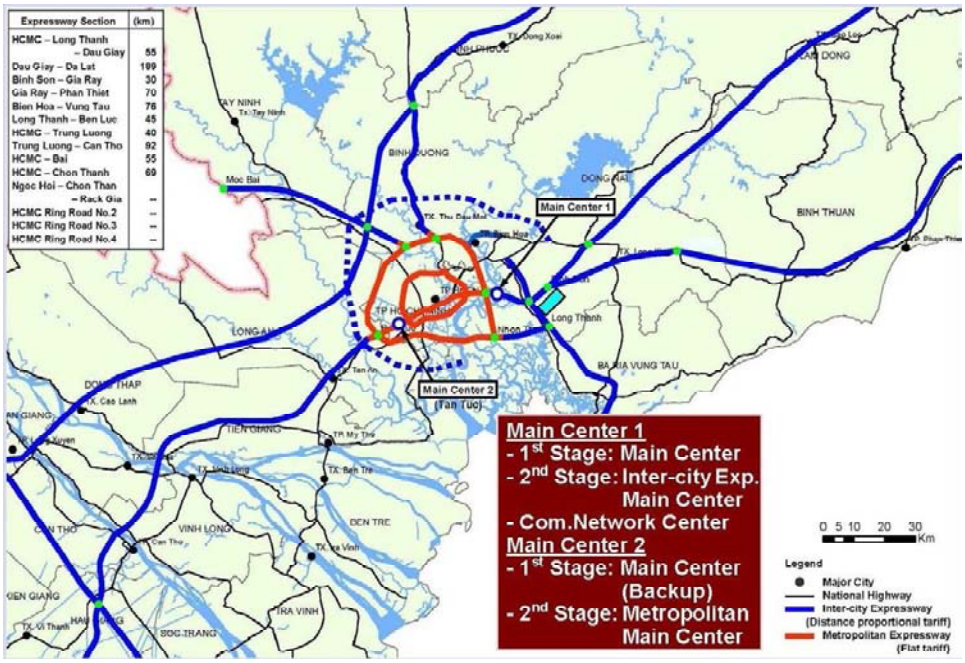
ITS standards need to be separated into two kinds in the 2nd stage: for inter-city expressways and for urban expressways/arteries. The two standards need to be based on the same policy, and will have some points in common while the other points will be different.

Figure 8.5.4 Cooperation of the Main Centers around Ha Noi



Source: VITRANSS 2 Study Team

Figure 8.5.5 Cooperation of the Main Centers around Ho Chi Minh



Source: VITRANSS 2 Study Team

9 REQUIREMENTS OF ITS STANDARDS

9.1 General

The concept of the key-stones of standardization is shown at the outset of this chapter. The requirements of ITS standards are listed up for the priority ITS user services: traffic information/control, non-stop toll collection and heavy truck control. The items to be described as the requirements of ITS message/data are shown subsequently referring to ISO11179 and ISO/DIS14817. Finally, necessity and urgency of the requirements are shown in comparison with the implementation status of ITS in ongoing expressway projects.

9.2 Key-stones of Standardization

Key-stones below are necessary for standardization of ITS to prevent the possible problems aforementioned in Chapter 1.

- Service requirements
- System architecture

} Shown in Chapter 5 and ***Appendix 1***

- Performance and installation of equipment
- Compatibility of equipment components
- Connectability of interfaces
- Inter-operability of data
- Communication network system.

} Specified in Chapter 9

(1) Service Requirements

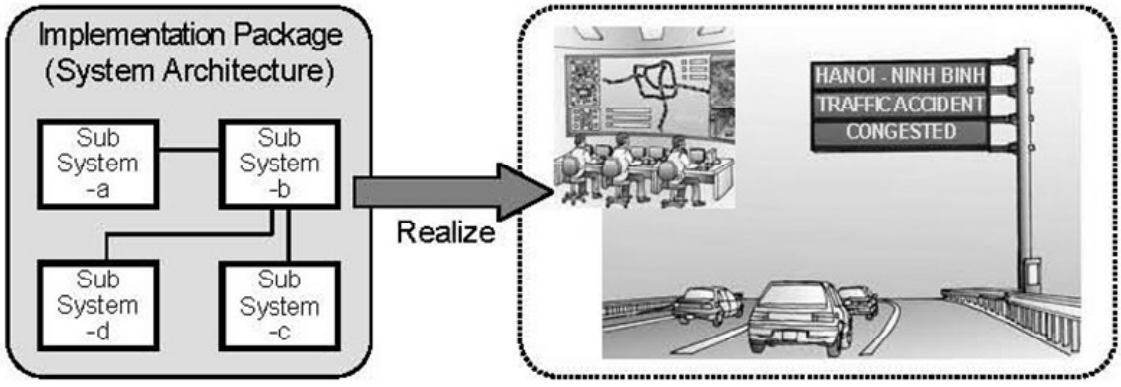
An implementation package realizes a part of the ITS. Distinct service requirements are to be defined for each implementation package in order to preclude unsuitable system installation and to eliminate profitless costs.

Service requirements of the specific implementation packages are already shown in Chapter 5.

(2) System Architecture

The implementation package aforementioned is realized by a set of subsystems that are segmented responding to the difference on the function and the location as shown below.

Figure 9.2.1 System Architecture of Implementation Package



Source: Southern Vietnam Expressway FS by JETRO

However, even for a set of service requirements, many different configurations of subsystems can be adopted. Unified system architecture needs to be defined for securing connectability of the interfaces, compatibility of the equipment and inter-operability of the data and for realizing efficient implementation. And taking a view of the total system architecture of ITS, appropriate organization is to be allocated to each subsystem for realizing efficient operation.

