4 Conceptual Design of ITS Projects

4-1 Consideration of ITS Architecture

4-1-1 Purpose of Architecture

The control systems that have been currently used are only capable of providing limited service and work in isolation as independent systems. But ITS provides data gathering with complex management and control services and its subsystems can be integrated to work in synergy. ITS architecture is an organized approach to evolve ITS based society by adding considerable value to the overall ITS development process.

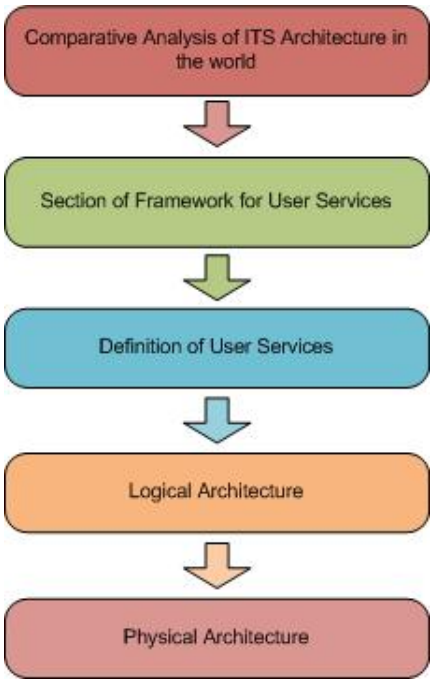
The system architecture provides the framework that enables planning, defining and integration of Intelligent Transportation System (ITS). Without proper architecture, ITS may lack coherent component integration, risk of spending higher costs for updates & changes, difficult in scaling services, difficult to adapt new technologies without large scale changes/replacements.

4-1-2 Steps for ITS Architecture Preparation

The first step in the formulation of ITS architecture is to select & prioritize the user services and determine the functional requirements that provide these services.

The second step is to formulate logical architecture that depicts the processes and data flow between processes. These processes are needed to meet the functional requirements as determined in first step.

In the context of system engineering, physical architecture maps the processes defined by logical architecture to physical subsystems that are delivered by hardware & software. Thus the physical architecture maps specific processes to physical subsystems by taking into account the institutional responsibilities.



Source: JICA Study Team

Figure 129 Formulation of ITS Architecture for Andhra Pradesh Work Flow

4-1-3 Analysis of ITS Architectures in Major Countries

The ITS Architectures in major countries were reviewed as reference for preparation of the ITS Architecture for Andhra Pradesh. It should be noted that the existing conditions in India and these countries are significantly different. However the ITS Architectures reviewed are utilized as basement for preparation of the basic framework of the ITS Architecture in Andhra Pradesh to be further modified in order to fit into the regional particular conditions. The countries of the ITS Architectures reviewed are listed in the Table 5-1. These countries were selected because these regions –North America (primarily USA and Canada), Europe and Asia (primarily Japan) have been dominating in research, development and deployment of ITS technologies.

Table 48 ITS Architectures Major Countries Analysed

No	Country
1	U.S.A.
2	Canada
3	Europe
4	Japan
5	ISO TC 204

(1) U.S.A.

U.S.A. is the first country to develop the national ITS Architecture. It was developed in 1996 by the US Department of Transport (US DoT) and is based on process-oriented methodology. It is maintained regularly and the current version of it is Version 6. As it is a POM-based architecture, maintenance and revision is a complex process and is being maintained courtesy of a reasonably large budget. The US national ITS architecture has stimulated similar and alternative architecture developments in Europe, Japan and a number of other countries around the world. Other countries ITS architecture differs from US architecture based on those countries user requirements.

The US national ITS architecture was defined based on the functions to implement vehicle oriented user services. The U.S.A. architecture did not include ITS services for pedestrians such as the Japanese or ISO architecture. In contrast, The US Architecture described “Ride matching and reservation” as one of user services. Special feature of The US architecture is to present specific goals for deployment services depending on Urban, Inter-urban or Rural.

The US national ITS Architecture is comprised of thirty three (33) user services and they bundled into eight (8) categories as shown in the Table below.

Table 49 ITS Architecture in the U.S.A.

USA National Architecture		
User Service Bundle	User Service	Performance Requirements
Traveller and Transportation Management	Pre-Trip Travel Information	Communication
		Information Management
		Processing Time
		Presentation
	En Route Driver	Communication

USA National Architecture		
	Information	Driver Advisory Presentation
		In-Vehicle Presentation
	Route Guidance	Communication
		Vehicle Location
		Processing Time
		Presentation
		Autonomous Route Guidance
	Ride Matching and Reservation	Communication
		Information Management
		Processing Time
		Presentation
	Traveller Services Information	Communication
		Information Management
		Processing Time
		Presentation
	Traffic Control	Communication
		Information Management
		Processing
		Control
		Presentation
		Surveillance Information
	Incident Management	Communication
		Surveillance Information
		Incident Detection
		Incident Verification
		Incident Classification
		Incident Response
		Incident Coordination
		Incident Record Keeping
		Incident Information Management
		Presentation
	Travel Demand Management	Communication
		Information Management
		Processing Time
		Presentation
	Emissions Testing and Mitigation	Emissions Testing and Mitigation
	Highway-Rail Intersection	Communication
		Supported Vehicle
		Rote Guidance Information
		Driver Advisory Presentation
		Safety Monitoring

USA National Architecture		
		Vehicle Detection Information
		In-Vehicle Infrastructure Condition Warning
		Display and Safety Warning
Public Transportation Management	Public Transportation Management	Communication
		Vehicle Identification
		Vehicle Location
		Route Guidance Information
		Traffic Signal Priority
		Data Collection
		Information Management and Analysis
		Maintenance Vehicle Management
		Transit Vehicle Scheduling
	En-Route Transit Information	Communication
		Information Management
		Processing Time
		Presentation
	Personalized Public Transport	Communication
		Vehicle Identification
		Vehicle Location
		Routing Information
		Service Hours
		Service Optimization
		Passenger Pick-up
		Passenger Information
	Public Travel Security	Communication
		Surveillance Information
		Threat Sensor Information
		Object and Intrusion Detection
		Transit Vehicle Operator Authentication
		Remote Disable of Transit Vehicle
		Deviation of Transit Vehicle from Planned Route
		Alarms
		Passenger Identification and Location
Electric Payment	Electric Payment Services	Communication
		Information Management
		Transaction Processing
Commercial Vehicle Operations	Commercial Vehicle Electric Clearance	Vehicle-Infrastructure Communication
		Supported Vehicle/Carriers
		Detection Range and Accuracy
		Information Management
		Safety and Regal Requirements
	Automated Roadside	Vehicle-Infrastructure Communication

USA National Architecture		
	Safety Inspection	Supported Vehicle/Carriers
		Information Management
		Brakes Inspection
		Vehicle Diagnostics
		Driver Diagnostics
	On-Board Safety and Security Monitoring	Vehicle-Infrastructure Communication
		Supported Vehicle/Carriers
		Critical On-Board Subsystem Monitoring and Storage
		Display and Safety Warnings
		Monitor On-Board Sensors
		Driver and Vehicle Identification and Assignment
		Information Management
	Commercial Vehicle Administrative Processes	Vehicle-Infrastructure Communication
		Supported Vehicle/Carriers
		Border Pre-clearance
		Mileage Recording
		Electronic Credential Transaction
	Hazardous Material Security and Incident Response	Classify the Hazardous Material
		Vehicle-Infrastructure Communication
		Supported Vehicle/Carriers
		HAZMAT Incident Management
		HAZMAT Security Function
		HAZMAT Vehicle Driver Authentication
	Freight Mobility	Communication
		Route Guidance Information
		Vehicle Identification
		Vehicle Location
		Fleet Maintenance
Emergency Management	Emergency Notification and Personal Security	Communication
		Vehicle Location
		Emergency Notification
		Critical In-Vehicle Subsystem Monitoring
		Surveillance Information from Critical Infrastructure
		Threat Sensor Information from Critical Infrastructure
		Object and Intrusion Detection of Critical Infrastructure
		Alarms in Secure Areas
	Emergency Vehicle Management	Communication
		Emergency Fleet Management
		Vehicle Identification
		Vehicle Location
		Traffic Signal Preemption
	Disaster Response and	Communication

USA National Architecture		
	Evacuation	Response Coordination
		Evacuation Coordination
		Information Management
		Processing Time
Advanced Vehicle Safety Systems	Longitudinal Collision Avoidance	Supported Vehicles
		Front or Rear of Vehicle Sensing
		Driver Collision Avoidance Action Elicitation
		Temporary Automatic Control
		Autonomous Intelligent Cruise Control
		Vehicle and Driver Monitoring
		Display and Safety Warning
	Lateral Collision Avoidance	Supported Vehicles
		Blind-spot Sensing
		Blind-spot Information and Display
		Potential Collision due to lane change warning
		Driver Collision Avoidance Action Elicitation
		Temporary Automatic Control
		Lane Maintenance
		Vehicle and Driver Monitoring
		Display and Safety Warning
	Intersection Collision Avoidance	Supported Vehicles
		Vehicle Detection
		Vehicle Detection Information
		Driver Collision Avoidance Action Elicitation
		Temporary Automatic Control
		Vehicle and Driver Monitoring
		Display and Safety Warning
	Vision Enhancement for Crash Avoidance	In-vehicle Sensing
		Visual Display
		Vehicle Monitoring
		Display and Safety Warning
	Safety Readiness	Supported Vehicles
		Impaired Driver Warning
		Vehicle Condition Warning
		In-Vehicle Information Condition Warning
		Vehicle Monitoring
		Display and Safety Warning
	Pre-Crash Restraint Deployment	Supported Vehicles
		Anticipate Imminent Collision
		Activate Passenger Safety Systems
		Vehicle Monitoring
		Display and Safety Warning

USA National Architecture		
	Automated Vehicle Operation	Infrastructure-Vehicle Communication
		Vehicle-Vehicle Communication
		Supported Vehicles
		Automated Highway Systems (AHS)
		Partially Automated Highway System (PAHS)
Information Management	Archived Data	Historical Data Archive
		Operational Data Control (ODC)
		Data Import and Validation
		Automatic Data Historical Archive (ADHA)
		Data Warehouse
		ITS Community Interface
Maintenance and Construction Management	Maintenance and Construction Operations	Maintenance Vehicle Fleet Management
		Roadway Management
		Work Zone Management and Safety
		Roadway Maintenance Conditions and Work Plan Dissemination

(2) Canada

Under the guidance of a steering committee of public and private sector representatives from the Canadian transport industries, the development of the ITS Architecture for Canada was initiated in 1999. Transport Canada is undertaking the development of the Border Information Flow Architecture (BIFA) in partnership with U.S. Federal Highway Administration.

The Canadian ITS architecture includes all of the U.S. National ITS Architecture work with some modifications to provide new services. Canadian Architecture excluded “Traffic Management” as an independent category compared to the US Architecture. Four services were specified that are not part of US Architecture such as safety of vulnerable road users, international border transportation management, etc.

ITS Architecture for Canada is comprised of thirty seven (37) user services and bundled into nine (9) categories as shown in Table below.

Table 50 ITS Architecture for Canada

User Service Bundle	User Services	User Service Requirements
Traveller and Transportation Management	Pre-Trip Travel Information (PTTI)	PTTI shall provide travellers with Available travel Services Information.
		PTTI shall provide the accessibility to users on the Current Situation Information of transportation system.
		PTTI shall include a Trip Planning Service.
		PTTI shall provide the capability for User Access.
	En Route Driver Information (DI)	DI shall be implemented in a manner that is beneficial to the public transportation system.

User Service Bundle	User Services	User Service Requirements
		DI shall include a Driver Advisory function, which shall be implemented in 2 phases with first a short term capability and later a long term capability.
		DI shall provide an In-vehicle Signing Capability.
	Route Guidance (RG)	RG shall include the capability to Provide Directions to travellers.
		RG shall include a Static Mode for issuing information to travellers.
		RG shall include a Realtime Mode for issuing information to travellers.
		RG shall include a User Interface function.
	Ride Matching and Reservation (RMR)	RMR shall include Rider Request capability.
		RMR shall include Transportation Provider Service function.
		RMR shall include Information Processing function.
	Traveller Services Information (TSI)	TSI shall include Information Receipt function for the collection of information to be provided to travellers.
		TSI shall include Information Access function that allows travellers to access the available information.
Traffic Management	Traffic Control (TC)	TC shall include a Traffic Flow Optimization function to provide the capability to optimize traffic flow.
		TC shall include a Traffic Surveillance function.
		TC shall include a Device Control function.
		Device Control shall provide traffic control information to other elements of the ITS, including but not limited to the In-vehicle navigation, Trip planning, Routing systems and Fleet management systems.
	Incident Management (IM)	IM shall provide an Incident Identification function to identify incidents.
		IM shall provide a Response Formulation function to formulate appropriate response actions to each identified incident and revise those actions when necessary.
		IM shall include a Response Implementation function to provide the services to implement a response coordinated with all appropriate agencies.
		IM shall provide the capability to Predict Hazardous Conditions, including the time and location of hazardous conditions that may cause an incident.

User Service Bundle	User Services	User Service Requirements
	Travel Demand Management (TDM)	TDM shall include a communications function.
		TDM shall include a processing function.
		TDM shall include a sensors/control function.
	Emissions Testing and Mitigation (ETAM)	ETAM shall include a Wide Area Pollution Monitoring capability.
		ETAM shall include roadside pollution assessment capability.
	Highway-Rail Intersection (HRI)	HRI function shall be applicable to operational, at-grade highway-rail intersections with train operational speeds up to 200 km/h.
		HRI shall provide interfaces between highway and rail management functions.
		At all HRIs with active railroad warning systems, HRI shall manage the traffic in the intersection.
		HRI shall include a Standard Speed Rail Sub service to manage highway and rail traffic at HRIs for rail lines with operational speeds less than 130 km/h.
		HRI shall provide a High Speed Rail Sub service for HRIs on rail lines with operational speeds between 130 and 200 km/h.
		At HRIs with active railroad warning systems, HRI shall provide the capability for automatic collision notification to rail operations and traffic management.
	Automated Dynamic Warning and Enforcement	The Automated Dynamic Warning and Enforcement user service provides systems that warn vehicles or motorists of imminent danger, and provide electronic enforcement of traffic control and regulations.
	Non-Vehicular Road User Safety	The Non-Vehicular Road User Safety user service provides warning systems primarily focused on pedestrian crossing lights, audible pedestrian signals, and traffic signal control of bicycle routes.
Public Transportation Management	Public Transportation Management (PTM)	PTM shall include an Operation of Vehicles and functions that provides computer assisted control of the operation of vehicles and their associated facilities.
		PTM shall include Planning and Scheduling Services function to automate the planning and scheduling of public transit operations.
		PTM shall include Personnel Management function to facilitate the management of operator, and

User Service Bundle	User Services	User Service Requirements
		maintenance personnel.
		PTM shall include a Communications function.
		PTM shall include Vehicle Management function to facilitate the management of Public Transit Vehicles.
	En Route Transit Information (TI)	TI shall include Information Distribution function that disseminates information to travellers.
		TI shall include Information Receipt function for acquiring data that are used for generation of the En-Route Transit Information.
		TI shall include Information Processing function for processing data that is used for generation of the En-Route Transit Information.
	Demand Responsive Transit (Personalized Public Transit : PPT)	The PPT shall include Rider Request function.
		The PPT shall include Vehicle Assignment function.
		The PPT shall include Data Collection function.
		The PPT shall include Information Processing function.
		The PPT shall include a Communication function.
	Public Travel Security (PTS)	PTS shall include specific Secure Area.
		PTS shall include Security Sensors function.
		PTS shall include Personal Sensor items.
		PTS shall include Security Management and Control function.
Electronic Payment	Electronic Payment Services	Electronic Payment shall provide Electronic Toll Collection capability.
		Electronic Payment shall include Electronic Fare Collection capability.
		Electric Payment shall include Electronic Parking Payment capability.
		ITS shall include Electronic Payment Services Integration feature.
		ITS shall Provide Roadway Pricing capability.
Commercial Vehicle Operations	Commercial Vehicle Electric Clearance (CVEC)	CVEC shall include Roadside Capability consisting of those mobile or fixed assets and equipment to include Ports of Entry, Inspection Stations, Weigh Stations and Toll Booths.
		CVEC shall include a Vehicle System capability.
	Automated Roadside Safety Inspection (ARSI)	The ARSI capability shall include Roadside Facility function that improves the ability to perform automated safety inspection.
		The ARSI capability shall include a Vehicle System function.

User Service Bundle	User Services	User Service Requirements
	On-Board Safety and Security Monitoring (OBSSM)	OBSSM shall include a Roadside Capability for the analysis and control of safety information.
		OBSSM shall include a Vehicle System that is a part of each vehicle.
		OBSSM shall include a Freight Security Management function.
	Commercial Vehicle Administrative Processes (CVAP)	CVEC shall include an Electronic Purchase of Credentials function with capabilities that include but are not limited to Annual Electronic Credentials, Temporary Electronic Credentials, Order Forms Computer Input Screens, Multiple Permits, Specific Situation Permits, Electronic Payment and Automated Processing of Applications.
		CVAP shall include an Automated Mileage and Fuel Reporting and Auditing (AMFRA) function that includes but is not limited to Quarterly Reports Submission, Electronic Vehicle Log, Fuel Purchase Data and Create & Audit Tax Reports.
		CVAP shall include an International Border Electronic Clearance (IBEC) function.
	Hazardous Material Security and Incident Response (HSIR)	HSIR shall include a HAZMAT Incident Notification (HIN) function.
		HSIR shall provide an Operation Focal Point for initiating appropriate responses.
		HSIR shall include a Communications function.
		HSIR shall include a HAZMAT Security function.
	Freight Mobility (FM)	FM shall include a Commercial Vehicle Fleet Management function.
		FM shall include a Freight Operations Management function.
		FM shall include a Route Management (RM) function.
	Intermodal Freight Management	The Intermodal Freight Management user service provides systems which will monitor the status of freight in-transit, and at Freight Terminals.
	International Border Transportation Management	The International Border Transportation Management user service provides systems for the registration, processing and inspection of international shipments and movement of travellers and drivers. The registration of importers, carriers, conveyance, and drivers provides for expedited clearance at the border. At the border the user

User Service Bundle	User Services	User Service Requirements
		service includes expedited pre-processing of manifest data and covers customs inspection of the cargo and driver.
Emergency Management	Emergency Notification and Personal Security (ENPS)	ENPS shall include Driver and Personal Security function.
		ENPS shall include an Automated Collision Notification function.
		ENPS shall include a Remote Security and Emergency Monitoring function to create environment of safety in secure areas.
		ENPS shall include a Wide Area Alert (WAA) function to notify the public in emergency situations using ITS driver information and traveller information capabilities.
		ENPS shall include a Protect Sensitive Traveller Information (PSTI) function to inhibit distribution of traveller information that is deemed to be sensitive.
	Emergency Vehicle Management (EVM)	EVM Service shall include an Emergency Vehicle Fleet Management System.
		EVM Service shall include a Route Guidance System.
		EVM Service shall include a Signal Priority System.
	Disaster Response and Evacuation	Disaster Response shall provide a Coordinate Response Plans function to support dissemination and coordination of emergency response plans, continuity of operations plans, and other emergency plans between agencies in preparation for a potential future disaster.
		Disaster Response shall provide a Monitor Alert Levels function.
		Disaster Response shall provide a Detect and Verify Emergency function that provides initial emergency situation information to all allied agencies.
		Disaster Response shall provide an Assess Infrastructure Status function.
		Disaster Response shall include a Manage Area Transportation function that manages the transportation system in the vicinity of the disaster. Depending on the nature of the disaster and the status of the infrastructure, the following actions may be taken.

User Service Bundle	User Services	User Service Requirements
		Disaster Response shall include a Critical Service Restoration function that will coordinate with allied agencies to restore critical transportation and utility services.
		Disaster Response shall include a Coordinate Response function to coordinate the disaster response between transportation, public safety, emergency management, and other allied agencies. Information may be shared with individual agency centres, emergency operations centres, and unified command systems at the scene.
		Disaster Response shall include a Disaster Traveller Information function that will coordinate with public information offices of the principal responding agencies in providing traveller information for the disaster scene and surrounding area. This includes - Special traffic restrictions, Detours and closures, Special transit schedules, Traffic conditions at and around the scene, and Special traffic allowances.
		Evacuation Coordination shall provide an Evacuation Planning Support function.
		Evacuation Coordination shall include an Evacuation Traveller Information function.
		ETI shall provide information regarding traveller services available along evacuation routes and at evacuation destinations including: Lodging, Restaurants, Stores, Hospitals and medical services, Rest areas and Vehicle fueling stations.
		Evacuation Coordination shall provide an Evacuation Transportation Management function to assist evacuation coordination personnel as they manage evacuation operations.
		Evacuation Coordination shall provide a Resource Sharing Function that allows information and resource sharing between agencies involved in the evacuation including transportation, emergency management, law enforcement and other emergency service agencies.
Advanced Vehicle Safety Systems	Longitudinal Collision Avoidance	Longitudinal Collision Avoidance Service shall include a Rear-End Sub service.
		Longitudinal Collision Avoidance Service shall include a Backing Sub service.

User Service Bundle	User Services	User Service Requirements
		Longitudinal Collision Avoidance Service shall include a Head-On/Passing Sub service.
	Lateral Collision Avoidance	Lateral Collision Avoidance Service shall include a Lane Change/Merge Sub service.
		Lateral Collision Avoidance Service shall include a Single Vehicle Roadway Departure Sub service.
	Intersection Collision Avoidance	Intersection Collision Avoidance Service shall include an Advisory System.
		Intersection Collision Avoidance Service shall include a Driver Action System.
		Intersection Collision Avoidance Service shall include an Automatic Control System.
	Vision Enhancement for Crash Avoidance	Vision Enhancement for Crash Avoidance Service shall include an Enhanced Vision System, which augments the vehicle operator's capability to see pedestrians and hazardous situations, where driving visibility is low.
	Safety Readiness	Safety Readiness Service shall include a Driver Monitor Sub service.
		Safety Readiness Service shall include a Vehicle Condition Sub service.
		Safety Readiness Service shall include an Infrastructure Condition Sub service.
	Pre-Crash Restraint Deployment	Pre-Crash Restraint Deployment Service shall include an Automatic Activation System.
	Automated Vehicle Operation	AVO service shall include an Automated Highway System (AHS), the Target Level System.
		AVO service shall include a Partially Automated Highway System (PAHS) as a Transitional System.
Information Management	Archived Data	The Archived Data function shall provide a Historical Data Archive system for ITS data.
		The Archived Data function shall include an Operational Data Control function to ensure integrity of operational data as received from field equipment or data collection devices.
		The Archived Data function shall include a Data Import and Verification (DIV) function to acquire historical data from the Operational Data Control function.
		The Archived Data function shall provide the Automatic Data Historical Archive function for permanently archiving the data.

User Service Bundle	User Services	User Service Requirements
		The Archived Data function shall provide a Data Warehouse Distribution function as the ITS data source to support the ITS community user functions.
		The Archived Data function shall provide users with an ITS Community Interface including all ITS users for the specification and retrieval of data products.
Maintenance and Construction Operations	Maintenance and Construction Operations	Maintenance and Construction Operations shall provide a Maintenance Vehicle Fleet Management function to schedule and dispatch, monitor and track location, and monitor operational condition and maintenance requirements of public and contracted fleets of maintenance, construction, and specialized service vehicles. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Vehicle Maintenance Crews, Equipment Maintenance Crews, Weather Services Organizations, and Information Service Providers.
		Maintenance and Construction Operations shall provide a Roadway Management function to monitor traffic, road surface, and environmental conditions and forecast traffic and road surface conditions to support management of routine and hazardous road condition remediation and to communicate changes in conditions. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Asset Managers, Planning Agencies, and Weather Services Organizations.
		Maintenance and Construction Operations shall provide a Work Zone Management and Safety function, which provides support for the effectiveness, safety, and efficiency of roadway operations during all work zone activities. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Public Safety Organizations, Information Service Providers, and Travellers.
		Maintenance and Construction Operations shall provide a Roadway Maintenance Conditions and Work Plan Dissemination function to provide Intra- and Inter-agency coordination of work plans. This function includes interactions among Traffic

User Service Bundle	User Services	User Service Requirements
		Managers, Supervisors, Planning Agencies, Public Safety Organizations, and Information Service Providers.

(3) Europe

The FRAME Architecture (originally called the European ITS Framework Architecture) was developed as a result of recommendations from the High Level Group on transport telematics. It was established and first published by the EC funded project KAREN (Keystone Architecture Required for European Networks) in 2000.

This pan-Europe architecture is also based on process-oriented methodology. The FRAME Architecture is only defined by the user needs and functional view point. The FRAME Architecture is comprised of nine (9) categories excluding "general" which explained Architecture as a guideline. The FRAME User Needs are total 677 numbers. The reason of tremendous numbers of "FRAME User Needs" is each category was explored with consideration of all aspects of tasks such as objective, planning, activation and so on. Secondly, it is intend that the use of FRAME architecture will make it possible to build common components that can be used by several different implementers with different approaches within European Union depend on each member's specific situation.

Other feature of FRAME is that the description of functionality for vehicle control system is limited because of the pressure from vehicle manufactures.

The latest Framework was issued in 2008 as shown in the Table below.

Table 51 ITS Framework Architecture in Europe

FRAME User Needs		
Group		**Description**
1. General		Architectural Properties
		Data Exchange
		Adaptability
		Constraints
		Continuity
		Cost/Benefit
		Expandability
		Maintainability
		Quality of Data Content
		Robustness
		Safety
		Security
		User Friendliness
		Special Needs
		Privacy
		Communications
2.Infrastructure	Transport Planning Support	Objectives

FRAME User Needs		
Group		**Description**
Planning and Maintenance		Information Management
		Planning
		Evaluation
		Reporting
	Infrastructure Maintenance Management	Basic Services
		Activation
		Monitoring
		Maintenance Units
		Contracts
3 Law Enforcement	Policing/Enforcing Traffic Regulations	Objectives
		Evidence Collection
4 Financial Transactions	Electronic Financial Transactions	Objectives
		Traffic Management
		Revenue Sharing
		Transaction
		Enforcement
5 Emergency Services	Emergency Notification and Personal Security	Basic Services
		Stolen Vehicles
	Emergency Vehicle Management	Basic Services
	Hazardous Materials and Incident Notification	Basic Services
		Incident Management
		Planning
6 Travel Information and Guidance	Pre-trip Information	Objectives
		Modal Choice
		Information Handling
		Traveller Interaction
	On-trip Information	Objectives
		Mode Change
		Information Handling
		Traveller Interaction
	Personal Information Services	
	Route Guidance and Navigation	Objectives
		Information Handling
		Traveller Interaction
7 Traffic, Incidents and Demand Management	Traffic Control	Objectives
		Monitoring
		Planning
		Traffic Control Centres
		Traffic Flow Control

FRAME User Needs		
Group		**Description**
		Exceptions Management
		O/D Computations
		Speed Management
		Roadside-Vehicle Communications
		Adaptive Traffic Control
		Lane Management
		Parking Management
		Vulnerable Road Users
	Incident Management	Objectives
		Emergency Services
		Information Management
		Reporting
		Post-Incident Management
		Pre-Incident Management
		Hazardous Goods
	Demand Management	Objectives
		Zoning
		Pricing Management
		Parking Management
		Vulnerable Road Users
	Cooperative Systems – Traffic Safety	Road Hazard Warning
		Ghost Driver Management
		Lane Utilization
		Speed Management
		Headway Management
		Collision Warning
		Vulnerable Road User Warning
		Emergency Vehicle Warning
	Cooperative Systems – Traffic Efficiency	Traffic Flow Optimization
		Advanced Adaptive Traffic Signals
		Flexible Lane Allocation
	Cooperative Systems – Value-Added and Other Services	eCall
		Enhanced Route Guidance and Navigation
		Access Control
		Service Continuity
8 Intelligent Vehicle Systems	Automated Vehicle Operation	Objectives
		Collision Avoidance
		Lane Keeping
		Platooning
		Short Range Communications
		Speed Control

FRAME User Needs		
Group		**Description**
	Longitudinal Collision Avoidance	Objectives
		Collision Avoidance
	Lateral Collision Avoidance	Objectives
		Collision Avoidance
		Lane Keeping
	Safety Readiness	Basic Services
		eCall
		Automatic Parking
		Environmental Monitoring
		Accident Data Recording
		Traffic Information & Signs
		Vehicle Information
		Improper Use
9 Freight and Fleet Management	Commercial Vehicle Pre-Clearance	Basic Services
	Commercial Vehicle Administrative Processes	Basic Services
	Automated Roadside Safety Inspection	Basic Services
	Commercial Vehicle On-Board Safety Monitoring	Basic Services
	Commercial Fleet Management	Objectives
		Road Freight Management
		Road Freight Fleet Management
		Road Vehicle, Driver, Equipment and Cargo Management
		Freight Distribution
		Inter-Modal Interface
		Hazardous Goods Vehicle Management
		Driver Rest Areas
		Loading Zone Management
10 Public Transport Management	Public Transport Management	Objectives
		Scheduling
		Monitoring
		Incident Management
		Information Handling
		Communications
		Priority
	Demand Responsive Public Transport	Objectives
		Information Handling
		Communications

FRAME User Needs		
Group		**Description**
		Route Guidance
		Reporting
	Shared Transport Management	Basic Services
	On-Trip Public Transport Information	Objectives
		Information Handling
		Traveller Interaction
	Public Travel Security	Basic Services

(4) Japan

The Japanese national ITS architecture was completed in 1999, jointly developed by five (5) government agencies that were involved in ITS.

- National Police Agency
- Ministry of International Trade and Industry
- Ministry of Transport
- Ministry of Posts and Telecommunications
- Ministry of Construction

The objectives of the ITS Architecture is to promote:

- Efficient development of integrated ITS
- Maintainable and expandable ITS
- Domestic and international ITS standards

Japanese ITS Architecture identified implementations and user services that are promoted systematically and efficiently as per user's perspective and is called object-oriented methodology. This method makes it easier for future alteration and expansion as there is no one-to-one correspondence between other countries and Japanese user services. Second advantage is each sub-services defined in detail so that a particular provided service provided will be explicit. Third advantage is based on OOM, since object cannot be changed frequently, it can be used for long period compared to other countries architectures.

The Japanese ITS Architecture has been used to study and shape the strategic developments of ITS more than any other country architecture.

It is composed 172 specific user sub-services and bundled into 9 groups of development areas as shown in the Table below.

Table 52 ITS Architectures in Japan

Development Area	User Services	Specific User Services	Specific User Sub- Services
Advances in Navigation Systems	Provision of route guidance traffic information	Provision of route guidance information to drivers	Provide optimum route information
			Provide road traffic information
			Provide required travel time when congested
			Guide along with the selected route

Development Area	User Services	Specific User Services	Specific User Sub- Services
			Exchange information between running vehicles
		Provision of information on other modes of transportation to drivers	Provide information on other modes operations
			Provide information on parking availability
			Reserve Parking lot
			Provide information on availability of other public transportation service during emergency
		Advance provision of route guidance information	Provide optimum route information in advance Provide traffic road information in advance
		Advanced provision of information on other modes of transportation	Provide information on other modes of transportation operations in advance Provide information on parking availability in advance Reserve parking lot in advance
	Provision of destination related information	Advanced provision of destination related information	Provide detailed information and reservation on destination and reservation on destination facility and others in advance
			Provide information on the facility of destination available for the disabled, the elderly and small children and others
		Provision of destination related information for drivers and others	Provide detailed information and reservation on the facility of destination and others
			Provide information on the facility of destination available for the disabled, the elderly and small children and others
			Provide weather information on the given area.
		Provision of destination-related information at service areas, parking areas and others	Provide detailed information and reservation on the facility of destination and others at service area etc.
			Provide information on the facility of destination for the disabled , the elderly and small children and others at service

Development Area	User Services	Specific User Services	Specific User Sub- Services
			area etc.
			Provide weather information on the given area at service area and others
2. Electronic toll collection systems	Electronic toll collection	Electronic toll collection on toll roads	Collect toll electronically on toll roads
			Collect motorcycle tolls electronically
			Collect tolls of the disabled electronically on toll road
			Issue receipts in various way
		Electronic charge of fare collection of parking lot, ferry and others	Collect parking charges electronically Collect the charges for roadside parking electronically. Collect fares for ferry and car-train electronically
3. Assistance for safe driving	4) Provision of driving and road conditions information	Provision of information on road conditions	Provide weather information
			Provide information on road surface condition
			Provide information on road alignment
		(11) Provision of information on vehicles in the vicinity and others	33. Provide information on obstacles ahead and behind
			34 Provide information on vehicles passing in another lane
			35 Provide information on intersection in city
			36 Provide information on vehicles in the vicinity on expressway
			37 Provide information on railroad crossing
			38 Provide information on traffic signals and others
	Danger warning	(12) Danger warning of vehicles ahead and others	39. Warn of danger due to road alignment and others
			40. Warn of danger due to vehicles ahead and following
			41. Warn of danger due to obstacles and pedestrians
		(13) Danger warning of vehicles in neighbouring areas and others	42. Warn of danger due to changing lanes
			43. Warn of vehicles lane departure
		(14) Danger warning of vehicles crossing ahead and others	44. Warn of danger at intersection
			45. Warn of danger at merging or diverging section
		(15) Danger warning of	46. Warn a driver of danger

Development Area	User Services	Specific User Services	Specific User Sub- Services
		condition of drivers or vehicles	47 Warn vehicles in the vicinity of danger
	6) Assistance for driving	(16) Assistance for driving against danger due to vehicles ahead and others	49. Assist driving against danger due to vehicles ahead and following
			50. Assist driving against danger due to obstacles or pedestrians
			51. Assist driving to maintain space with a leading vehicles and to maintain specified speed
			52. Assist stopping vehicles during emergency stops
		(17) Assistance for driving against danger due to vehicles in neighbouring areas	53. Assist driving when changing lanes
			54. Assist driving when changing lanes
		(18) Assistance for driving against danger due to vehicles crossing ahead and others	55. Assist driving at intersection
			56. Assist driving at merging or diverging
		(19) Assistance for driving against in driver's unusual situations	57. Assist drivers when driving in abnormal conditions
	7) Automated highway systems	(20) Automated cruise of general vehicles	58. Cruise automatically in dedicated lane
			59. Cruise automatically when congested
			60. Cruise automatically through a long tunnel
			61. Cruise automatically in harsh weather
			62. Park automatically in parking lot
		(21) Automated cruise of service vehicles	63. Cruise services vehicles automatically
			64. Cruise snowplow automatically
4 optimization of traffic management	8) Optimization of traffic flow	(22) Assistance for traffic management	65. Assist traffic management planning for wide area
			66. Traffic management planning for local area
			67. Assist decision-making process on traffic management
			68. Collect and provide basic

Development Area	User Services	Specific User Services	Specific User Sub- Services
			information on traffic demand management
		(23) Assistance for traffic management and traffic management facility operations	69. Analyze and evaluate traffic restriction plans
			70. Assist operation and maintenance of traffic control facility.
			71. Assist design and installation of traffic control facility
			72. Assist advancement for road usage approval operation.
		(24) Assistance for parking policy and others	73. Provide guidance to parking lots
			74. Conduct traffic control suitable for residential zone
			75. Assist efficiency of illegal parking enforcement
			76. Assist parking control plan
			77. Control traffic to maintain environment along roads
		(25)Advancement of driver assistance	78. Advance driver assistance
			79. Assist in planning and recording of vehicles operations
		(26) Assistance for police activities	80. Discover and retrieve the theft vehicles
			81. Improve management of police vehicles
			82. Assist police activities
		(27) Maintenance of traffic order	83. Improve conducting after accident procedure
			84. Advance analysis of accident results
			85. Make Operational recording automatically
			86. Detect, warn and prevent dangerous driving control
		(28) Optimization of traffic signal control	87. Control traffic signal at an intersection
			88 Control traffic signal at arterial roads
			89. Control wide-area traffic
			90. Control traffic signals at railroad crossing
			91. Control corresponding to a lane
		(29) Route guidance	92. Guide to a route corresponding to the needs to traffic management

Development Area	User Services	Specific User Services	Specific User Sub- Services
			93. Guide to a lane corresponding to a vehicle type
		(30) Dynamic lane control	94. Reversible lane control
			95. Control bus lane dynamically
			96. Control bicycle lane dynamically
			97. Control lanes allowed for parking
			98. Control one-way driving dynamically
	9) Provision of traffic restriction information in case of incident	(31) Assistance for traffic management under usual conditions	99. Manage traffic when disaster occurs
			100. Manage traffic under atypical traffic conditions
			101. Manage traffic under usual weather
			102. Manage traffic under atypical traffic conditions
5. Increasing efficiency in road management	10) Improvement of maintenance operations	(32) Assistance for road management works	103. Assist traffic survey
			104. Assist road maintenance inspection
			105. Assist environmental maintenance along road
			106. Provide information on road maintenance
		(33) Improvement of road management works	107. Collect information on road surface
			108. Assist service vehicles operations
		(34) Optimization of implementing traffic restrictions	109. Collect information on unusual weather and disaster
			110. Assist decision-making on implementing traffic restrictions.
			111. Assist decision-making on lifting of traffic restrictions
		(35) Improvement of efficiency in disaster restoration	112. Assist collecting information when disaster occurs
			113. Assist vehicles allocation for disaster restoration
			114. Provide road traffic information when restoring
	11) Management of specially permitted commercial vehicles	(36) Management of specially permitted commercial vehicles and others	115. Improve approval works for specially permitted commercial vehicle.
			116. Provide route information available for vehicles operations
			117. Monitor overloaded vehicles operations

Development Area	User Services	Specific User Services	Specific User Sub- Services
		(37) Collecting information on dangerous load vehicle operations	118. Collect information on dangerous load vehicle operations
	12) Provision of roadway hazard information	(38) Provision of roadway hazard information	119. Provide information on traffic restrictions and lifts
			120. Provide information on bypass
6. Support for public transport	13) Provision of public transport information	(39) Provision of information on public transport operations or other transit transfer	121. Provide information on public transport in advance
			122. Provide information on public transport en-route
			123. Provide information on other public transportation service while on board public transportation
			124. Provide information on delay or accidents of public transport
		(40) Assistance for taxi and on demand bus use	125. Assistance for bus use on demand
			126. Assistance for taxi use
	14) Assistance for public transport operations and operations management	(41) Implementation of priority passing for public transport	127. Provide signal priority to bus and tram
			128. Monitor operations on dedicated lanes such as for a bus
		(42) Provision of public transport operations and others	129. Provide road traffic information and others
			130. Provide information on public transport operations
			131. Provide information on expressway occurrence on transit
7. Increasing efficiency in commercial vehicle operations	15) Assistance for commercial vehicle operations management	(43) Provision of information on commercial vehicle operations and others	133. Provide commercial vehicles with road traffic information and others
			134. Provide information on commercial vehicles operations
			135. Provide information on commercial vehicles emergency when occurs
		(44) Provision of freight information	136. Provide freight information
		(45) Provision of operation information on other modes	137. Provide information on other modes of transportation operations
	16)	(46) Automated	138. Implement platooning of truck

Development Area	User Services	Specific User Services	Specific User Sub- Services
	Automated platooning of commercial vehicles	platooning of commercial vehicles	139. Implement platooning of truck on the dedicated lane
8. Support for pedestrians	17) Pedestrian route guidance	(47) Provision of information on Pedestrian facilities routes and others	140. Provide information on pedestrian self-location and facility location
			141. Provide information on pedestrian route along to the given destination
			142. Provide information on pedestrian refuge places
		(48) Pedestrian route guidance	143. Provide guidance to pedestrians to the given Destination
			144. Provide guidance to the visually impaired to avoid dangerous locations
			145. Provide guidance to wheel chair users
	18) Vehicle – pedestrian accident avoidance	(49) Ensuring pedestrian safety by traffic signal control	146. Provide longer green lights and information on waiting time and traffic signal colours
		(50) Ensuring safety of pedestrian and others in cooperation with vehicles	147. Warn pedestrians of approaching vehicles and others
			148. Restrict speed of vehicles concerning pedestrians
			149. Provide pedestrian with information on approaching train at railroad crossing
			150. Ensure safety passing of the wheelchair users
		(51) Provision of information on location of pedestrian and others	151. Provide pedestrian emergency notification automatically
			152. Provide information on current location of the elderly and others automatically
9. Support for emergency vehicles	19) Automated emergency notification	(52) Emergency notification	153. Notify of disasters and accidents
			154. Notify vehicles in the vicinity of accidents
	20) Route guidance for emergency vehicles and support for	(53) Guidance for emergency vehicles and support for relief activities	155. Guide emergency vehicles along the optimum routes
			156. Control traffic signals for priority guidance of emergency vehicles
			157. Inform vehicles of an emergency

Development Area	User Services	Specific User Services	Specific User Sub- Services
	relief activities		vehicles Approaching
			158. Manage emergency vehicles operations
			159. Assist vehicles for restoration and rescue works during disasters.
	21) Utilization of advanced information enabled in the advanced and telecommuni cations society	(54) Utilization of information in the advanced information and telecommunications society	160. Utilize information on shopping and amenities en route.
			161. Access to the network information when travelling
			162. Utilize banking service information on board
			163. Utilize information on the sight-spot guidance
		(55) Utilization of information related to multi-modal transport	164. Warn train of danger due to rail-crossing
			165. Reserve on public transportation and use check-in serve en route
			166. Reserve public transportation at home or office and use ticket issue service
			167. Reserve public transportation and use check-in service
			168. Utilize public transportation with cashless payment
		(56) Coordination of ITS functions with advanced information and telecommunications society	169. Utilize all-purpose transaction method including for toll roads.
			170. Coordinate with the functions provided by facilities along routes
			171. Utilize information on emergency relief activity
			172. Assist for efficient logistics by EDI.

(5) ISO 14813-1 (ISO TC204)

ISO technical committees prepared ISO 14813-1 2006 as a reference model Architecture for the ITS sector.

Within this framework, there are varying levels of details related to definitions of different services. These details differ from nation to nation, depending on whether the specific national architecture building blocks are based directly upon services or on groups of functions. Thus, the intent is to address groups of services and the respective domains within which they fit.

ISO 14813 is designed to assist the integration of services into cohesive reference architecture,

assist interoperability and with common data definition. Overall, ISO 14813 is a function base like U.S.A. ITS architecture. But it elaborates more in detail and descriptions of vulnerable users, disaster and facilities for the many nations. Australian National ITS architecture has been based on ISO 14813

ISO 14813-1 identifies 11 service domains and 43 service groups as shown in Table below.