The system architectures of the specific implementation packages and the total system architecture are shown in Chapter 5, and are detailed as the ITS System Architecture for Priority User Services in ***Appendix 1***.

(3) Performance and Installation of Equipment

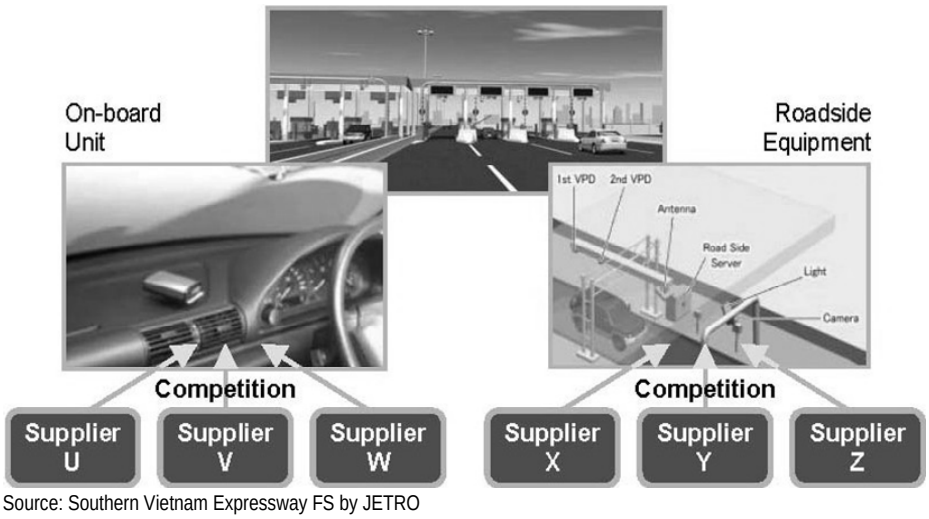
The service requirements are realized by integrating the performance of equipment. The equipment is to be segmented into a set of subsystems that provide the function of sensing, processing and indication, and each subsystem needs to have adequate HMI (Human Machine Interface) and to be installed in the appropriate location on the road network or in the center responding to its function.

Accordingly, fulfillment of the service requirements depends on the performance and installation of equipment, and that is the major part of the ITS standards. Requirements on performance and installation of equipment are to be listed up in the following section.

(4) Compatibility of Equipment Components

ITS comprises enormous pieces of equipment, and compatibility among them is indispensable requisite for the efficiency of system implementation. Standardization needs to be pursued in order to secure the compatibility among them. That allows many suppliers to enter the market of equipment and will provide the cost reduction through competition. That will expand business opportunities for Vietnamese companies as well.

Figure 9.2.2 Competition in Equipment Component Market



Source: Southern Vietnam Expressway FS by JETRO

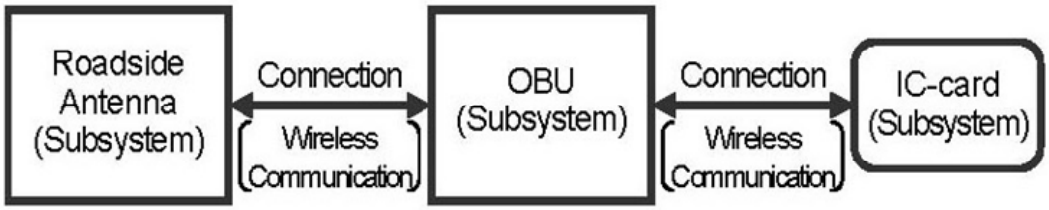
Requirements for compatibility of equipment component are to be listed up in the following section.

(5) Connectability of Interfaces

The system architecture is actualized by the connection of subsystems for data exchange. For example, the roadside antenna, OBU and IC-card are to be connected by wireless

communication to exchange the data for toll collection.

Figure 9.2.3 Connectability of Interfaces



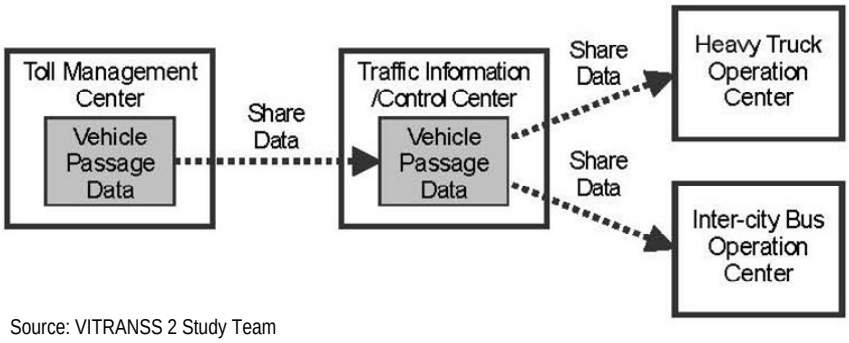
Source: VITRANSS 2 Study Team

Requirements for connectability of interfaces are to be listed up in the following section.

(6) Inter-operability of Data

Shared use of the data among different subsystems is necessary for efficient operation of ITS and can be achieved by the standardization of data. For example, inter-operability of the vehicle passage data among different centers is necessary for ITS as shown below.

Figure 9.2.4 Inter-operability of Vehicle Passage Data



Source: VITRANSS 2 Study Team

Requirements for inter-operability of data are to be listed up in the following section.

(7) Structure of Communication Network System

ITS will be actualized on the communication network. A unified communication network system with the rational hierarchical structure and center location is to be defined with consideration given to the following issues:

(i) Required capacity and security of data communication

(ii) Existence of different operating organizations

(iii) Implementation and operation cost.

Requirements on communication network system are to be listed up in the following section.