Table 53 ISO 14813-1 (ISO TC204)

Service domain	Service group	Example services
1.Traveller information	1.1 Pre-trip information	Pre-trip information – Traffic and roadway
		Pre-trip information – Public transport (bus and rail)
		Pre-trip information – Commercial vehicle
		Pre-trip information – Personal interactive
		Pre-trip information – Modal changes and multi-modal information
	1.2 On-trip information	On-trip information – Roadside
		On-trip information – In-vehicle signing
		On-trip information – Public transport vehicle
		On-trip Information – Parking information
		On-trip information – Mobile devices
	1.3 Route guidance and navigation – Pre-trip	Dynamic in-vehicle route guidance and navigation programming/setup
		Integrated multi-modal trip guidance
		Pedestrian and bicycle route guidance
	1.4 Route guidance and navigation – On-trip	Autonomous in-vehicle navigation
		Dynamic in-vehicle route guidance and navigation (based on realtime
		network information)
		Integrated multi-modal trip guidance
	1.5 Trip planning support	Individual trip planning
		Centralized trip planning
		Data archiving
		Data warehouse
	1.6 Travel services information	Travel services information – In-vehicle
		Travel services information – Personal interactive
		Travel services information – Dedicated location
2.Traffic management and operations	2.1 Traffic management and control	Traffic monitoring
		Surface street control
		Freeway traffic control
		Preferential treatment for specific vehicle types (signal priority and preemption)
		Reversible lane management
		Coordination of surface street and freeway control
		Intermodal highway junction management

Service domain	Service group	Example services
		Parking management
		Work zone traffic management
		Traffic information dissemination
	2.2 Transport related incident management	Incident monitoring and confirmation
		Incident on-site motorist assistance
		Incident on-site traveller assistance
		Incident coordination and clearance
		Hazardous materials monitoring and management
	2.3 Demand management	Variable road pricing
		Access management
		High-occupancy lane management
		Air quality-based transport management
	2.4 Transport infrastructure maintenance management	Roadway construction and maintenance management
		Winter maintenance
		Pavement management
		Automated road management
		Work zone safety management
	2.5 Policing/enforcing traffic regulations	Access control
		High-occupancy vehicle facility usage
		Parking regulation enforcement
		Speed limit enforcement
		Signal enforcement (e.g. red light violation)
		Emissions monitoring
3. Vehicle	3.1 Transport related vision enhancement	In-vehicle driver vision management
	3.2 Automated vehicle operation	Automated highway operation
		Automated low-speed maneuvering
		Precision docking for public transport vehicles
		Automated cruise control
	3.3 Collision avoidance	Longitudinal collision avoidance
		Lateral collision avoidance
		Intersection collision avoidance
	3.4 Safety readiness	Vehicle internal systems monitoring
		Vehicle external conditions monitoring
	3.5 Pre-crash restraint deployment	Pre-crash restraint deployment
4. Freight transport	4.1 Commercial vehicle pre-clearance	Weigh-in-motion
		Non-stop pre-clearance
		Vehicle safety records monitoring
	4.2 Commercial vehicle administrative processes	Automated credential filing
		Automated commercial vehicle administration

Service domain	Service group	Example services
		Automated border crossings
	4.3 Automated roadside safety inspection	Remote access to commercial vehicle safety data
	4.4 Commercial vehicle onboard safety monitoring	Commercial vehicle internal systems monitoring
		Commercial vehicle driver alertness monitoring
	4.5 Freight transport fleet management	Commercial vehicle fleet tracking
		Commercial vehicle fleet dispatching
		Freight container tracking
	4.6 Intermodal information management	Vehicle and container arrival information exchange
		Customer freight information access
	4.7 Management and control of intermodal centres	Intermodal centre facility management
		Intermodal vehicle and container control
	4.8 Management of dangerous freight	Dangerous goods movement data sharing
		Dangerous goods movement data registry
		Dangerous goods movement fleet coordination
		Dangerous goods movement police/safety coordination
5. Public transport	5.1 Public transport management	Public transport vehicle internal systems monitoring
		Public transport vehicle fleet tracking
		Public transport scheduling services
		Public transport service dispatch
		Public transport service planning
	5.2 Demand responsive and shared transport	Para transit fleet dispatch
		Dynamic ridesharing
6. Emergency	6.1 Transport related emergency notification and personal security	Automated emergency call and mayday dispatch
		Automated vehicle intrusion and stolen vehicle monitoring
	6.2 After-theft vehicle recovery	User-initiated distress calls
		Automated theft warning
		Automated vehicle intrusion and stolen vehicle monitoring
		Stolen vehicle tracking
		Remote vehicle immobilization
	6.3 Emergency vehicle management	Emergency vehicle fleet tracking
		Emergency vehicle traffic management coordination
	6.4 Hazardous materials and incident notification	HAZMAT vehicle tracking
		Automated HAZMAT emergency call/mayday notification
		HAZMAT pre-clearance services

Service domain	Service group	Example services
7. Transport-related electronic payment	7.1 Transport related electronic financial transactions	Electronic transit fare payment
		Electronic toll collection
		Electronic parking payment
		Electronic services payment (e.g. traveller information, reservations)
		Electronic distance-based road user fee payment services
	7.2 Integration of transport-related electronic payment services	Integration of multi-jurisdictional electronic payment systems
		Integration of regional multi-modal payment systems
8. Road transport related personal safety	8.1 Public travel security	Silent alarm
		Emergency call/mayday alert for public transport
		Intrusion detection
		Public transport surveillance
	8.2 Safety enhancements for vulnerable road users	Non-motorized vehicle and pedestrian monitoring systems
		Systems to monitor specialized vehicles
	8.3 Safety enhancements for disabled road users	Intersection monitoring of specialized conveyances (e.g. wheelchairs, carts)
		Driver warnings for specialized conveyances
	8.4 Safety provisions for pedestrians using intelligent junctions and links	Signal display advance warning
		Oncoming vehicle advance warning (for non-signalized junction)
		In-vehicle signage and warning systems
9. Weather and environmental conditions monitoring	9.1 Weather monitoring	Road weather information monitoring
		Road weather prediction
	9.2 Environmental conditions monitoring	Water level/tidal monitoring and prediction
		Seismic monitoring
		Pollution monitoring
		Avalanche, mud slide and fallen rock monitoring
10. Disaster response management and coordination	10.1 Disaster data management	Disaster and emergency data collection
		Disaster and emergency data sharing
	10.2 Disaster response management	Disaster response planning for the transport network
		Disaster response implementation
	10.3 Coordination with emergency agencies	Disaster response coordination
11. National security	11.1 Monitoring and control of suspicious vehicles	Vehicle HAZMAT and explosives monitoring
		Vehicle disablement
		Road traffic management
		Identification of suspicious vehicles

Service domain	Service group	Example services
	11.2 Utility or pipeline monitoring	Pipeline and utility HAZMAT/explosives monitoring
		Emergency notification to key agencies
12. ITS Data Management	12.1 Data registries	Registration of ITS data concepts and subroutines for re-use and interoperability
	12.2 Data dictionaries	Local registration of ITS data concepts and subroutines for re-use and interoperability
	2.3 Emergency messages	Registration of emergency related messages, both originated from vehicles and from transport system users via portable or other devices, to provide interpretable data to assistance providers that is relevant to the emergency
	12.4 Control centre data	Registration of data concepts that may be exchanged between control centres
	12.5 Enforcement	Data storage and exchange for law enforcement
	12.6 Traffic management data	Data storage and exchange for use within and between traffic management centres, road operators, government agencies, law enforcement and emergency services.

(6) Comparison aAnalysis of ITS Architecture in Major Counties

The comparison analysis is summarised in the clause (6) Comparison Analysis of ITS Architecture in Major Counties, 3-6 Review of ITS Architectures in Major Countries.

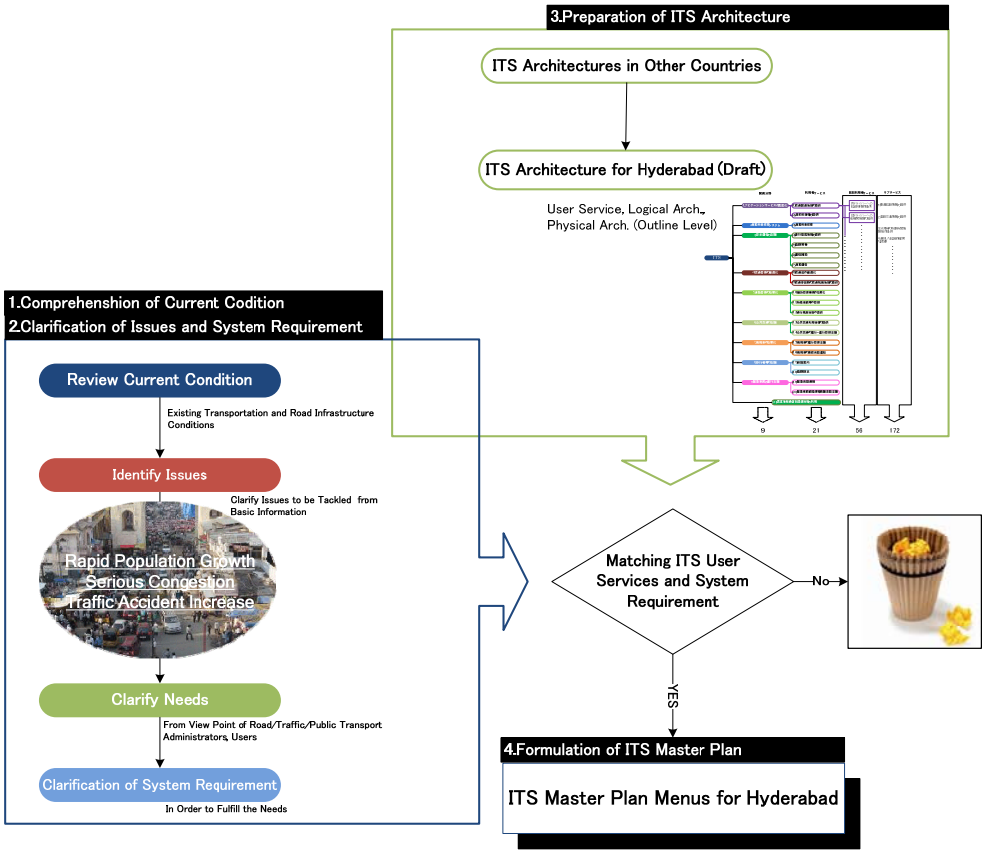
(7) Summary of ITS Architectures in the World

ITS architecture in the world is summarised in the clause (7) Summary of ITS Architectures in the World, 3-6 Review of ITS Architectures in Major Countries.

4-2 Formulation of ITS Architecture

4-2-1 Methodology for Identification of ITS Services for ITS Master Plan

The ITS services appropriate for the Hyderabad Metropolitan Area are identified based on the issues on traffic clarified and the ITS user services prepared as the ITS Architecture in the studies so far. The latest technical trends are taken into account for identifying the ITS services, as well. The figure below shows the methodology for identifying the ITS Services for Master Plan.



Source: JICA Study Team

Figure 130 Flow for the Study on ITS Services for ITS Master Plan

4-2-2 Policy for Preparation of Regional ITS Architecture

The regional ITS architecture is prepared by the following policies.

(1) Basic Concerned Points related to Regional Characteristics

- To cover all possible aspects related to transport systems
- To provide blue print for vast ITS to develop over time
- To be utilized for assistance by the agencies for planning/designing projects
- To ensure that the system fulfills the regional needs

(2) Essences Taken into Consideration for Practical Use

- Consideration for future evolution
- Incorporation of ITS Architectures in other countries: Object-Oriented

- Object-oriented in consideration of flexibility to accommodate requirements
- Specifying the user services for clear understanding

(3) Considering Points for Grouping

- Implementing large grouping based on users view point

4-2-3 Preparation of ITS User Services

In consideration of the regional issues and analysis of the ITS Architectures in other major countries, the ITS User Services that shall be provided in the region are identified with the following features.

- Goals: As envisaged in the Study that the result of ITS technology shall contribute to basic human requirements, the following user services are determined as Goals for ITS Architecture
  - ✓ Safety Improvement
  - ✓ Environmental Mitigation
  - ✓ Enhancement of Economic Productivity of Industries, Organizations and Others
  - ✓ Enhancement of Mobility, Convenience and Comfortableness
- Target Items: The categories of target items are specific objects for approaching Goals. Some unique items identified for ITS Architecture are as listed below.
  - ✓ Improvement/Resolve the Regional Conditions including -
  - ✓ Minimization of Security Risks
  - ✓ Reduction of Expense for Traffic/Road Management
- Required Services: Required services are objects of sub services to attain the targets. All required services are organized by subsystems which are either roadside subsystem, vehicle subsystem or traveller subsystem. Thus, a player of each required services can be found. Some unique features of required services for ITS Architecture for A.P. are as listed below.
  - ✓ Special Attention for Accidents, Vulnerable Uses and Public Expense Reduction

The regional ITS architecture for Andhra Pradesh are composed of 120 required services and categorized 4 large groups as shown in Table below.

Table 54 ITS Architecture for Andhra Pradesh

Goal	Target Items	Required Services
Safety Improvement (1/2)	Minimization of traffic accidents	●Services provided by roadside subsystem
		・Providing weather information
		・Providing information on road surface condition
		・Providing information on road alignment
		・Providing information on accident occurred in the vicinity
		・Providing information on vehicle coming in the opposite direction in bad visibility
		・Providing information on intersection
		・Providing information on railroad crossing

Goal	Target Items	Required Services
		・Alert of danger due to road alignment and others
		・Alert of danger due to accident in the vicinity
		・Alert of danger due to changing lane
		・Alert of danger due to vehicle ahead & following
		・Alert of danger due to obstacles or pedestrians
		・Alert of danger at intersection
		・Alert of danger at merging or diverting section
		・Alert of danger due to vehicles lane departure
		●Services provided by vehicle subsystem
		・Alert of danger due to road alignment and others
		・Alert of danger due to accident in the vicinity
		・Alert of danger due to changing lane
		・Alert of danger due to vehicle ahead & following
		・Alert of danger due to obstacles or pedestrians
		・Alert of danger at intersection
		・Alert of danger at merging or diverting section
		・Alert of danger due to vehicles lane departure
		・Assisting driving against danger due to road alignment & others.
		・Assisting driving against danger due to vehicle ahead & following.
		・Assisting driving against danger due to obstacles or pedestrians
		・Assisting driving to maintain distance with vehicle ahead and maintain specific speed.
		・Notification of vehicles in the vicinity of accidents
		・Assisting driving to stop in an emergency
		・Assisting driving when changing lane
		・Assisting driving when departing lane
		・Assisting driving at intersection

Goal	Target Items	Required Services
		・Assisting driving at merging or diverting section
		・Immobilization of vehicle engines against danger caused by drunk driving
		・Alert of danger when motorist is in abnormal conditions
Safety Improvement (2/2)	Minimization of security risk	●Services provided by roadside subsystem
		・Discover and retrieve the stolen vehicles
		・Assistance of police activities
		・Advanced analyzing of accident data
		・Providing information on pedestrian's refugee area.
		・Provision disaster, terror and accidents information
	Improve correspondence in an emergency	●Services provided by roadside subsystem
		・Notification of disasters and accidents promptly
		・Guidance for emergency vehicles to the optimum routes
		・Controlling traffic signals for priority guidance of emergency vehicles
		・Provision of Information to vehicles of an emergency vehicle approaching
		・Dispatching nearest emergency vehicles to destination
		・Assistance vehicles for the purpose of restoration and rescue works when disaster occur
	Implementation of adequate enforcement	●Services provided by roadside subsystem
		・Monitoring overloaded vehicle operation
		・Monitoring excess crews
		・Monitoring wrong way driving vehicles
		・Monitoring violation of traffic signal
		・Monitoring over speed
		・Monitoring illegal parking vehicle and any other violated vehicle
		・Monitoring fraud act vehicles on toll plaza
Environmental Mitigation	Improvement of roadside environment Preventing global warming Contributing to a resource recycling society	●Services provided by roadside subsystem
		・Controlling traffic to maintain roadside environment
		・Analyzing and evaluation of traffic restriction plans
		・Introducing Electronic Road Pricing

Goal	Target Items	Required Services
		・Installation of Electronic Toll Collection
		・Providing road traffic information
		・Providing information on public transport operation
		・Providing park & ride information
		・Introducing reversible lane control
Enhancement of economic productivity of industries, organizations and others(1/2)	Reduction of time loss	●Services provided by roadside subsystem
		・Installation of Electronic Toll Collection
		・Collection of parking charges automatically
		・Guidance of optimum route
		・Provision information on delay or accidents of public transport
	Reduction of traffic/road management expense	●Services provided by roadside subsystem
		・Assistance of traffic survey
		・Assistance of traffic management planning for wide and/or specific area.
		・Collection and provision statistical data for traffic demand control
		・Analyzing and evaluation of traffic restriction plans
	Reduction of traffic/road management expense	・Assistance of operation and maintenance of traffic control facilities
		・Assistance of decision-making and provision of information on traffic restrictions and lift
		・Assistance road maintenance inspection
		・Collection of information on road surface
		・Assistance of parking plan
		・Providing information on availability of parking lot
		・Improvement of prompt of address and clearance of accident
		・Storing of traffic and accidents data automatically
		・Controlling traffic signals
		・Controlling of traffic signals at railroad crossing
		・Guidance of route based on traffic management
		・Guidance of route & lane corresponding to a vehicle types
		・Controlling lanes for parking purpose
		・Controlling one way driving dynamically

Goal	Target Items	Required Services
		・Collection of information on adverse weather and disaster
		・Traffic management when disaster and/or adverse weather.
		・Traffic management for VIP
		・Monitoring overloaded vehicle operation
		・Collection of information on dangerous-load vehicle operation
	Application of tourism resources and creation of business chance for commercial facilities	●Services provided by traveller subsystem
		・Providing detailed information and reservation on destination facilities
		・Providing information on the destination facilities regarding availability of vulnerable people
		・Providing information on the rest area
		・Providing weather information on the given area
		・Providing information on parking availability
		・Providing information on park and ride
Enhancement of economic productivity of industries, organizations and others(2/2)	Validity of bus and taxi service	●Services provided by traveller subsystem
		・Provision of information on bus/taxi operation
		・Reservation of bus/taxi
		・Providing information on delay or accidents of bus/taxi transport
		・Introducing bus location system
		・Collection of bus/taxi location and operation to their service centre
	Increasing efficiency in freight vehicles operation	●Services provided by traveller subsystem
		・Providing road traffic information to commercial vehicles
		・Providing information on freight vehicles operation such as present location
		・Providing information on commercial vehicles emergency when occurs
		・Providing information on freight vehicle condition
		・Providing information on other shipment operation such as schedule
		・Implementing platooning of trucks
Enhance the mobility, convenience and	Enjoyable driving	●Services provided by traveller subsystem
		・Providing information on optimum route

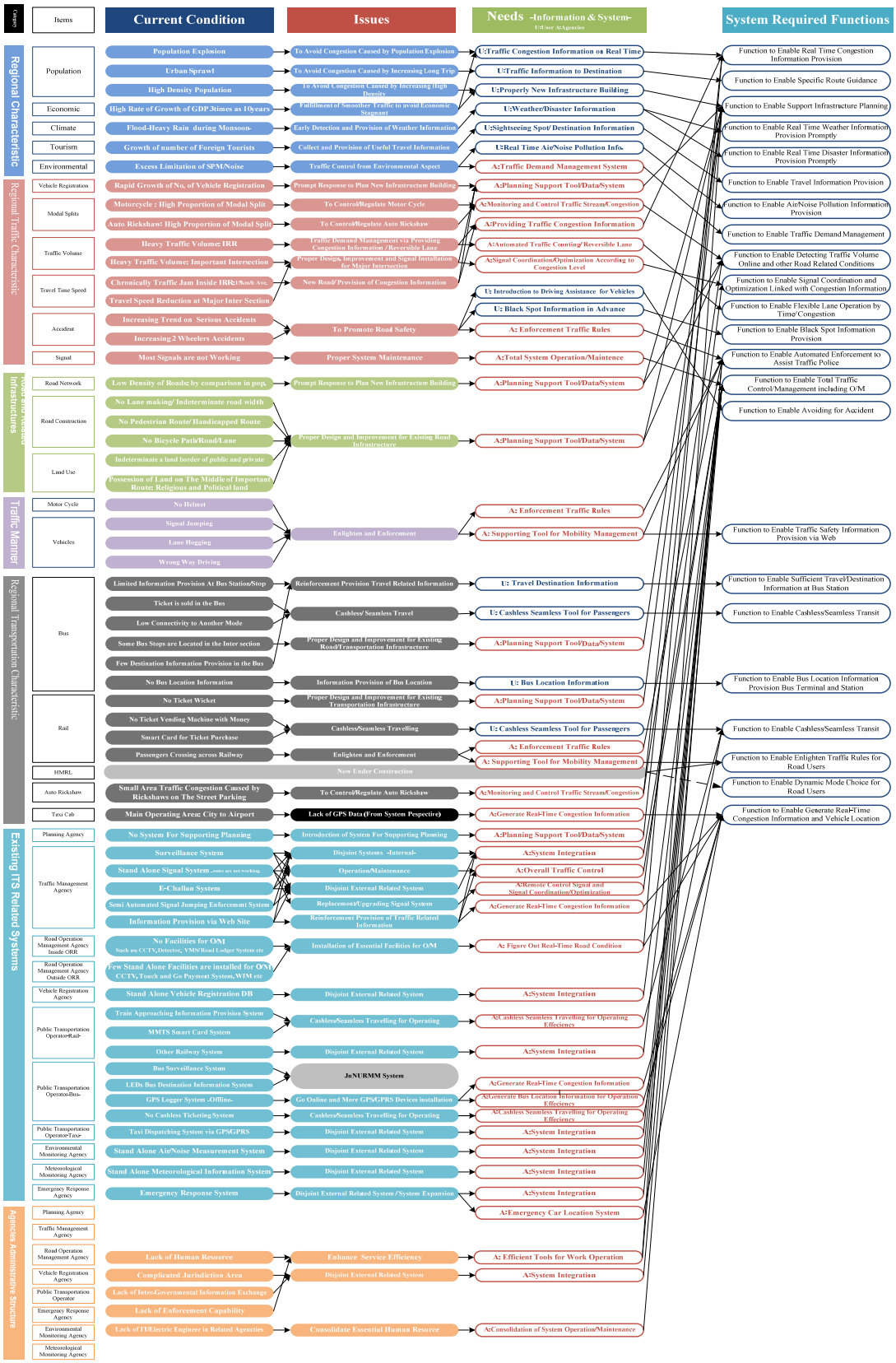
Goal	Target Items	Required Services
comfort		・Providing of road traffic information
		・Providing information on travel time to destination
		・Providing other mode operation information
		・Providing parking availability information
		・Introducing signal coordination system
	Convenient society	●Services provided by roadside subsystem
		・Providing information to pedestrian/disabled people
		・Introducing integrated charge system by single smart card
		・Enhancement of safety measures for vulnerable people
		●Services provided by traveller subsystem
		・Providing information on pedestrian self-location and facility location
		・Providing information on pedestrian route and guidance to the destination
		・Providing guidance on visually impaired to avoid dangerous locations
		・Guidance on available route for wheelchair users.
		・Guidance on availability route for bicycle
		●Services provided by vehicle subsystem
		・Enhancement of safeguard system for vulnerable people

4-2-4 Clarification of Required System Functions

The required system functions are the functions which shall be equipped with the system to meet the identified needs. They are identified and summarized through the analysis of the issues and needs on transportation in the Hyderabad Metropolitan Area, based on the analysis for clarification of issues which is described in the previous corresponding section. The required system functions are summarized in Figure 131.

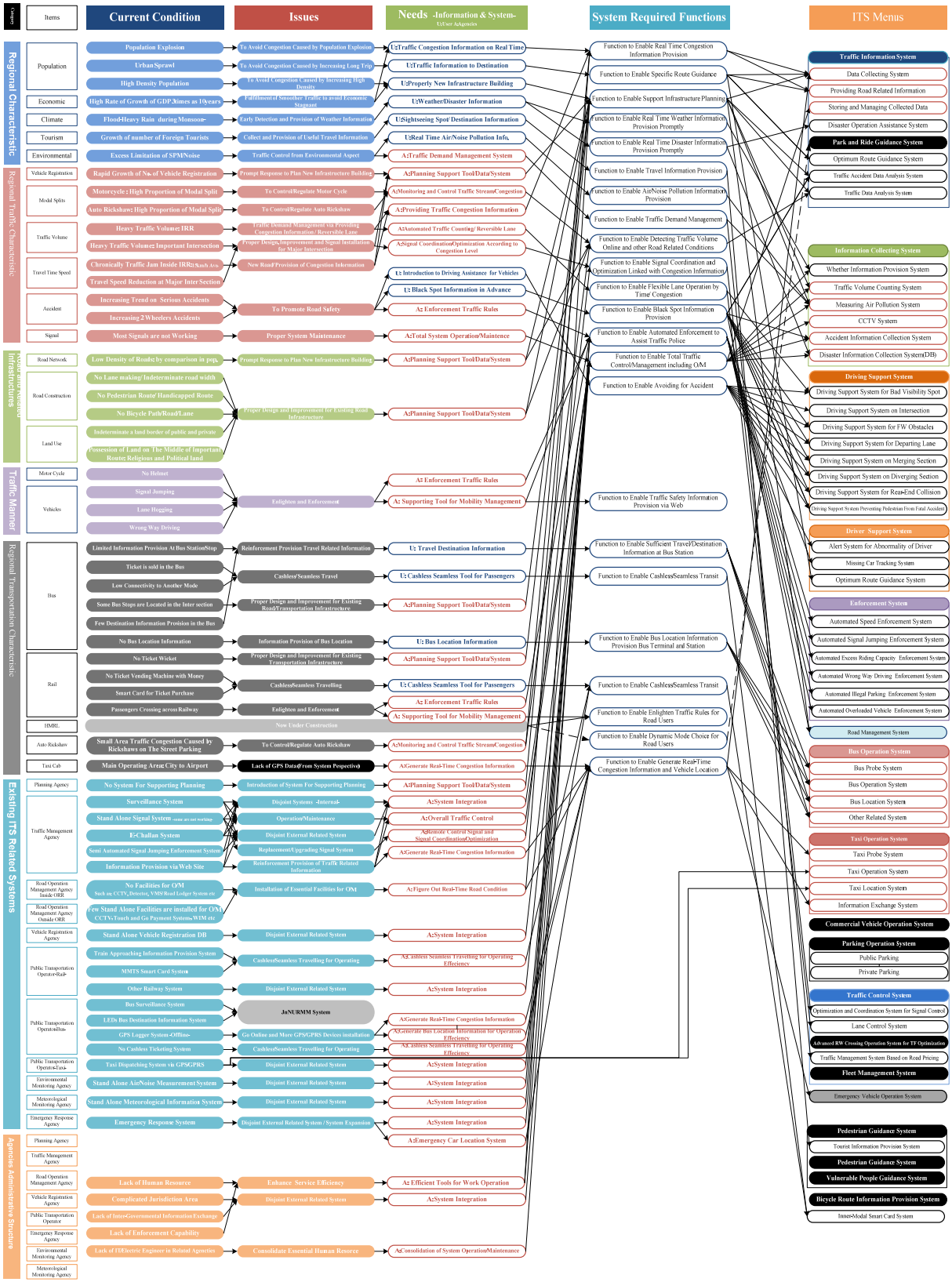
4-2-5 Identification of ITS Services by Matching Required System Functions and ITS User Services of ITS Architecture

The ITS services for the ITS Master Plan for Hyderabad Metropolitan Area are further identified based on the ITS User Services of the ITS Architecture for Andhra Pradesh by matching with the required system functions to be equipped, as shown Figure 132.



Source: JICA Study Team

Figure 131 Clarification of Required System Functions



Source: JICA Study Team

Figure 132 Identification of ITS Services by Matching the Required System Functions and ITS User Services of ITS Architecture

4-2-6 Re-Categorization of ITS Services

The ITS Services identified above are re-categorized by the sub-system for the purpose of clarification as the systems to be prepared in Hyderabad Metropolitan Area, as shown below.

Table 55 Re-Categorized ITS Services

Title of Sub-System		Required Service from Architecture
1. Traffic Information System		
	1-1. Data Collecting (using probe-car, on-road unit, telephone and other related unit to collect)	Collecting traffic volume by using Vehicle Detector
		Collecting traffic volume (road congestion) information by using vehicle probe sensor
		Collecting road weather information by using roadside weather sensor
		Collection weather information from the meteorological agency
		Collecting road pollution information by using roadside weather sensor
		Collecting CCTV image from related CCTV System
		Collecting parking information from parking Information System
		Collecting public transportation information (bus, metro and train)
		Collecting road disaster information from related agencies (by human resources)
		Collecting traffic accident Data (by human resources)
		Collecting traffic information from related traffic organization such as ORR Traffic Control Centre
	1-2. Providing Road Related Information (Using VMS, Web Site and E-mail system to provide.)	Providing Road Traffic information via Provision Tool (Internet Web Site, VMS, SMS, Telephone Call Centre and Media)
		Providing (Adverse) Weather Information via Provision Tool
		Providing Disaster Information via Provision Tool
		Providing Guidance Information for Park and Ride via Provision Tool
		Providing Route Guidance via Internet Web Site, VMS and Telephone Call Centre
		Providing Tourist Information via Internet Web Site and Telephone Call Centre

Title of Sub-System		Required Service from Architecture
	1-3. Control System (using related system such as signal and lane-control to control traffic)	Traffic Monitoring System with Large Display at Monitoring Room
		Providing necessary information to Media/Call centre
	1-4. Storing, Managing and Aggregate of collected data (Supporting System such as Database and GIS)	Storing collecting data
		Aggregate collection data periodically
	1-5. Disaster Operation Assistance System (Supporting System)	Traffic Management when Disaster and/or adverse weather.
		Assisting Driving to stop in an Emergency
		Assistance Vehicles for the purpose of restoration and rescue works when Disaster occur
		Provision to notify the need of Emergency
		Provision to accurate location of vehicle/site
	1-6. Park and Ride Guidance System (Supporting System)	Providing information on Park and Ride
		Providing other mode operation information
	1-7. Optimum Route Guidance System (Supporting System)	Guidance of route based on traffic management
		Providing information on travel time to destination
		Providing information on optimum route
		Guidance of optimum route
		Guidance of route & lane corresponding to a vehicle types
	1-8. Traffic Accident Data Analysis System (Supporting System)	advanced analysis of accident data
		Storing of traffic and accidents data automatically
		Quickly attending/addressing the incident and clearance of Accident
	1-9. Traffic Data Analysis System (Supporting System)	Assistance of Traffic Management planning for wide and/or specific area.
		Assistance of decision-making and provision of information on Traffic restrictions and lift
		Assistance of Traffic survey
		Analysis and evaluation of Traffic restriction plans
		Collection and provision statistical Data for Traffic demand Control

Title of Sub-System		Required Service from Architecture
2. Information Collecting System		
	2-1. Weather Information Collection System	Collecting weather information automatically by using meteorological sensor
		Storing sensor data to database and aggregate stored data periodically
		Sending weather information data to other related agencies
	2-2. Traffic Volume Counting System	Collecting traffic count by using Image sensor
		Storing sensor data to database and aggregate stored data periodically
	2-3. Measuring air pollution System	Collecting air pollution (NOx, SOx, SPM)
		Storing sensor data to database and aggregate stored data periodically
	2-4. CCTV	On road CCTV camera
		CCTV dispatch system to other traffic related agency
	2-5. Accident information collection system (DB)	Collection of information from related organization such as police, GHMC and ORR TCC.
		Storing sensor data to database and aggregate stored data periodically
	2-6. Disaster Information Collection System (DB)	Collection of disaster information from related organization such as police, GHMC and ORR TCC.
		Storing sensor data to database and aggregate stored data periodically
3. Information Provision System		
	VMS	
	Web Information System	
	E-Mail and SMS Information System	
4. Driving Support System		
	4-1. Alert and Driving Support System for Critical Road Alignment	Providing information on Road alignment
		Alert of danger due to Road alignment and others
		Providing information on Vehicle coming in the opposite direction in Bad Visibility
		Assisting Driving against danger due to Road alignment & others.
	4-2. Alert and Driving Support System at intersection	Alert of danger at Intersection
		Providing information on Intersection
		Assisting Driving at Intersection

Title of Sub-System		Required Service from Architecture
	4-3. Alert and Driving Support System for accidents in the vicinity	Providing information on Accident occurred in the vicinity
		Alert of danger due to Accident in the vicinity
		Notification of Vehicles in the vicinity of Accidents
	4-4. Alert and Driving Support System for Keeping Lane/Departing Lane	Alert of danger due to Changing Lane/ Lane Departure
		Assisting Driving when Changing Lane/Departing Lane
	4-5. Alert and Driving Support System on Merging Section	Alert of danger at Merging Section
		Assisting Driving at Merging Section
	4-6. Alert and Driving Support System on Diverging Section	Alert of danger at Diverging Section
		Assisting Driving at Diverging Section
	4-7. Alert and Driving Support System for Rear-end Collision	Alert of danger due to Vehicle ahead & following
		Assisting Driving against danger due to Vehicle ahead & following.
		Assisting Driving to maintain distance with Vehicle ahead and maintain specific Speed.
	4-8. Alert and Driving Support System Preventing Pedestrian from Accident	Alert of danger due to Obstacles or Pedestrians
		Assisting Driving against danger due to Obstacles or Pedestrians
	4-9. Alert System for Abnormality of Driver	Alert of danger when Motorist is in abnormal conditions
		Immobilization of vehicle engines against danger caused by drunk driving
	4-10. Missing Car Tracking System	Discover and retrieve the stolen Vehicles
	4-11. Optimum Route Guidance System	Guidance of route based on traffic management
		Providing information on travel time to destination
		Providing information on Optimum Route
		Guidance of Optimum Route
		Guidance of Route & Lane corresponding to a Vehicle types
5. Enforcement System		-
	5-1. Assistance of Police activities	Assistance of Police activities (Provide and support security of society used by ITS monitoring system.)
2nd	5-2. Automated Speed Enforcement	Monitoring Over Speed

Title of Sub-System		Required Service from Architecture
Phase		
by Police	5-3. Automated Signal Jumping Enforcement	Monitoring violation of Traffic Signal
	5-4. Automated Excess Riding Capacity Enforcement	Monitoring Excess Crews
	5-5. Automated Wrong Way Driving Enforcement	Monitoring Wrong Way Driving Vehicles
	5-6. Automated Illegal Parking Enforcement	Monitoring Illegal Parking Vehicle and any other violated Vehicle
	5-7. Automated Overloaded Vehicle Enforcement	Monitoring Overloaded Vehicle Operation
6. Road Management System		
		Collection of information on Road surface
		Providing information on Road surface condition
		Assistance Road maintenance inspection
		Assistance of Operation and maintenance of Traffic Control facilities
7. Bus Operation System		
	7-1. Bus Probe System	Surveying position of bus by using GPS unit installed each bus
	7-2. Bus Operation System	Observing realtime bus positioning by using GIS base system
	7-3. Bus Location System	Providing information on public transport Operation (delay and accident of bus and public transport)
	7-4. Other related system	Reservation of bus
		Maintenance of bus
		Dispatch control system for driver
8 Taxi Operation System (Partially already under operating)		
	8-1. Taxi Location System	Surveying position of bus by using GPS unit installed each bus
	8-2. Taxi Operation System	Reservation of Taxi
		Taxi Dispatching System
	8-3. Information Exchange System	Sending probe data information to ITSC
9. Commercial Vehicle Operation System		Providing Road Traffic information to Commercial Vehicles
	9-1. By Private Corp.	Providing information on freight Vehicles Operation such as present location
		Providing information on freight Vehicle condition
		Providing information on other shipment

Title of Sub-System		Required Service from Architecture
		Operation such as schedule
		Providing information on Commercial Vehicles Emergency when occurs
		Collection of information on dangerous-load Vehicle Operation
		Interstate Border Electronic clearance
10. Parking Operation System		
	10-1. Public Parking	Providing information on Parking availability
		Controlling Lanes for Parking purpose
		Collection of Parking charges automatically
		Sending information of parking availability to ITSC
		Assistance of Parking plan
	10-2. Private Parking	Providing information on Parking availability
		Controlling Lanes for Parking purpose
		Collection of Parking charges automatically
		Sending information of parking availability to ITSC
		Assistance of Parking plan
11. **Traffic Control System**		
	11-1. Optimization and Coordination System for Signal Control	Controlling Traffic Signals
		Introducing Signal Coordination System
		Traffic Management for VIP
	11-2. Lane Control System	Controlling one way Driving dynamically
		Introducing reversible Lane Control
	11-3. Advanced Railway Crossing Operation System for Traffic Flow Optimization	Collecting train position
		Controlling railway crossing gate and signal and VMS optimally
	11-4. Traffic Management System Based on Road Pricing ERP, ETC	Installation of Electronic Toll Collection
		Monitoring fraud act Vehicles on toll plaza
		Introducing Electronic Road Pricing
		Controlling Traffic to maintain Roadside environment
		Traffic Management for VIP
	11-5. Fleet Management System 3rd Stage	Implementing platoon of trucks
12. Emergency Vehicle Operation System		Dispatching nearest Emergency Vehicles to destination

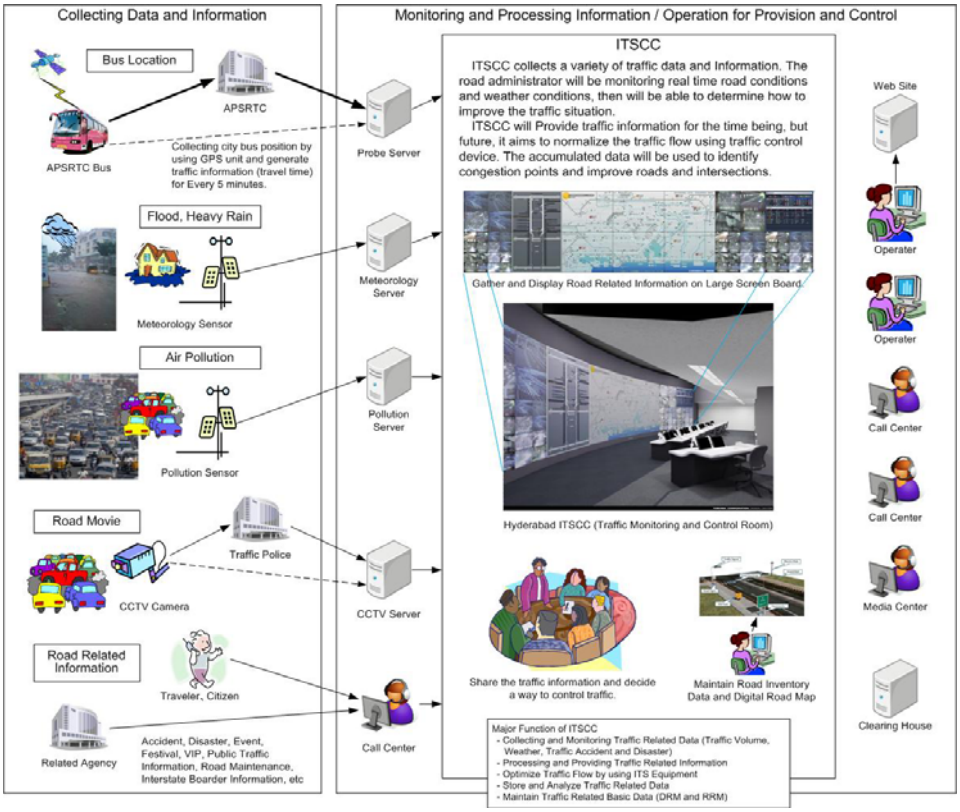
Title of Sub-System	Required Service from Architecture
	Guidance for Emergency Vehicles to the Optimum Routes
	Provision of Information to Vehicles of an Emergency Vehicle approaching
	Controlling Traffic Signals for priority Guidance of Emergency Vehicles
13. Pedestrian/Vulnerable people guidance system	Providing information on pedestrian/vulnerable people self location and facility location
	Providing information on route guidance towards destination to pedestrians and vulnerable people to avoid dangerous locations.
	Providing information on the destination facilities regarding availability of vulnerable people
	Providing information on pedestrian's refugee area.
	Enhancement of safety measures for pedestrians/vulnerable people
	Providing information to pedestrian/disabled people
	Guidance on available Route for wheelchair users.
	Enhancement of safeguard system for vulnerable people
14 Tourist Information Provision System	Providing information on the rest area
	Providing detailed information and reservation on destination facilities
	Pre-trip information (traffic and roadway, public transport (bus and rail), commercial vehicle, personal interactive, modal change and multi-modal information)
	On-trip information (roadside, in-vehicle signing, public transport vehicle, parking information and mobile devices)
	Route and guidance to the tourist spots.
15. Bicycle Route Information Provision System	Guidance on availability Route for bicycle
16 Inter-Modal Smart Card System	Introducing integrated charge System by single Smart card
	Using Smart Card at Train, Metro, Taxi, Shopping

4-2-7 ITS Services

Based on the studies thus far, the ITS services were identified and prepared in the form of ITS Services Carte, as shown below.

(1) 1. Traffic Information System (1-1. Data Collection)

Item	Contents	
ITS Sub-Service Services	1. Traffic Information System (1-1. Data Collection)	
Purpose	Collect the realtime data from probe vehicles, vehicle detectors weather monitor, etc. and information from related agencies, other public transportation etc. ITSC analyze and process these data before providing to travellers and supporting related agencies in decision making.	
Effectiveness	Collected realtime traffic related data will be analyzed and processed at ITSC before providing to travellers as a realtime traffic information include current location of travellers, optimum routes, travel time of selected route, ongoing road work, weather etc. Travellers can improve traveller's satisfaction and reduce the traffic congestion by optimal usage of road infrastructure. As the result, it can mitigate the environmental impact of air pollution and CO2.	
Service flow	1. ITSC collects the realtime traffic data from subsystems such as weather monitors, vehicle detectors, probe vehicles, etc. 2. ITSC collect the necessary information from related agencies such as traffic police, road administrator, public transport operators, meteorological agency and call from informer. 3. ITSC analyzes and processes the collected data and start the provision process and/or control system. All process has to be implemented within few minutes. 4. Collected data and information will be stored with stamps at ITSC.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Realtime Traffic information is collected at TCC by GPS navigation, GPRS communication, roadside antenna and Traffic counters through online or offline communication network and linked the traffic information to map data. The realtime traffic information is sent to in-vehicle navigation systems, internet, personal navigation devices (PNDs), cell phones, Variable Message Sign Board (VMS), and highway radio and media. These systems can contribute travellers for selecting another route, changing the travel starting time, making preparation of the event coming ahead.	1. SMS messages warn to travellers by Hyderabad Traffic Police (HTP) 2. GHMC is planning to implement Traffic Information and Optimization System in the future using around 20 VMS system across Hyderabad. 3. APSRTC is planning to implement GPS based bus location system and passenger information system.

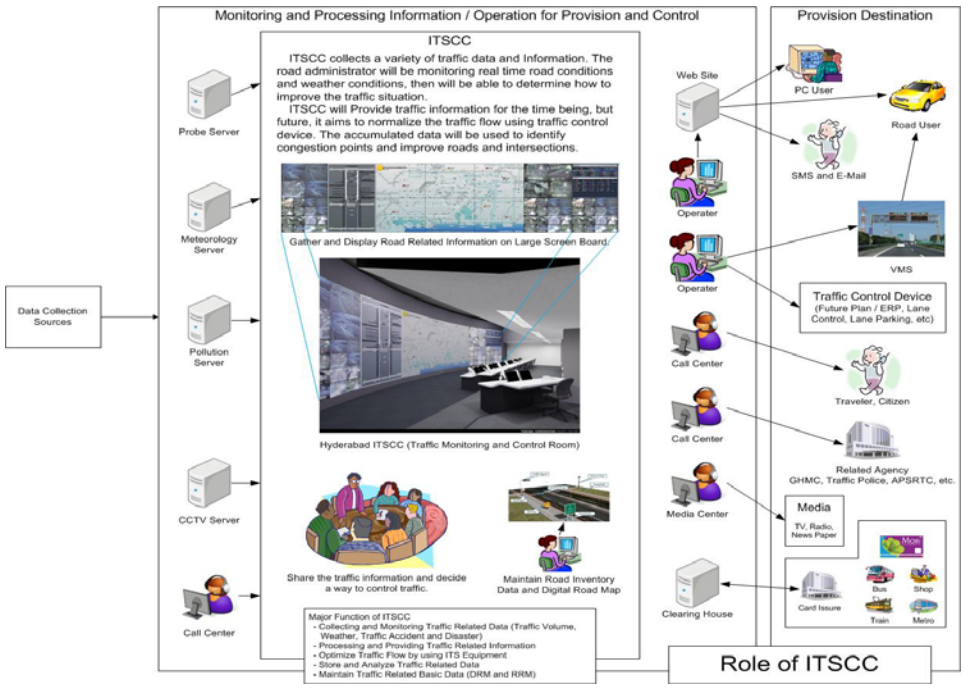
Item	Contents
Image (Example)	

Item	Type	Device	Cost	
			Initial	Running
Outline of ITS sub-system	Collection System	Server Workstation UPS power supply with 30 minute backup (30KVA) Power distribution board (16 circuit) Software	14,000,000Rs/system	8,000,000Rs/year

Item	Contents
Target Area	Inside ORR
Implementation Period	Pilot Project, Phase-1, Phase-2
Related Agency	ITSC, Traffic Police, GHMC, HMDA, HGCL, NHAI and Meteorology Department
Remarks	

(2) 1. Traffic Information System (1-2. Providing Road Related Information)

Item	Contents	
ITS Sub-Service Services	1. Traffic Information System (1-2. Providing Road Related Information)	
Purpose	After ITSC analyze and process the data from own equipment and information by other agencies, etc., ITSC prioritize needs of information and provide users and travellers on realtime by VMS, Website, SMS and media etc. ITSC also provide required data to related agencies for supporting to use for planning or any decision making.	
Effectiveness	Realtime traffic information include optimum routes, travel time of selected route, ongoing road work etc., in order to improve travellers satisfaction and reduce the traffic congestion by optimal usage of road infrastructure. As the result, it can mitigate the environmental impact of air pollution and CO2. Related agencies such as traffic police and road administrator can use these data for planning or optimum maintenance.	
Service flow	1. ITSC exchanges the necessary information with road administrator, traffic police and other related-agencies. 2. ITSC prepare the traffic information for provision by inputting manually or automatically assembling messages for informing travellers using various equipments or devices such as VMS, SMS, e-mail, call centre etc. 3. ITSC control system display current messages showing VMS on each workstation and/or large display. 4. ITSC provides necessary information to on-trip traveller's accordance with their request through in-vehicle device. 5. ITSC store and manage the collected data 6. When any incidents occur, messages provide to provision equipment/device immediately. After cleared these incidents, messages deleted from provision equipment/device immediately.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Realtime Traffic information is collected at TCC by GPS navigation, GPRS communication, roadside antenna and Traffic counters through online or offline communication network and linked the traffic information to map data. The realtime traffic information is sent to in-vehicle navigation systems, internet, personal navigation devices (PNDs), cell phones, Variable Message Sign Board (VMS), and highway radio and media. These systems can contribute travellers for selecting another route, changing the	1. SMS messages warn to travellers by Hyderabad Traffic Police (HTP) 2. GHMC is planning to implement Traffic Information and Optimization System in the future using around 20 VMS system across Hyderabad. 3. APSRTC is planning to implement GPS based bus location system and passenger information system.

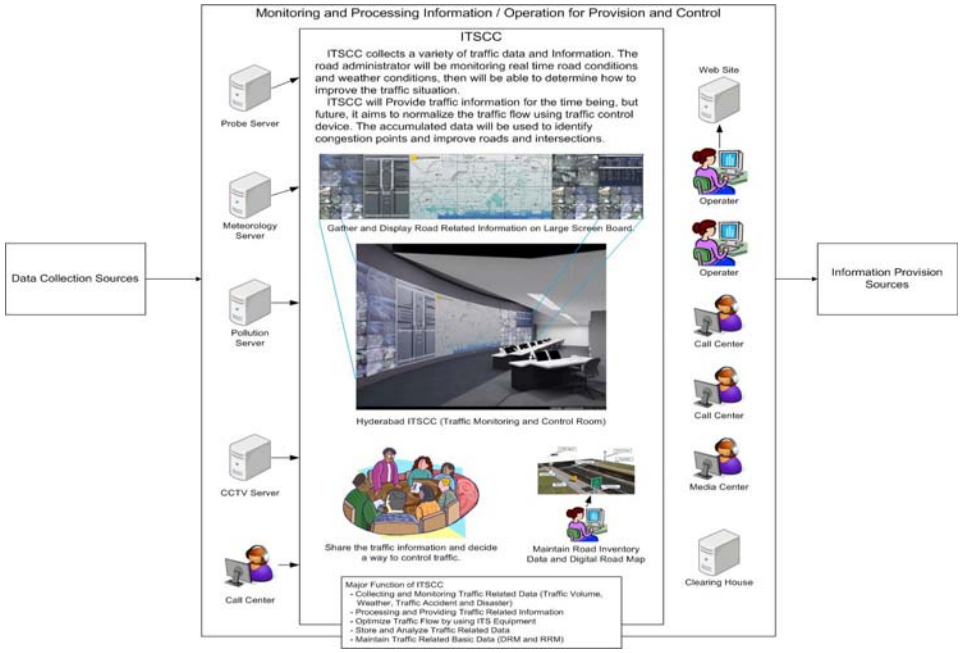
Item	Contents	
	travel starting time, making preparation of the event coming ahead.	
Image (Example)		

Item	Type	Device	Cost	
			Initial	Running
Outline of ITS sub-system	Provision System	Sever Workstation Software	13,500,000 Rs/System	8,000,000 Rs/year

Item	Contents
Target Area	Inside ORR
Implementation Period	Pilot Project, Phase-1, Phase-2
Related Agency	ITSC, Traffic Police, GHMC, HMDA, HGCL, NHAI and Meteorology Department
Remarks	

(3) 1. Traffic Information System (1-3. Control System)

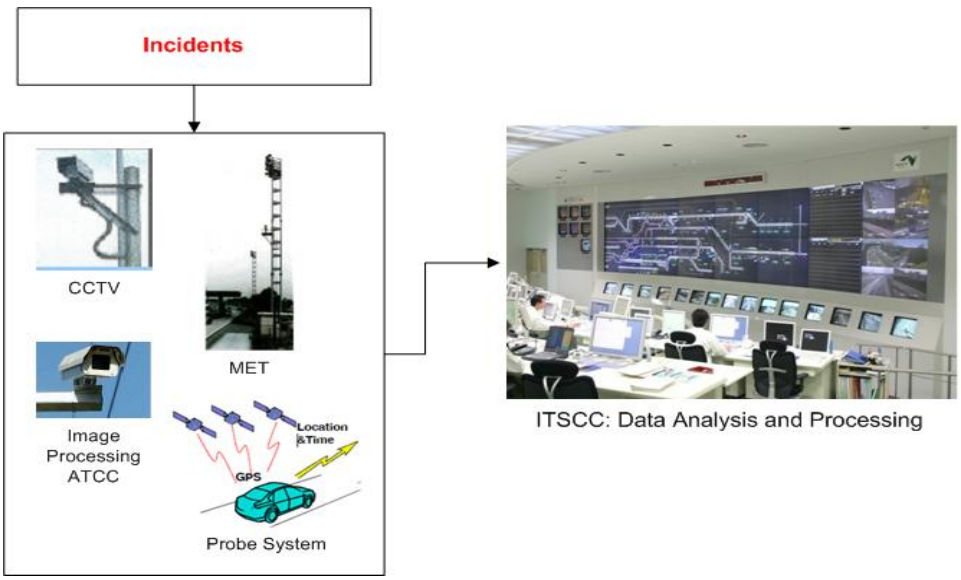
Item	Contents	
ITS Sub-Service Services	1. Traffic Information System (1-3. Control System)	
Purpose	To operate efficiently from ITSC or Traffic Control Centre (TCC) of traffic police, control and monitoring room with large display for monitoring traffic flow or incidents is required.	
Effectiveness	Control room monitor the traffic and any incidents with large display and monitor each workstation. If necessary, control room control signals, lane-controller. Control room also monitors functioning of equipment. Centralized control system enables to provide efficient operation for traffic control.	
Service flow	1. Operator can confirm all data and information from subsystems and other related agencies at their workstations at ITSC and/or TCC at traffic police. 2. Necessary information such as current messages presenting on VMS and status of traffic flow are displayed on large display. 3. Emergency information will be shown on large display automatically. 4. Next action will be decided by officer with considering regional traffic flow displayed on the large display. 5. Higher-priority information is automatically assembled and sent to Information Provision System (VMS or travellers through internet, in-vehicle device, mobiles, etc). 6. Necessary information will be sent to Media/Call centre through Support centre.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Most of the TCC has a large display and used for observing traffic and incidents by staff and share the information at glance. When the accidents or any incidents captured by CCTV, image is displayed automatically with higher-priority. Any other emergency incidents occur such as receiving emergency telephone call, warning by alarm.	Currently traffic police's TCC has LCD displays for showing images from CCTV. But this is only displaying images, but not the control system.

Item	Contents
Image (Example)	

Item	Type	Device	Cost	
			Initial	Running
Outline of ITS sub-system	Centralized System	Large Display (DLP Monitor) CCTV Monitor (52inches) Workstation Software	65,000,000 Rs/system	16,000,000 Rs/year

Item	Contents
Target Area	Inside Outer Rind Rode (ORR)
Implementation Period	Pilot Project
Related Agency	ITSC, GHMC, HGCL, Traffic Police
Remarks	

(4) 1. Traffic Information System
(1-4. Storing, Managing and Aggregate of collected data)

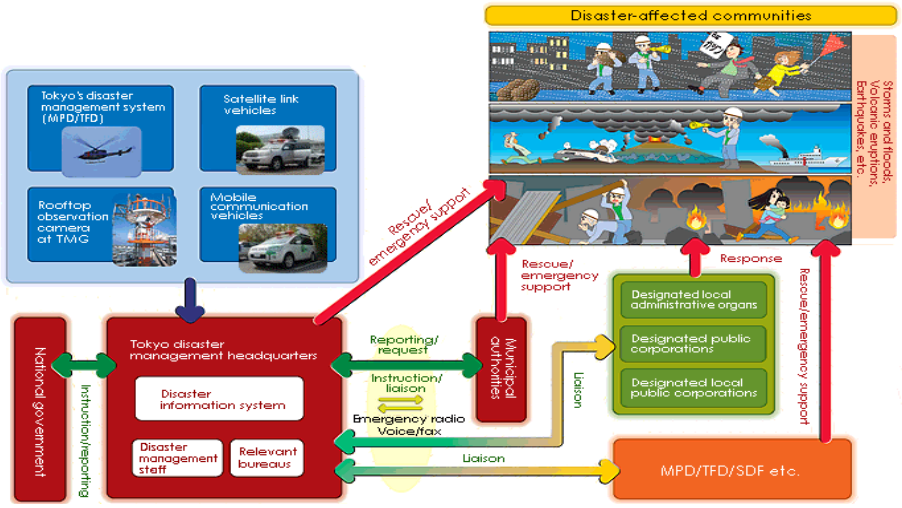
Item	Contents	
ITS Sub-Service Services	1. Traffic Information System (1-4. Storing, Managing and Aggregate of collected data)	
Purpose	Collected data at ITSC are stored automatically and required data will be plot into GIS. It can be useful for data analysis.	
Effectiveness	Automatic data collection, analyzing and plotting into GIS can be useful for management and planning of transport related infrastructures.	
Service flow	1. ITSC collected traffic/incidents data from subsystems, TCC of traffic police, emergency call, etc. 2. Collected data will be plot into required form and/or GIS mapping for easy understanding and future analysis.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Collected traffic data at centre are automatically stored and plot into various forms such as equipments surveillance, traffic volume, travel speed, types of vehicles, etc. Statistic data is also organized based on required group automatically for efficient maintenance and future planning. In addition, Statistical data of traffic volume used for prospection for specific date are provided to travellers through internet.	Currently Hyderabad has monitored the traffic by CCTV. But CCTV images are not properly stored and deleted after while without proper statistical data organization.
Image (Example)		

Item	Type	Device	Cost	
			Initial	Running

Item	Contents			
Outline of ITS sub-system	Storing, Managing and Aggregate of collected data	Work Station Laser Printer External Storage Device Software	13,000,000 Rs/location	8,000,000 Rs/year
Item	**Contents**			
Target Area	Inside Outer Rind Rode (ORR)			
Implementation Period	Pilot Project, Phase-1, Phase-2			
Related Agency	ITSC, GHMC, HGCL, Traffic Police			
Remarks				

(5) 1. Traffic Information System
(1-5. Disaster Operation Assistance System)

Item	Contents	
ITS Sub-Service Services	1. Traffic Information System (1-5. Disaster Operation Assistance System)	
Purpose	Collection of disaster and adverse weather information/data from Disaster Information Collection System for efficient traffic management, emergency vehicles, provision of users.	
Effectiveness	Immediate notification of disaster/adverse weather information to travellers can warn them to decide next action to avoid getting involved. Road administrator has to make decision of closing road or lane regulation according to the road condition and situation of disaster/adverse weather. In addition, road administrator has to find the available route for traffic aftermath. This system also supports the vehicle for the purpose of restoration and rescue works.	
Service flow	1. Disaster Information Collection System of ITSC collect the adverse weather data and disaster information from roadside equipment, meteorological agencies and others on realtime. 2. Accessing to ITSC from travellers through in-vehicle device or other provision devices. 3. ITSC analyzes and processes the collected data. 4. ITSC exchanges the necessary information with road administrator, police and other agencies. 5. ITSC provides the adverse weather/disaster information to travellers by various equipments or devices.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Disaster and adverse weather information is collected at centre by roadside equipments and meteorological agencies or other agencies which monitor the frequent disaster area through communication network. Road administrator dispatch the special vehicle enables to communicate with centre by satellite. This information is sent to in-vehicle navigation systems, internet, mobiles, VMS, highway radio and Media. Risky area of land sliding, earthquake, heavy snowing, dense fog and road depression are monitored by road administrator routinely, since they cause the serious accidents. Analyzing aftermath probe data clarify available route. Travellers can select another route, changing the	Regarding disaster and adverse weather, there is no immediate information provision system to achieve to road users.

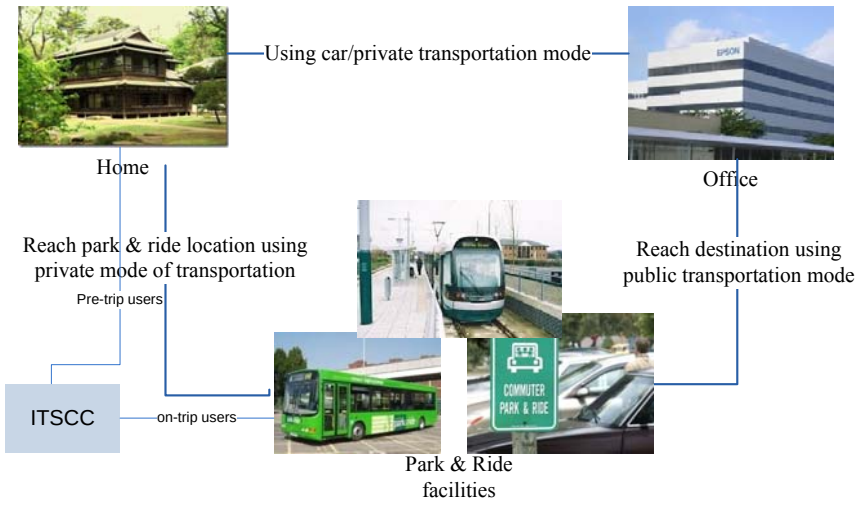
Item	Contents	
	travel starting time or destination and prepare adverse weather coming ahead. This information is also used for road administrator for decision making of closing road or lane regulation aftermath.	
Image (Example)		

Item	Type	Device	Cost	
			Initial	Running
Outline of ITS sub-system	Disaster Operation Assistance System	Workstation Software	10,000,000 Rs/location	8,000,000 Rs/year

Item	Contents
Target Area	Inside Outer Rind Rode (ORR)
Implementation Period	Pilot Project
Related Agency	ITSC, Meteorology Department, National Disaster Management Authority, GHMC, HGCL, Traffic Police
Remarks	

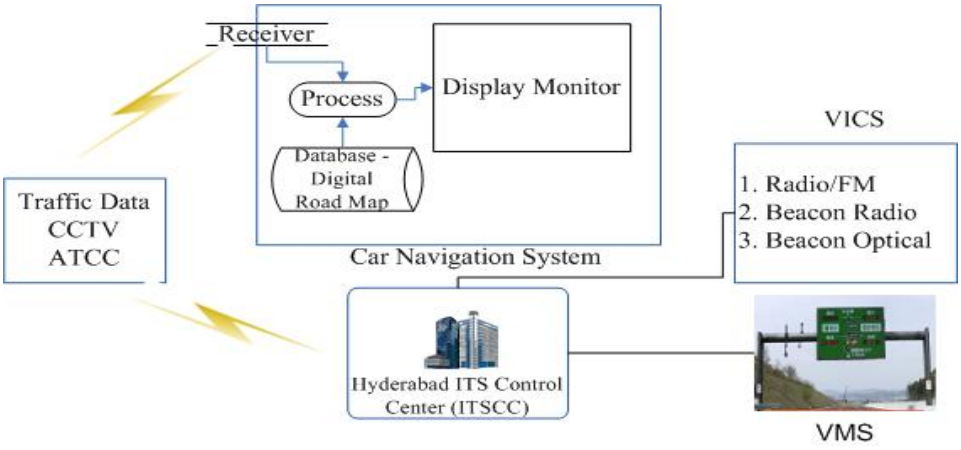
(6) 1. Traffic Information System (1-6. Park and Ride Guidance System)

Item	Contents	
ITS Sub-Service Services	1. Traffic Information System (1-6. Park and Ride Guidance System)	
Purpose	To provide option of shifting from vehicle to bus/train or other transportation modes enable to reduce the traffic congestion and air pollution.	
Effectiveness	When traveller make the movement, traveller tends to take a vehicle for transportation even other mode is more reliable such as punctuality because of collecting other mode information on pre-trip and on-trip takes a plenty of time and toil. Providing other modes' information urge the traveller to shift to other modes from vehicle enable to reduce the traffic congestion, air pollution and improve the punctuality to destination.	
Service flow	1. Traveller accesses other modes information by in-vehicle device or mobile and input the kinds of mode and destination. 2. ITSC collects the information of other modes periodically from operation companies of other modes. 3. ITSC analyzes and processes the data of other modes. 3. ITSC provides the information of travel time, connectivity to other modes, and fare of other modes based on traveller's requirement to traveller both pre-trip and on-trip.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	The necessary data is collected by other mode's operation companies. Traveller's mobile with GPS can define the location of travellers and guide travellers to the best and alternative options as per traveller's requirement. Some manufactures are researching even what mode traveller currently taking by acceleration sensor embedded in mobiles.	Currently Hyderabad has only bus for partial intermodal transport system. Metro trains are under constructions.

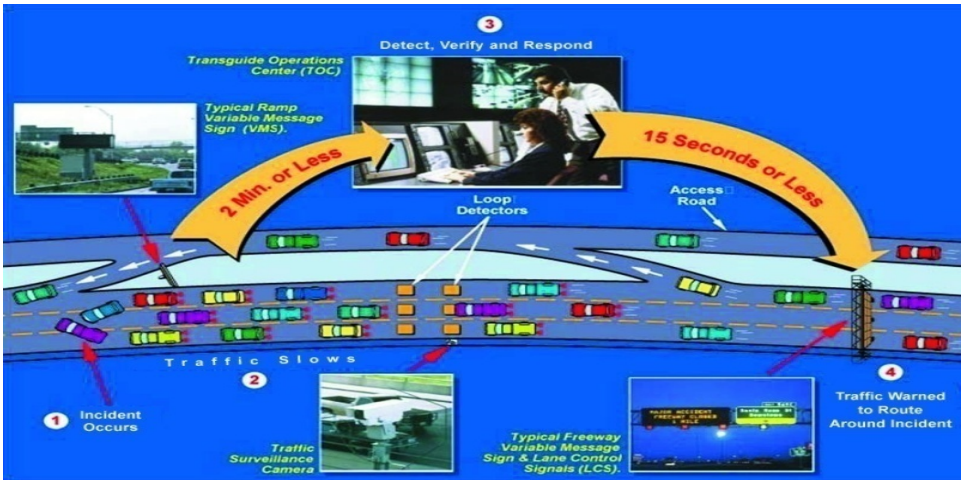
Item	Contents
Image (Example)	
Target Area	Inside Outer Rind Rode (ORR)
Implementation Period	Phase I Project
Related Agency	ITSC, HMRL(Metro), APSRTC, GHMC
Remarks	

(7) 1. Traffic Information System
(1-7. Optimum Route Guidance System)

Item	Contents	
ITS Sub-Service Services	1. Traffic Information System (1-7. Optimum Route Guidance System)	
Purpose	Guide optimum route to travellers to avoid traffic congestion and ease traveller's stress. This system is also used for traffic control by traffic police/road administrator.	
Effectiveness	Optimum route guidance system enable on-trip driver to guide optimum route dynamically towards destination to avoid congestions, road work etc. Road administrator and/or Traffic police can use this system for controlling traffic for road works, reduction of pollution level at specific area, etc. In addition, this system can be used for guiding heavy truck to a specific lane, where road administrator restrict the lane for heavy truck because of mitigation of roadside environment, school-commuting road, or reduction of traffic congestion etc.	
Service flow	1. Traveller accesses to ITSC using in-vehicle device or mobile. 2. ITSC collects data from road administrator, traffic information from traffic police and probe vehicle. 3. ITSC provides necessary information and optimum route guidance service which meets traveller's request through in-vehicle device or mobile after analyzing and processing of data. 4. If there are restricted lane for heavy trucks, ITSC lead them to specific lane through in-vehicle device or mobile. 5. ITSC also guides travellers at the request of traffic police and/or road administrator.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Optimum route guidance is in practically used in developed countries. Necessary information for providing to driver is analyzed at traffic information centre. Data collection devices are roadside sensors or probe vehicles (vehicle embedded device, mobile, navigation device) based on GPS & GPRS technology and provision devices are in-vehicle devices through GPRS or roadside antenna. 2. Some car manufactures embed navigation device with probe system into the vehicle and guidance optimum route by navigation device based on collection and analyzing probe data.	Currently in Hyderabad optimum route guidance system is not available.
Image (Example)		

Item	Contents
	
Target Area	Inside ORR
Implementation Period	Phase-1, Phase-2
Related Agency	ITSC, Traffic Police, GHMC, HGCL
Remarks	

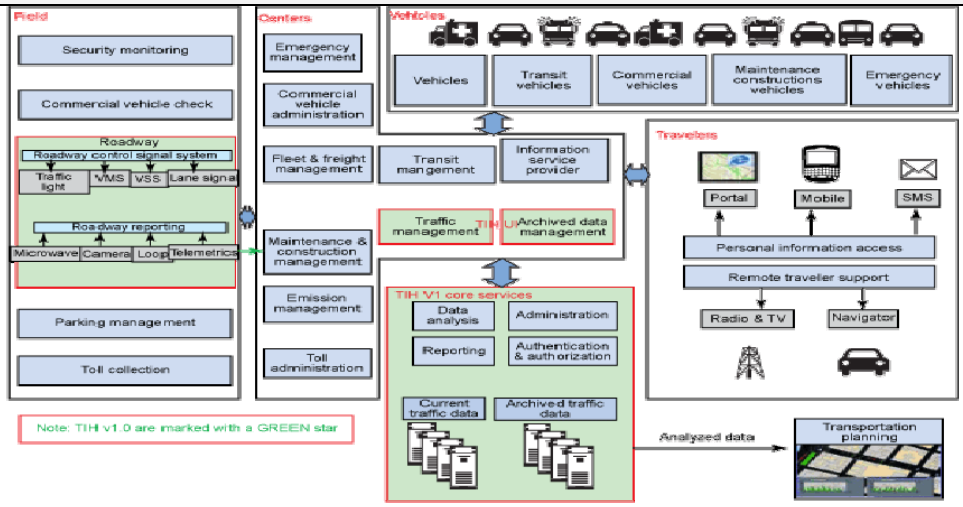
(8) 1. Traffic Information System
(1-7. Optimum Route Guidance System)

Item	Contents	
ITS Sub-Service Services	1. Traffic Information System (1-7. Optimum Route Guidance System)	
Purpose	Static analysis and automated store accident data collected by Accident Information Collection System, in order to improve prompt attending, addressing the incidents and clearance of accident.	
Effectiveness	To clear the accidents promptly and restore the smooth traffic flow, statistical analysis of accident data is required to reduce the time taken for addressing accidents by coordination with controlling other facilities on road and informing any incidents occurring on the road. Storing these data can use for anti-accident program in the future.	
Service flow	1. Police or any informant provides information of accidents to traffic control centre of traffic police. 2. ITSC collects and exchange necessary data and information with traffic police. 3. ITSC analyze and processing data and information in cooperation with traffic police for requiring signal control, other accident, road restriction, and redundancy road. 4. ITSC informs necessary information to travellers and police through roadside equipments, in-vehicle device and other provision equipments. 5. ITSC stores the processed data into database.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Traffic data analysis system is an offline accidents analysis system that is being implemented in various regions like USA, Japan, Singapore, Europe etc. The system is used in analyzing current black spots in road network and helps in appropriate decision making for reducing the accidents.	Hyderabad traffic police have accident data statistical reports published on their website. These reports are prepared based on data collected from EMRI, traffic police and police agencies. However, these data are not used for proper address of accidents and no coordination with ITS.
Image (Example)	 Source: http://www.swri.org/4org/d10/its/atms/	

Item	Contents
Target Area	Inside ORR
Implementation Period	Phase-1, Phase-2
Related Agency	ITSC, Traffic Police, GHMC,
Remarks	

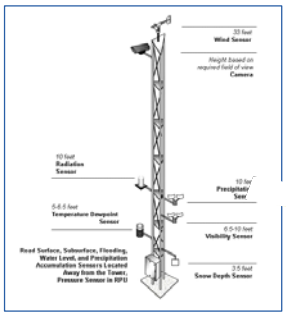
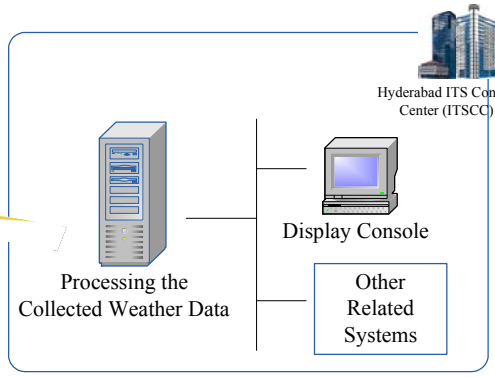
(9) 1. Traffic Information System
(1-9. Traffic Data Analysis System)

Item	Contents	
ITS Sub-Service Services	1. Traffic Information System (1-9. Traffic Data Analysis System)	
Purpose	For efficient planning, policy assessment and advanced road management require traffic data based on statistical analysis.	
Effectiveness	1. Traffic demand strategy such as traffic management planning should be established for both wide and specific area based on various traffic data with higher accuracy. Utilization of roadside sensor, in-vehicle device enable to collect the cost-effective necessary data for city-planning, road planning such as traffic volume, travel speed, OD, etc. instead of censors. 2. When adverse weather or disaster occurs, road administrator must make prompt decision of closing or restriction of traffic with considering risk level. Collection of weather data from meteorological monitors(MET) and various data from database such as road conditions, weather records, traffic regulation records enable to support the prospection of damage level comprehensibly and decision making for implementing traffic regulation and its lift timing.	
Service flow	1. ITSC establishes the comprehensive database in cooperation with traffic police and road administrator regarding traffic congestion, road work, lane closing, transportation of vehicle, passenger & cargo, road rehabilitation work, planning, opening date of any roadside facilities, MET data and roadside environment data. Although this database is used for searching alternation of traffic flow and prospecting traffic conditions, road administrator enable to decide various traffic control methods. 2. ITSC collects the data of OD and demand of various transportation modes and carrying out traffic simulation. 3. ITSC provides processed data to traffic police, road administrator or other related agencies, when they require.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Road in metropolitan area or inter-state highway/expressway were equipped various roadside sensor such as traffic counter, MET, CCTV, etc and these equipments are monitoring traffic 24hours 365days. Monitoring data collected by these equipments send to TCC every 1 - 5 minutes. These data are analyzed and processed at TCC and cumulated database. These data used for planning and advanced maintenance.	Currently Hyderabad does not have any traffic data analysis system.
Image (Example)		

Item	Contents
	 Source: http://www.ibm.com/developerworks/industry/library/ind-tmdd/index.html
Target Area	Inside ORR
Implementation Period	Phase-1, Phase-2
Related Agency	ITSC, GHMC, Traffic Police, HGCL
Remarks	

(10) 2. Information Collection System
(2-1. Weather Information Collection System)

Item	Contents	
ITS Sub-Service Services	2. Information Collection System (2-1. Weather Information Collection System)	
Purpose	Collection of information on weather conditions by roadside sensors and from meteorological agencies.	
Effectiveness	To provide proper weather information to travellers, collection of sufficient weather data is significant. Provide weather information to travellers can make them start an action of avoidance or preparation of bad weather such as heavy rain. Providing weather information of given area support travel planning or changing original plan. As the result, traffic incidents/congestion reduced and improves traveller's satisfaction. Storing and managing weather data can contribute the prospecting traffic situation and proper planning	
Service flow	1. ITSC collects the weather data from roadside weather monitor every 5-10 minutes and from meteorological agencies. 2. ITSC analyzes and process these data and information and prioritizes the providing information. 3. ITSC updates the information for provision and start to display providing equipments such as VMS. 4. ITSC also provides information to on-trip travellers as per their request through in-vehicle devices. 5. ITSC store information into database and manage them for utilize prospection of traffic under similar weather. 6. ITSC provides stored data, if traffic police or road administrator require.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Weather information is collected at TCC by roadside equipments and meteorological agencies through communication network. The weather information is sent to in-vehicle navigation systems, internet, personal navigation devices (PNDs), mobiles, VMS, highway radio and Media. Especially, snowing and fog are must monitored by road administrator, since they frequently cause the serious accidents by slippery road surface and lack of visibilities. These systems can contribute travellers for selecting another route, changing the travel starting time or destination and making preparation for bad weather coming	Currently Hyderabad has weather report information provided on website and radio channel but not the specific spot such as causing flood. Travellers are not able to get realtime weather information while travelling.

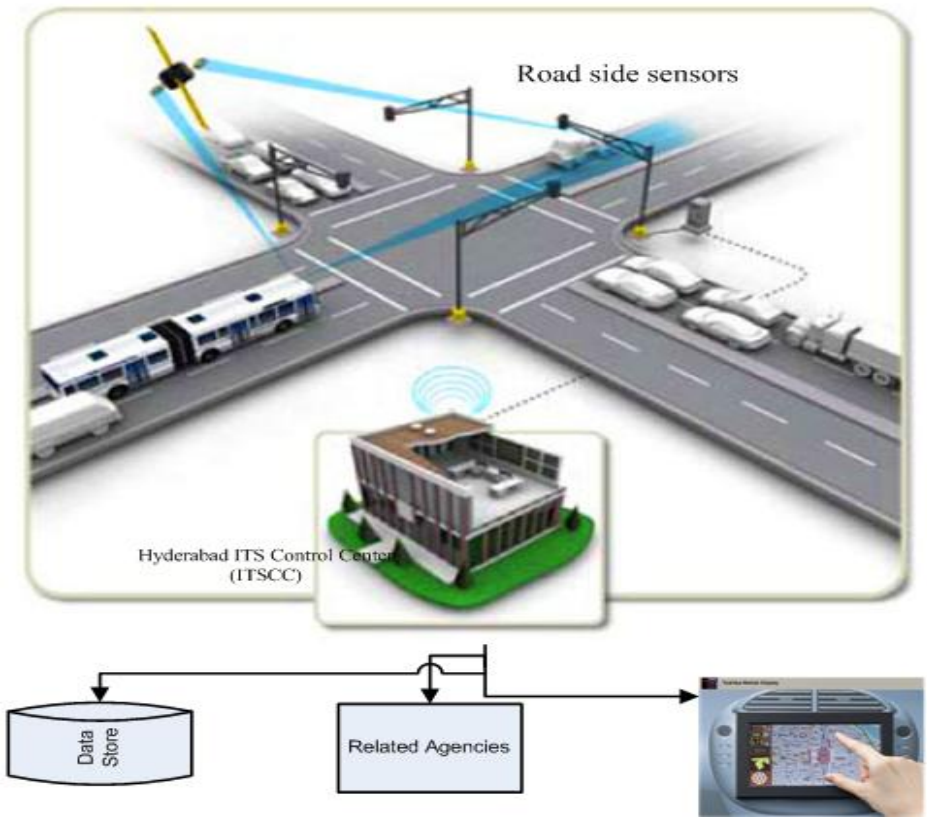
Item	Contents	
	ahead.	
Image (Example)	 Weather Sensor Station (WSS) on Road 	

Item	Type	Device	Cost	
			Initial	Running
Outline of ITS sub-system	Weather Information Collection System	Meteorological Monitoring System :20 sets Flood Surveillance system :20 sets	95,000,000 Rs/System 25,000,000 Rs/System	19,500,000 Rs/year

Item	Contents
Target Area	Inside Outer Rind Rode (ORR)
Implementation Period	Pilot, Phase-I
Related Agency	ITSC, Meteorology Department, GHMC, HGCL
Remarks	

(11) 2. Information Collection System (2-2. Traffic Volume Counting System)

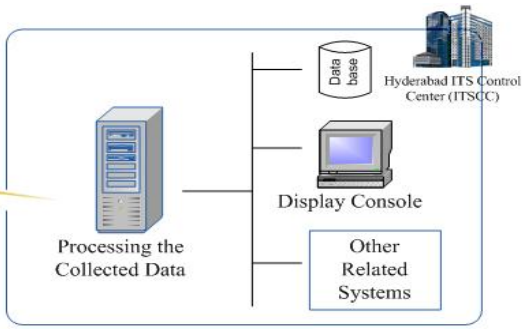
Item	Contents	
ITS Sub-Service Services	2. Information Collection System (2-2. Traffic Volume Counting System)	
Purpose	Collection of traffic status information by roadside sensors and from traffic police.	
Effectiveness	To provide proper traffic information to travellers, collection of sufficient traffic status data is significant. Storing and managing traffic data can recognize the feature of traffic by section and time. It also contribute the prospecting traffic situation and proper planning	
Service flow	1. ITSC collect the traffic status data such as traffic volume, vehicle class, vehicle speed from roadside image processor every 5-10 minutes and from traffic police. 2. ITSC analyzes and process these data and information and prioritizes the providing information. 3. ITSC updates the information for provision and start to display providing equipments such as VMS. 4. ITSC also provides information to on-trip travellers as per their request through in-vehicle devices. 5. ITSC store information into database and manage them for utilize prospection of traffic under similar condition. 6. ITSC provides stored data, if traffic police or road administrator require.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Automatic traffic counter and classifier (ATCC) are installed all major road which traffic congestions occur frequently. Loop coil is the most popularly used since its high accuracy, but maintenance work of loop coil requires lane restriction. Now, image processing is getting popular because of it can even track the vehicles with images.	Currently Hyderabad has no traffic data collection system.

Item	Contents
Image (Example)	

Item	Type	Device	Cost	
			Initial	Running
Outline of ITS sub-system	Traffic Volume Counting System	ATCC (Automatic Counter & Classifier : 50 sets)	104,000,000 Rs/System	17,600,000 Rs/year

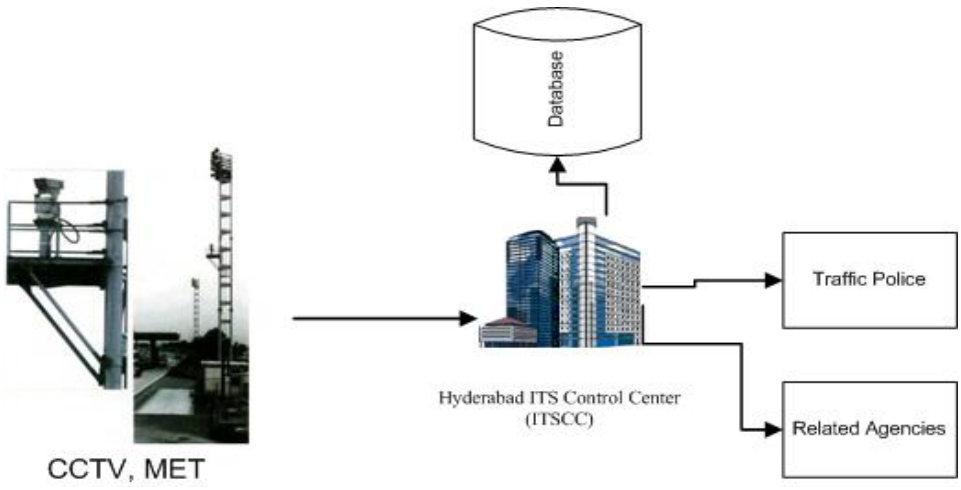
Item	Contents
Target Area	Inside Outer Rind Rode (ORR)
Implementation Period	Phase I Pilot Project
Related Agency	ITSC, Meteorology Department, GHMC, HGCL
Remarks	

(12) 2. Information Collection System
(2-3. Measuring Air Pollution System)

Item	Contents	
ITS Sub-Service Services	2. Information Collection System (2-3. Measuring Air Pollution System)	
Purpose	Collection of air pollution level by roadside sensors and from related agencies.	
Effectiveness	India's air pollution level is the worst in the world. Installing roadside sensor for measuring NOx, SOx, and SPM. These data used for diverting traffic to detour for reduce the exposure level of the current suffering road.	
Service flow	1. ITSC collects the air pollution data (NOx, SOx, and SPM) from roadside sensor and environmental agencies. 2. ITSC analyzes and processes these data and inform to traffic police, road administrator and environmental agency. 3. When these related agency request to ITSC for leading traffic to detour to alternative road, ITSC start the guidance to traffic through VMS, internet, in-vehicle devices, etc.4. 4. ITSC store information into database and manage them for utilize infrastructure planning or any measures against air pollution.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Environmental checking posts are installing roadside of many trunk road. These checking post monitoring the data every day. However, Action for deterring traffic to alternative way is not implementing promptly.	Currently Hyderabad has some check post for air pollution but never utilize for road planning.
Image (Example)	 Air monitoring station 	
Target Area	Inside Outer Rind Rode (ORR)	
Implementation Period	Phase-1, Phase-2	
Related Agency	ITSC, AP Pollution Control Board and GHMC	

Item	Contents
Remarks	

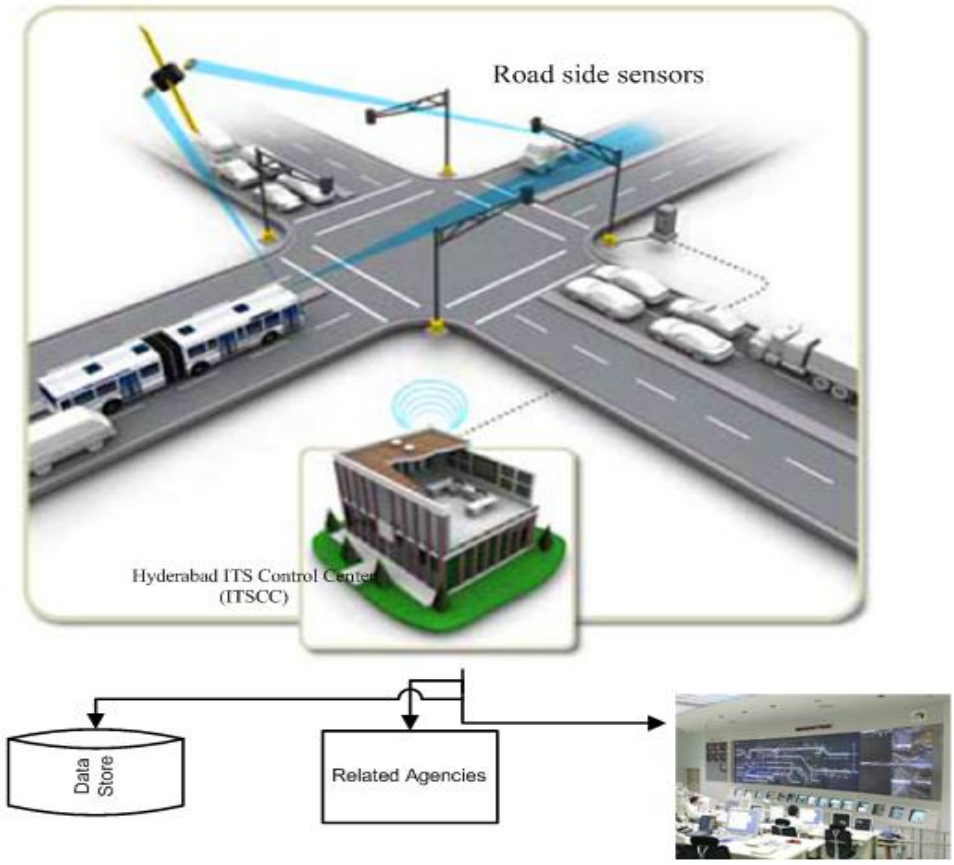
(13) 2. Information Collection System (2-4. CCTV)

Item	Contents	
ITS Sub-Service Services	2. Information Collection System (2-4. CCTV)	
Purpose	Capturing traffic status by images. When any incident occurred, CCTV automatically zooming up the incident and send to ITSC/traffic police.	
Effectiveness	CCTV camera enables to support the probe system since it can send images to ITSC. It also enables to capture the any incident by moving PTZ (Pan, Tilt, Zoom) function automatically.	
Service flow	1. ITSC collects the traffic flow data by roadside CCTV, ATCC and probe vehicles or CCTV images from traffic police. 2. ITSC analyze and process these data comprehensively and figuring out clear reason of traffic congestion or any others. 3. CCTV captures the incidents and sends clear images to ITSC. 4. ITSC sends above information to traffic police, road administrator and related agencies. 5. ITSC store information and images into database and manage them for utilize infrastructure planning or any measures against incidents.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	CCTV is installed very short pitch around trunk road since images can help to make any proper decision and it can be the evidence for any fraud act or violations. Such as tunnel or road without lighting are introducing night vision CCTV. All CCTV images are sent to centre. When any incidents occur, that image is zooming up and highlighted screen of centre. So all staff can make prompt next action required.	Currently Hyderabad has more than 220 CCTV but only 170 CCTV are working since lack of proper maintenance. ALL images are send to TCC at traffic police and used only for enforcement. Any PTZ functions are not used since the purpose of CCTV ins not capturing incidents.
Image (Example)		
Item	**Type**	**Device** / **Cost**

Item	Contents			
			Initial	**Running**
Outline of ITS sub-system	CCTV Surveillance System	CCTV System : 50sets	30,000,000 Rs/System	6,500,000 Rs/year
Item	**Contents**			
Target Area	Inside Outer Rind Rode (ORR)			
Implementation Period	Pilot, Phase-I			
Related Agency	ITSC, Traffic Police and GHMC			
Remarks				

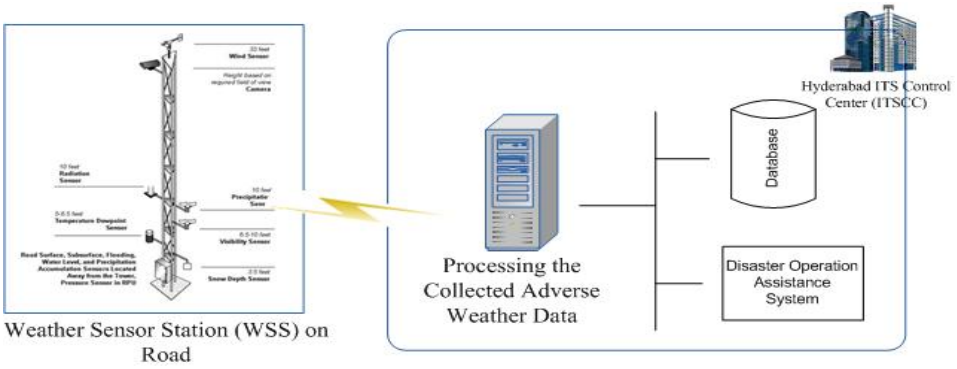
(14) 2. Information Collection System
(2-5. Accident Information Collection System)

Item	Contents	
ITS Sub-Service Services	2. Information Collection System (2-5. Accident Information Collection System)	
Purpose	Collecting accident information by roadside sensor and other related agencies such as traffic police, road administrator etc.	
Effectiveness	Sometime accident causes the large traffic congestion or large numbers of causalities. To reduce accidents and impact of accidents such as secondary accidents, proper analyzing, processing, storing and managing of accident data can contribute mitigation of future accidents and establishing action programme against accidents.	
Service flow	1. ITSC collects accident data and related data by roadside sensors and from traffic police. 2. ITSC analyze and process these data comprehensively and figuring out clear reason of traffic accidents or any others. 3. ITSC sends above information to traffic police, road administrator and related agencies. 5. ITSC store related information into database and manage them for infrastructure planning, any measures against accidents, establishing action programme against accidents.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	To utilize various roadside devices and probe data made clear analysis possible. Japanese government declared the realization of zero traffic accidents society used ITS technologies. Optimum guidance system informs traveller about traffic congestion, road work, road closing.	Accidents data are cumulated but not proper analysis are implemented.

Item	Contents
Image (Example)	
Target Area	Inside Outer Rind Rode (ORR)
Implementation Period	Phase-1, Phase-2
Related Agency	ITSC, Traffic Police GHMC, HGCL
Remarks	

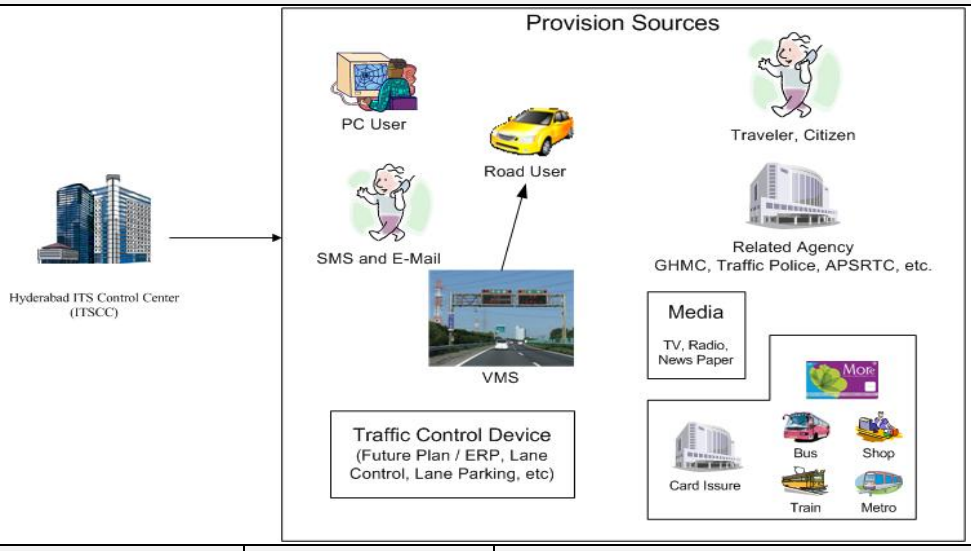
(15) 2. Information Collection System
(2-6. Disaster Information Collection System)

Item	Contents	
ITS Sub-Service Services	2. Information Collection System (2-6. Disaster Information Collection System)	
Purpose	Collection of disaster and adverse weather information/data for "Disaster Operation Assistance System.	
Effectiveness	Collection of disaster/adverse weather information can contribute road administrator to make decision of closing road or lane regulation according to the road condition and situation of disaster/adverse weather. In addition, collection of information of damaged structure help to road administrator to set up maintenance plan with priority based on damaged level.	
Service flow	1. ITSC collects the adverse weather data and disaster information from roadside equipment, meteorological agencies and others on realtime. 2. Sending these data to "Disaster Operation Assistance System". 3. ITSC analyzes and processes the collected data. 4. ITSC stored these data into database.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Disaster and adverse weather information is collected at centre by roadside equipments and meteorological agencies or other agencies which monitor the frequent disaster area through communication network. Road administrator dispatch the special vehicle enables to communicate with centre by satellite. This information is sent to in-vehicle navigation systems, internet, mobiles, VMS, highway radio and Media. Risky area of land sliding, earthquake, heavy snowing, dense fog and road depression are monitored by road administrator routinely, since they cause the serious accidents. Analyzing aftermath probe data clarify available route. Travellers can select another route, changing the travel starting time or destination and prepare adverse weather coming ahead. This information is also used for road administrator for decision making of closing road or lane regulation aftermath.	Disaster and adverse weather information are collected but no utilization to travellers or any related agencies with proper analysis.
Image (Example)		

Item	Contents
	
Target Area	Inside Outer Rind Rode (ORR)
Implementation Period	Phase-I, Phase-2
Related Agency	ITSC, Meteorology Department, National Disaster Management Authority, GHMC, HGCL
Remarks	

(16) 3. Information Provision System (VMS, Web Information System, E-mail & SMS Information System)

Item	Contents	
ITS Sub-Service Services	3. Information Provision System (VMS, Web Information System, E-mail & SMS Information System)	
Purpose	After ITSC analyze and process the data from own equipment and information by other agencies, etc. ITSC prioritize needs of information and provide users and travellers on realtime by VMS, Website, SMS and media etc.	
Effectiveness	This system is a provider to public by VMS, Website, E-mail and SMS on realtime. Realtime traffic information include optimum routes, travel time of selected route, ongoing road work etc. to travellers, in order to improve travellers satisfaction and reduce the traffic congestion by optimal usage of road infrastructure. As the result, it can mitigate the environmental impact of air pollution and CO2. Related agencies such as traffic police and road administrator can use these data for planning or optimum maintenance.	
Service flow	1. ITSC exchanges the necessary information with road administrator, traffic police and other related-agencies. 2. ITSC prepare the traffic information for provision by inputting manually or automatically assembling messages for informing travellers using various equipments or devices such as VMS, SMS, e-mail, call centre etc. 3. ITSC control system display current messages showing VMS on each workstation and/or large display. 4. ITSC store and manage the collected data 5. When any incidents occur, messages provide to provision equipment/device immediately. After cleared these incidents, messages deleted from provision equipment/device immediately.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Realtime Traffic information is collected at TCC by GPS navigation, GPRS communication, roadside antenna and Traffic counters through online or offline communication network and linked the traffic information to map data. The realtime traffic information is sent to in-vehicle navigation systems, internet, personal navigation devices (PNDs), cell phones, Variable Message Sign Board (VMS), and highway radio and media. These systems can contribute travellers for selecting another route, changing the travel starting time, making preparation of the event coming ahead.	1. SMS messages warn to travellers by Hyderabad Traffic Police (HTP) 2. GHMC is planning to implement Traffic Information and Optimization System in the future using around 20 VMS system across Hyderabad. 3. APSRTC is planning to implement GPS based bus location system and passenger information system.

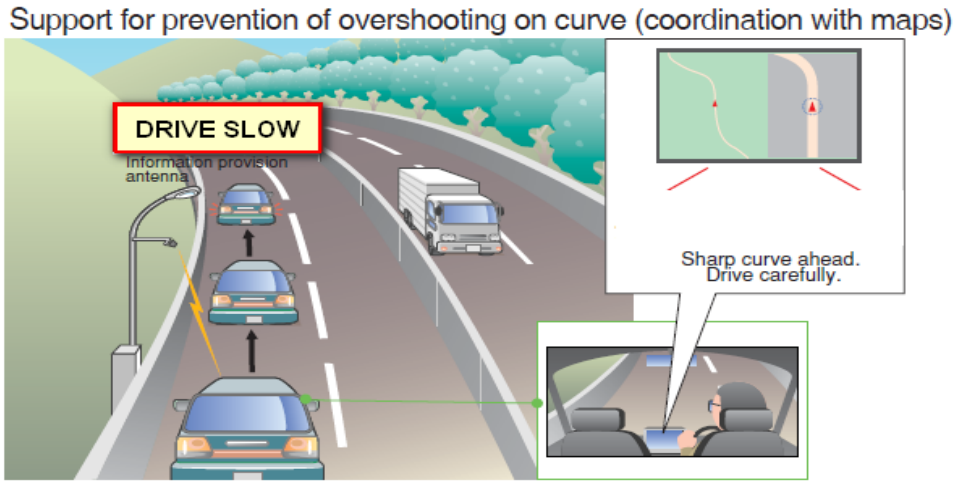
Item	Contents
Image (Example)	

Item	Type	Device	Cost	
			Initial	Running
Outline of ITS sub-system	VMS, Web Information System, E-mail & SMS Information System	VMS System : 30 sets Web Information System	460,000,000 Rs/System 8,100,000 Rs/System	74,000,000 Rs/year

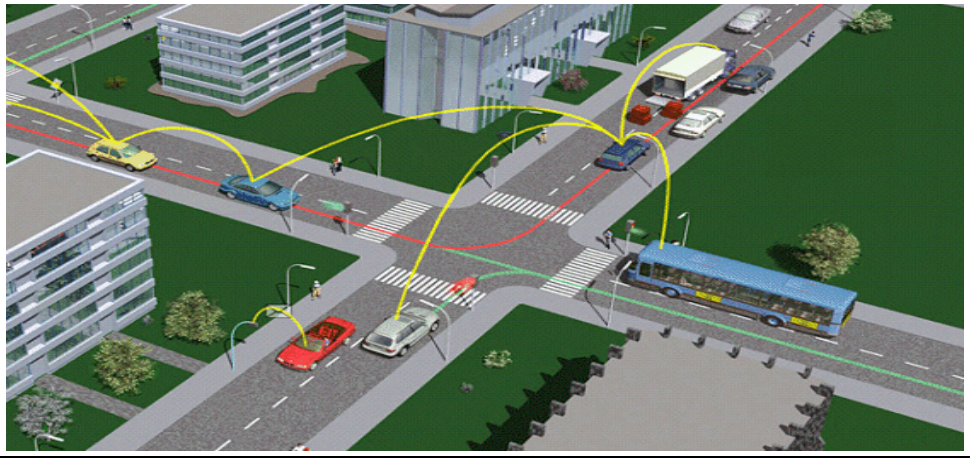
Item	Contents
Target Area	Inside ORR
Implementation Period	Pilot, Phase-1, Phase-2
Related Agency	ITSC, Traffic Police, GHMC, HMDA, NHAI, HGCL and Meteorology Department
Remarks	

(17) 4. Driving Support System
(4-1 Alert and Driving Support System for critical road alignment)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-1 Alert and Driving Support System for critical road alignment)	
Purpose	Alert and assist driver against danger due to critical road alignment such as sharp curves, down slope and others.	
Effectiveness	Driving at sharp curves or down slopes often tend to cause accidents due to over speeding or inadequate handling even existing of warning signs. To warn the risky road alignment to drivers before emerging of critical alignment, driver can prepare the adequate driving and driving support system can assist the breaking, adequate speed and handling.	
Service flow	1. According to current location of vehicles, collect the road alignment data based on Digital road mapping and/or road inventory database. 2. Collect the information of road alignment, gradient, radius of curves, vehicle speed and skid resistance of pavement, lane closing by in-vehicle sensor and roadside sensor. 3. Monitor the safety level from road alignment, speed, road surface condition and other information, vehicle alerts the driver. If the vehicle evaluated the current driving is risky, automatically vehicle will be controlled by itself such as braking.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Road alignment information can provide based on digital mapping with warning, image and verbally. 2. Many car manufactures have developed Driving support system and such braking support system which are already embedded in many vehicles. This technology is already implemented practically but regulation is not yet achieved.	Currently in Hyderabad, no such systems are in use.

Item	Contents
Image (Example)	
Target Area	Inside ORR
Implementation Period	Phase-3
Related Agency	ITSC, GHMC and Traffic Police
Remarks	

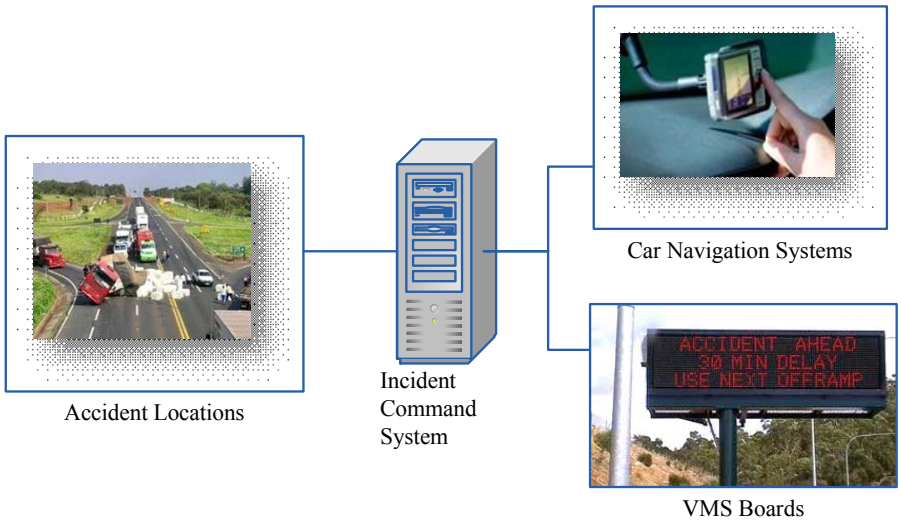
(18) 4. Driving Support System
(4-2 Alert and Driving Support System at intersection)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-2 Alert and Driving Support System at intersection)	
Purpose	Alert and assist drivers against danger at intersection.	
Effectiveness	Intersection is a crossing point of all kinds of vehicles, the chances of collision between vehicles, vehicle and pedestrian, vehicle and bicycle is high. Warning drivers before collision or accidental can be effective in avoiding accidents. Driving support system can assist the breaking and handling to avoid such collisions.	
Service flow	1. Collect the information of vehicles location, speed, and travelling direction from the roadside sensor, 2. Collect the information of location and speed to recognize the behaviour of pedestrians, bicycles (stopping, walking, etc.). 3. The sensor embedded in vehicles collect the information of location and speed of vehicles, pedestrians and bicycles. 4. If the vehicle or roadside sensor recognize the risk of collision, vehicle alert and/or vehicle is automatically controlled by performing activities like breaking or handling to avoid collision.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Vehicle to Roadside Communication can help to alert driver about the structure of intersection using visual and audio messages. 2. Many car manufactures have developed Driving support system and such braking support system which are already embedded in many vehicles. This technology is already implemented practically but regulation is not yet achieved.	Hyderabad does not have such systems currently for assisting drivers at intersections.
Image (Example)		
Target Area	Inside ORR	

Item	Contents
Implementation Period	Phase - 3
Related Agency	ITSC, GHMC and Traffic Police
Remarks	

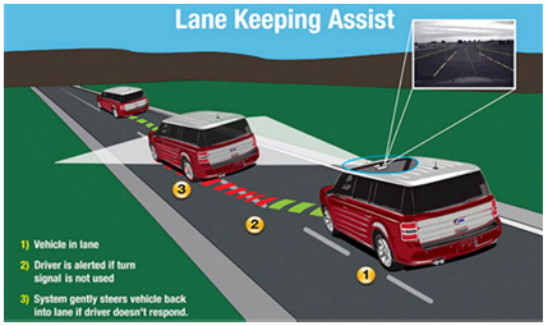
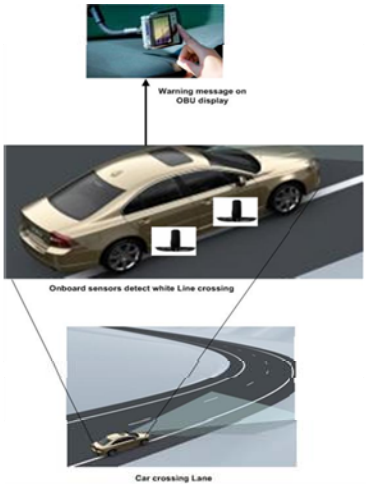
(19) 4. Driving Support System
(4-3 Alert and Driving Support System for accidents in the vicinity)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-3 Alert and Driving Support System for accidents in the vicinity)	
Purpose	Alert and assist driver to avoid the involvement of secondary accident.	
Effectiveness	In case of accident in the vicinity, accident tends to become larger and may generate casualties. Providing accident information in the vicinity, alert and assistance to the driver by automatic braking or handling can help in reducing the risk of secondary accidents.	
Service flow	1. Collect the information of accidents, traffic congestion, road works, fallen objects, location & speed of vehicle running ahead, etc. by roadside sensor and/or in-vehicle sensor, at more than several hundred meters upstream. . 2. When the vehicle is beyond the requisite minimum braking distance, the vehicle alert to the driver and around vehicles by their in-vehicle devices. If necessary, vehicle starts the braking automatically. 3. Collect the information of location and speed of behind vehicles by roadside sensor and/or sensor embedded in vehicle. 4. When the vehicle recognize the risk of rear-end collision by vehicle behind, in-vehicle device alert to the driver and around vehicles.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. CCTV collects the data of accidents and provides information to highway radio, VMS and in-vehicle devices by visual and/or audio messages. 2. Many car manufactures have developed Driving support system and such braking support system which are already embedded in many vehicles. This technology is already implemented practically but regulation is not yet achieved.	Currently Hyderabad does not have any system to inform the driver about forward obstacles.

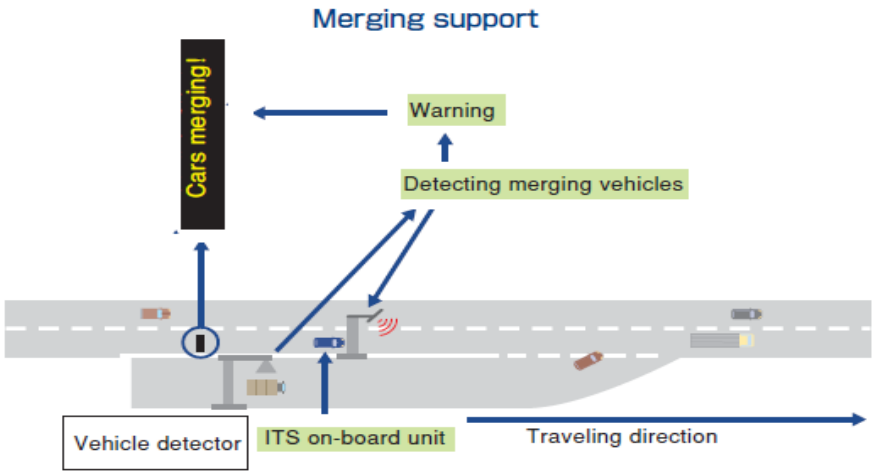
Item	Contents
Image (Example)	
Target Area	Inside ORR
Implementation Period	Phase - 3
Related Agency	ITSC, GHMC and Traffic Police
Remarks	

(20) 4. Driving Support System
(4-4. Alert and Driving Support System for Keeping Lane/Departing Lane)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-4. Alert and Driving Support System for Keeping Lane/Departing Lane)	
Purpose	Alert and assist driver in danger due to departing Lane.	
Effectiveness	When the vehicle departs the lane by careless driving, It may cause the collision against pedestrians, roadside facilities or vehicles running in parallel. Providing assistance to driver in maintain lane or while departing lane would be effective in reducing the risk of collision and accidents.	
Service flow	Alert while Departing Lane: 1. Monitor the location, speed of own and vehicle around using roadside sensors and/or sensor embedded in vehicle. 2. Alert driver, when the vehicle get too much closer to either side of lane or detect the lane departing. 3. When the in-vehicle sensor detects a risk because vehicle is getting too close to either side of lane or departing lane, vehicle will be controlled automatically for keeping in lane or handling lane changing. Assist in Keeping Lane: 1. Monitor the location, speed, inter-vehicular distance and behaviour of vehicle running around by roadside sensor and/or sensor embedded in vehicle. 2. Alert to driver, when the risk of collision or accidental contact to around vehicles arise. 3. When the vehicle recognizes the risk of collision against around vehicles, vehicle will be controlled automatically for keeping in lane or handling for lane changing.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Many car manufacturers developed Lane Keeping Assist System by detecting lane marking and warn driver if necessary. 2. Avoidance of rear-end collision system is also developed and introduced in many vehicles.	Currently Indian cars are not fitted with such onboard devices.

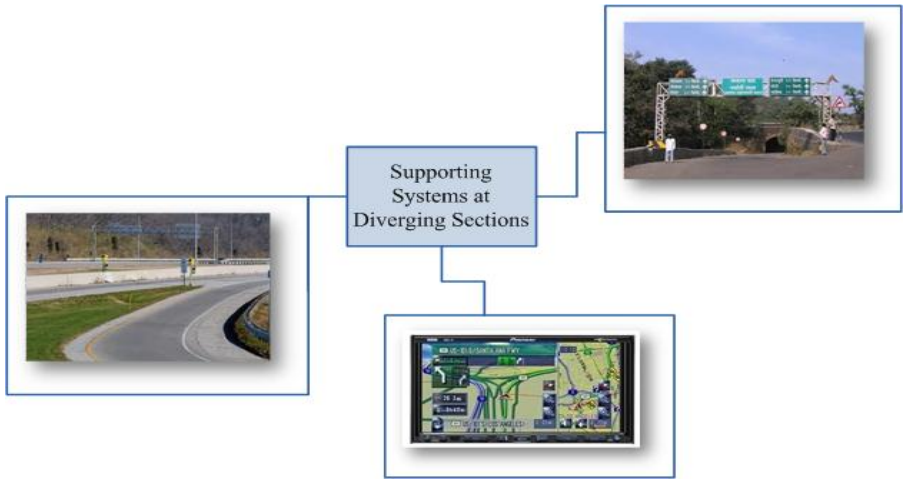
Item	Contents
Image (Example)	 Lane Keeping Assistance  Lane Departing Assistance
Target Area	Roadside: Inside ORR Initially. Vehicle : All area
Implementation Period	Phase - 3
Related Agency	ITSC, GHMC and Traffic Police
Remarks	

(21) 4. Driving Support System
(4-5. Alert and Driving Support System on Merging Section)

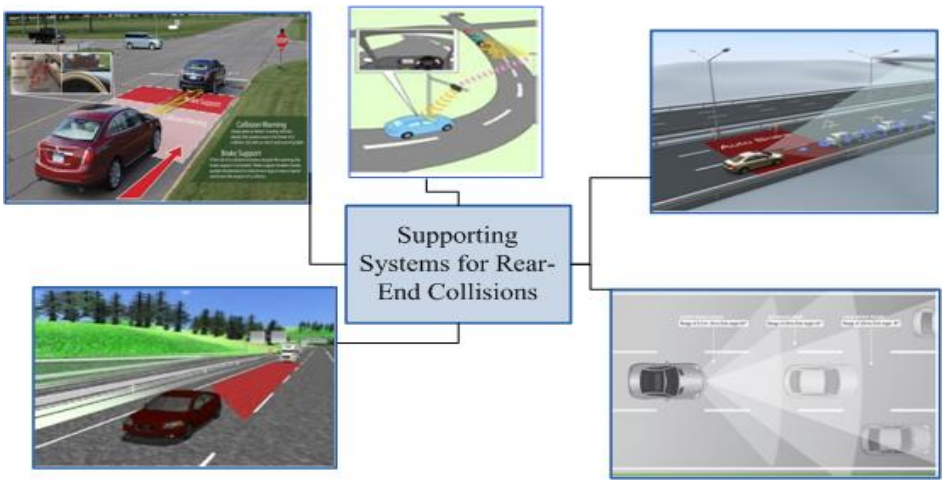
Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-5. Alert and Driving Support System on Merging Section)	
Purpose	Alert and assist driver to avoid danger at merging section.	
Effectiveness	In the expressway or flyover with ramp, the risks of occurrence of rear-end collision and accidental contact is high. Alert and assistance to driver would help in reducing the risk of accidents and mental load.	
Service flow	1. Monitor the location, speed of own and vehicle around by roadside sensor and in-vehicle sensor. 2. When the in-vehicle sensor and roadside sensor detect the risk of accident, alert to driver and/or vehicle will be controlled automatically such as braking and/or handling.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Providing the audio/visual information of approaching vehicle at margining section to the vehicle upstream by roadside sensor 2. Many car manufactures have developed Driving support system and such braking support system which are already embedded in many vehicles. This technology is already implemented practically but regulation is not yet achieved.	Sign boards are available at merging sections and no ITS systems implemented.
Image (Example)		
Target Area	Roadside: Inside ORR Initially. Vehicle : All area	
Implementation	Phase - 3	

Item	Contents
Period	
Related Agency	ITSC, GHMC, HGCL and Traffic Police
Remarks	

(22) 4. Driving Support System
(4-6. Alert and Driving Support System on Diverging Section)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-6. Alert and Driving Support System on Diverging Section)	
Purpose	Alert and assist driver to avoid danger at diverging section.	
Effectiveness	In the expressway or flyover with ramp, the risk of occurrence of collision between vehicles and roadside facilities like crash barrier at diverting section is high. Alert and assistance to driver would help in reducing the risk of accidents and mental load.	
Service flow	1. Monitor the location, speed of own, vehicle around and facilities on road by roadside sensor and in-vehicle sensor. 2. When the in-vehicle sensor and roadside sensor detect the risk of accident, alert to driver and/or vehicle will be controlled automatically such as braking and/or handling.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Many car manufactures have developed Driving support system and such braking support system which are already embedded in many vehicles. This technology is already implemented practically but regulation is not yet achieved.	Currently in Hyderabad, sign boards are used at some places indicating drivers about the divergent lane sections.
Image (Example)		
Target Area	Roadside: Inside ORR Initially. Vehicle : All area	
Implementation Period	Phase - 3	
Related Agency	ITSC, GHMC, HGCL and Traffic Police	
Remarks		

(23) 4. Driving Support System
(4-7. Alert and Driving Support System for Rear-end Collision)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-7. Alert and Driving Support System for Rear-end Collision)	
Purpose	Alert and assist driver to avoid rear-end collision.	
Effectiveness	Rear-end collisions occur frequently due to careless driving and not keeping safety inter-vehicular distance. Alert and assistance to driver would help in reducing the probability of rear-end collisions.	
Service flow	1. Collect and monitors the factors like road surface condition ahead, low speed vehicles ahead, traffic congestion, location, speed & braking distance of vehicle, location & speed of vehicles behind using roadside sensor and in-vehicle sensor. 2. When the in-vehicle sensor and roadside sensor detect the invading requisite minimum braking distance or high risk of occurrence the rear-end collision by behind vehicles, alert to driver and/or vehicle will be controlled automatically such as braking and/or accelerating.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Some vehicles are embedded with auto cruse system, braking support system, sensors to warn the risk of collision and camera displaying vehicles behind.	Currently in Hyderabad rear-end collision prevention system is not available.
Image (Example)		
Target Area	Roadside: Inside ORR Initially. Vehicle : All area	
Implementation Period	Phase - 3	
Related Agency	ITSC, GHMC, HGCL and Traffic Police	
Remarks		

(24) 4. Driving Support System
(4-8. Alert and Driving Support System Preventing Pedestrian from Accident)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-8. Alert and Driving Support System Preventing Pedestrian from Accident)	
Purpose	Alert and assist driver to avoid the accident with pedestrians.	
Effectiveness	Driving at night or in heavy rain reduces driver's visual angle. Bad visibility increases the risk of accidents since the recognition of pedestrians or objects is difficult. Providing this obstacle information, alert and assistance while driving by automatic braking or handling during these conditions helps in reducing the risk of accidents.	
Service flow	1. Collect the information like road works, fallen objects, location & speed of vehicle using roadside sensor and/or in-vehicle sensor. 2. When the vehicle detects the risk of collision with pedestrians, bicycle or any obstructs by roadside sensor and in-vehicle device, driver is alerted using audio or video messages. If it necessary, vehicle starts braking or handling automatically.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Some signals has image processing equipments on roadside when the equipment detects the pedestrian, roadside sensor transmit the signal to bus for warning. 2. Some vehicles in market are embedded with braking support system, sensors to warn the risk of collision and camera for displaying blind angle of vehicle.	There is only sign board for safety of pedestrians and no ITS methods.
Image (Example)	 Millimeter-Wave sensor for Pedestrian Detection  Pedestrian crosswalk lights flash when pedestrian cross the road.  Example view of vision generated by night vision system and sound (ping) within the car	
Target Area	Roadside: Inside ORR Initially. Vehicle : All area	
Implementation	Phase - 3	

Item	Contents
Period	
Related Agency	ITSC, GHMC and Traffic Police
Remarks	

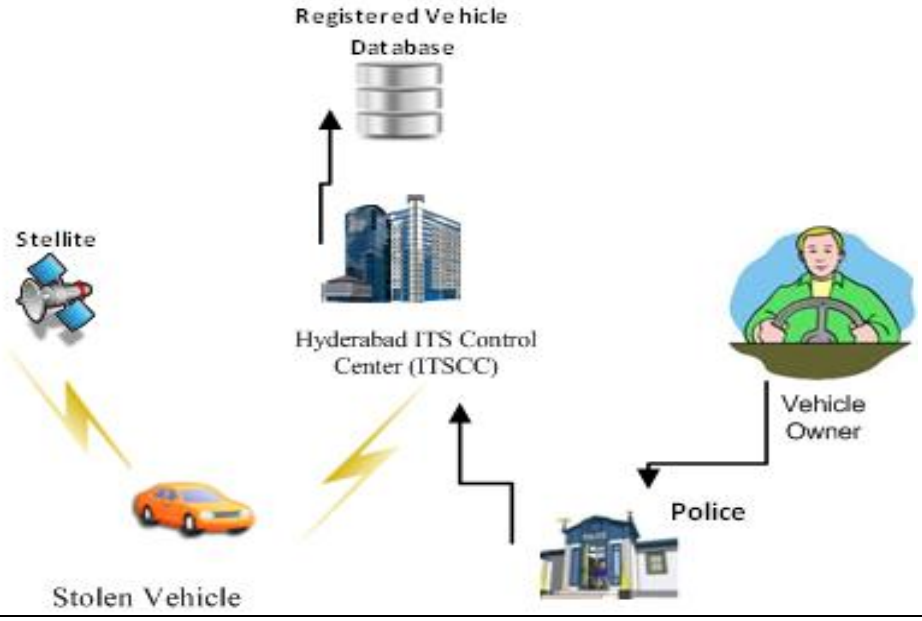
(25) 4. Driving Support System
(4-9. Alert System for Abnormality of Driver)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-9. Alert System for Abnormality of Driver)	
Purpose	Alert when motorist is in abnormal condition. When driver is drunk, immobilized vehicle engines.	
Effectiveness	Illness, drowsiness and drunk driving can lead to accidents. Monitoring driver's condition using in-vehicle sensor can avoid these accidents.	
Service flow	1. Monitor the driver's condition using in-vehicle sensor. 2. When in-vehicle sensor detect the abnormality of driver, alert system triggers and vehicle is stopped automatically with monitoring running condition of vehicle, around vehicles and road conditions. 3. The information of abnormality of driver is forwarded to centre where after, the information is passed to ambulance. 4. When in-vehicle sensor detects the alcoholic, immobilize the vehicle engine.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Some car manufacturers have developed the drowsiness warning system that uses a camera mounted to the instrument panel to monitor the blinking pattern of the driver’s eyes to detect drowsiness at an early stage and issue a warning sound. When this system detects that the driver has begun dozing, the drowsiness Relieving System triggers activities like emitting a warning sound, turns on the air conditioning etc.	Hyderabad does not have systems to detect abnormality of motorist.

Item	Contents
Image (Example)	 Traveler abnormality detection system  Detects abnormality of driver  Stops vehicle if the traveler does not respond for long time
Target Area	
Implementation Period	Phase 3
Related Agency	Traffic Police, Ambulance
Remarks	

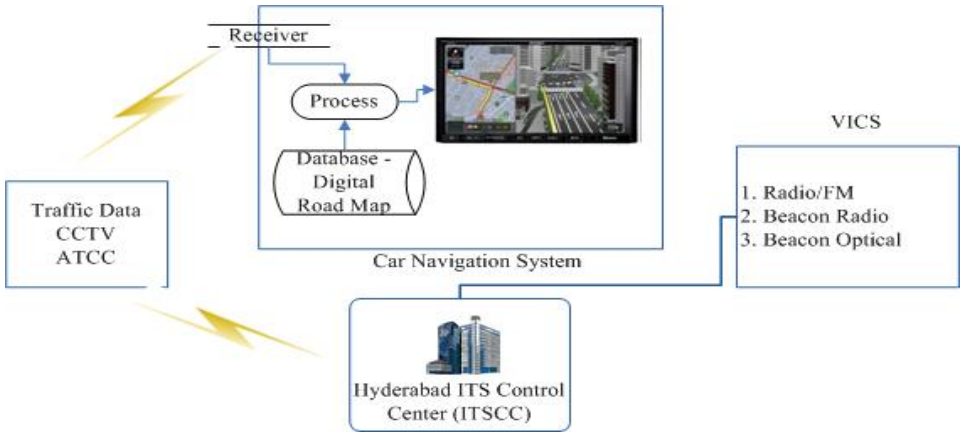
(26) 4. Driving Support System
(4-10. Missing Car Tracking System)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-10. Missing Car Tracking System)	
Purpose	Discover and retrieve the stolen vehicles.	
Effectiveness	Auto theft happens frequently during parking or stopping without discoverer or informer. In such case, discover and retrieval of stolen vehicle is very difficult. Application of ITS technologies can help in enforcement for auto theft.	
Service flow	1. Driver submits the stolen vehicle report to police and information is sent to traffic police. 2. Traffic police request to traffic control centre and forward the details of stolen vehicle. 3. Traffic control centre detect the location and track the stolen vehicle.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	One of the Major stolen vehicle systems are "LoJack". The core of the LoJack Stolen Vehicle Recovery System is a small, silent radio transceiver that is installed in a vehicle. Once installed, the unit and the vehicle's Vehicle Identification Number (VIN) are registered in a database which interfaces with the National Crime Information Centre system used by local law enforcement agencies. In the event of a theft, a customer reports the incident to the police, who make a routine entry into the state police crime computer, including the stolen vehicle's VIN. This theft report is automatically processed by LoJack computers, triggering a remote command to the specific LoJack unit in the stolen vehicle.	In Hyderabad some of the car manufacturers providing the LoJack Stolen Vehicle Recovery system. Traffic Police and Civil Police manually processing the theft complaints.

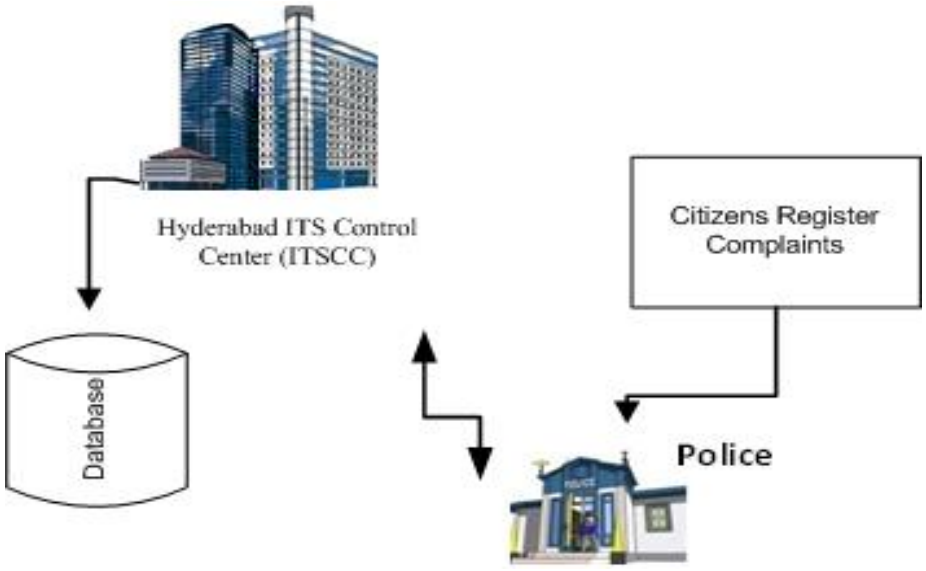
Item	Contents
Image (Example)	
Target Area	Inside ORR
Implementation Period	Partially implemented (already by manufacturer)
Related Agency	ITSC, Traffic Police and Police
Remarks	

(27) 4. Driving Support System
(4-11. Optimum Route Guidance System)

Item	Contents	
ITS Sub-Service Services	4. Driving Support System (4-11. Optimum Route Guidance System)	
Purpose	Guide optimum route to travellers to avoid traffic congestion and ease driver's stress.	
Effectiveness	On-trip driver require dynamic optimum route guidance towards destination to avoid congestions, road work etc. Providing optimum route guidance would help in reducing traffic congestions.	
Service flow	1. Driver access to traffic information centre (Public or Private) by in-vehicle device. 2. The information centre collects data from road administrator and traffic information from traffic police. 3. ITSC provides information and guidance of optimum route and the reason why selected route meet the driver's request by in-vehicle device after the analyzing and processing of data.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	1. Optimum route guidance is practically used in developed countries. Information provided to driver is processed at traffic information centre. Data collection devices are roadside sensors or probe vehicles (vehicle embedded device, mobile, navigation device) based on GPS & GPRS technology and provision devices are in-vehicle devices through GPRS or roadside antenna. 2. Some car manufacturers embed probe systems in the vehicle and these probe system provide route guidance service.	Currently in Hyderabad optimum route guidance system is not available.

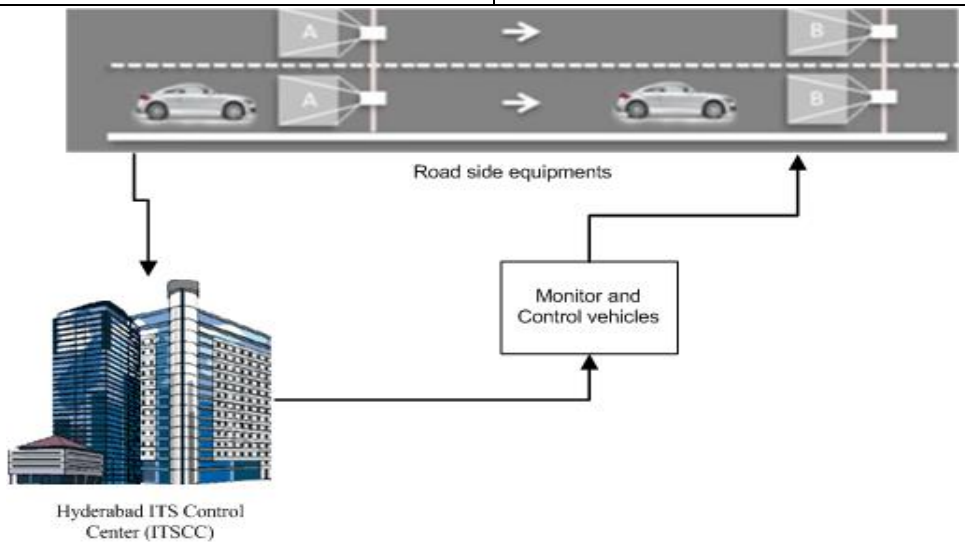
Item	Contents
Image (Example)	
Target Area	Inside ORR
Implementation Period	
Related Agency	ITSC, Traffic Police, GHMC, GPS Navigation Provider
Remarks	

(28) 5. Enforcement System
(5-1 Assistance of Police Activities)

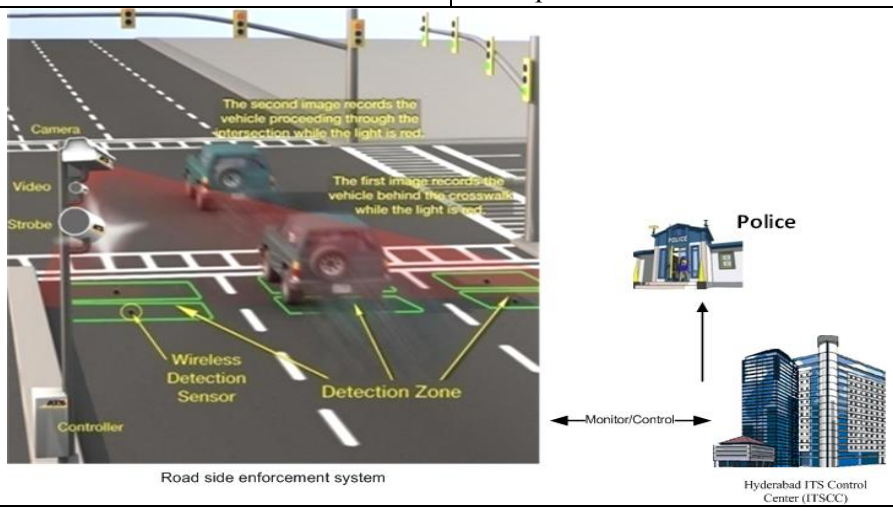
Item	Contents	
ITS Sub-Service Services	5. Enforcement System (5-1 Assistance of Police Activities)	
Purpose	Assistance of police activities for security of society.	
Effectiveness	In order to ensure the safety and protection of individuals and society, police activities require more efficient information of drivers and citizens on road for police investigation. Using ITS technology enable to improve current information collection by helping in collecting more information in less time.	
Service flow	1. Citizen registers complaint at police station and requests the service to solve their problem. 2. The police contact police stations and request to start the service and provide necessary information through online communication. 3. Police and ITSC collect the CCTV images and vehicle detecting information related to citizen request. 4. Police and ITSC provide necessary information related to citizens requirements to police station and road-administrator. 5. Police station transmits information to police for serving the citizen.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Currently, many CCTV surveillance public places, roads, etc. However, this surveillance system is not integrated traffic monitoring system.	Currently, Hyderabad has CCTV surveillance system for recording the activities on road. In case of any offence, the CCTV recording is used in investigating the case.
Image (Example)		
Target Area	Inside ORR	
Implementation Period	Phase 3	
Related Agency	ITSC, GHMC, Traffic Police & RTA	

Item	Contents
Remarks	

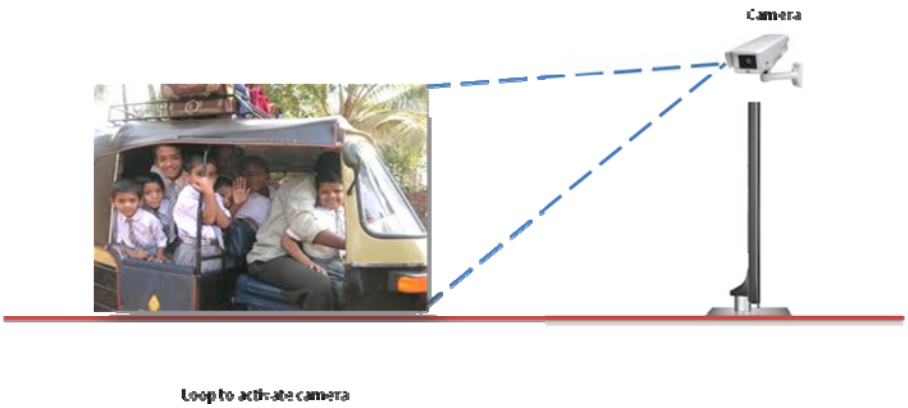
(29) 5. Enforcement System
(5-2 Automated Speed Enforcement System)

Item	Contents	
ITS Sub-Service Services	5. Enforcement System (5-2 Automated Speed Enforcement System)	
Purpose	Detect, alert to over speeding vehicle and prevent dangerous driving.	
Effectiveness	Over speeding vehicle tends to cause serious accident and involves other vehicles. This service covers the application of ITS technologies to the enforcement of traffic laws and regulations.	
Service flow	1. Roadside sensor detect the over speeding vehicle and send vehicle ID to ITSC. 2. ITSC sends the violated vehicle information to traffic police immediately and continuously. 3. ITSC warns the violated vehicle through roadside antenna and in-vehicle device. 4. Traffic police deter the violated driving by controlling signals.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Wireless vehicle detectors are used to detect the over speed vehicle. Whenever an over speed vehicle is detected, the monitoring camera captures the vehicle image and are sent to traffic control room.	Currently Hyderabad traffic police are using "Laser Gun" to detect over speeding vehicles. This Laser gun is being placed at some identified locations by traffic police on each day and over speed vehicles are identified.
Image (Example)		
Target Area	ORR and its Inside	
Implementation Period	Phase -2, Phase-3	
Related Agency	ITSC, Traffic Police, RTA, GHMC, HGCL	
Remarks		

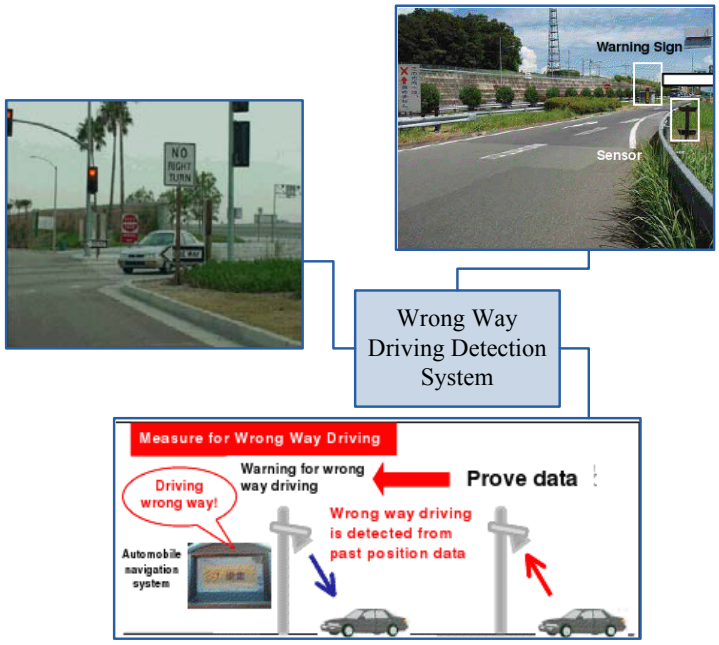
(30) 5. Enforcement System
(5-3 Automated Signal Jumping Enforcement)

Item	Contents	
ITS Sub-Service Services	5. Enforcement System (5-3 Automated Signal Jumping Enforcement)	
Purpose	Detect and alert to dangerous driving vehicle and prevent dangerous driving.	
Effectiveness	The vehicle informing traffic signal tends to cause serious accident and involves other vehicles. This service covers the application of ITS technologies to the enforcement of traffic laws and regulations.	
Service flow	1. Roadside sensor detects the vehicle ignoring traffic signal and send vehicle ID and image to ITSC. 2. ITSC sends the violated vehicle information to traffic police immediately and continuously. 3. ITSC warns the violated vehicle through roadside antenna and in-vehicle device. 4. Traffic police deter the violated driving by controlling signals. 5. Send the information of violated vehicles to traffic police.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Image processing type CCTV is used for capture the violated vehicles and send images to police control centre.	Detection of the violation is usually made by loop coil sensors that are buried in the pavement and tied into the timing system of a traffic signal and a pole mounted camera.
Image (Example)		
Target Area	Inside IRR	
Implementation Period	Already implemented	
Related Agency	ITSC, Traffic Police & GHMC	
Remarks		

(31) 5. Enforcement System
(5-4 Automatic Excess Riding Capacity Enforcement)

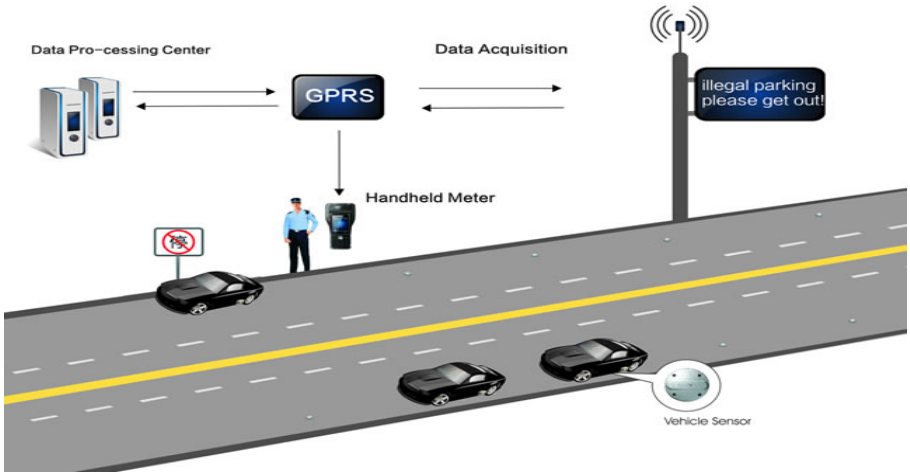
Item	Contents	
ITS Sub-Service Services	5. Enforcement System (5-4 Automatic Excess Riding Capacity Enforcement)	
Purpose	Detect and alert the violated vehicle and prevent dangerous driving.	
Effectiveness	Violated vehicle tends to cause serious accident and involve other vehicles. This service covers the application of ITS technologies for enforcement of traffic laws and regulations.	
Service flow	1. Roadside sensor detects the vehicle with excess capacity and send vehicle ID and image to ITSC. 2. ITSC sends the violated vehicle information to traffic police immediately and continuously. 3. ITSC warns the violated vehicle through roadside antenna and in-vehicle device. 4. Send the information of the vehicle to traffic police.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	When a vehicle is having excess crew, cameras mounted on a pole will record and transfer the data to traffic control station. The traffic police will enforce the penalty on offenders.	In Hyderabad traffic police currently use mounted cameras and manual cameras to record the offenders and issue e-Challans.
Item	**Contents**	
Image (Example)		
Target Area	Inside IRR	
Implementation Period	Phase - 3	
Related Agency	ITSC, Traffic Police, RTA & GHMC	
Remarks		

(32) 5. Enforcement System
(5-5 Automated Wrong Way Driving Enforcement

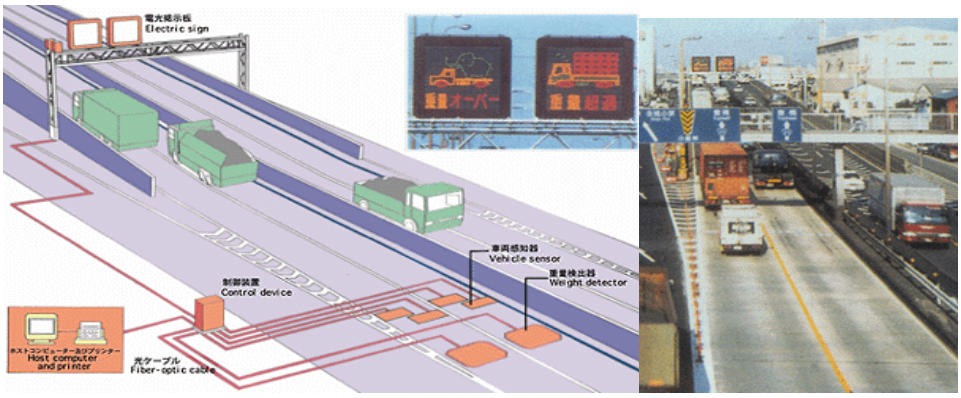
Item	Contents	
ITS Sub-Service Services	5. Enforcement System (5-5 Automated Wrong Way Driving Enforcement	
Purpose	Detect, alert and prevent dangerous driving.	
Effectiveness	Wrong way driving vehicle tends to cause serious accident and involve other vehicles. This service covers the application of ITS technologies to the enforcement of traffic laws and regulations.	
Service flow	1. Roadside sensor detects the wrong way driving vehicle and send vehicle ID and image to ITSC. 2. ITSC sends the violated vehicle information to traffic police immediately and continuously. 3. ITSC warns the violated vehicle through roadside antenna and in-vehicle device. 4. Traffic police deter the violated driving by controlling signals.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Sensors are mounted on the pathway to detect wrong way drivers and warn them in time either through flashing red light with message on VMS or displaying message to the driver on his in-vehicle device display unit.	Currently in Hyderabad & Cyberabad few sign boards are placed to indicate one-way, wrong way driving pathways. But there is no advanced system that preempts the driver about wrong way driving.
Image (Example)		
Target Area	Inside IRR.	
Implementation Period	Phase - 3	

Item	Contents
Related Agency	ITSC, Traffic Police, RTA and GHMC
Remarks	

(33) 5. Enforcement System (5-6 Automated Illegal Parking Enforcement)

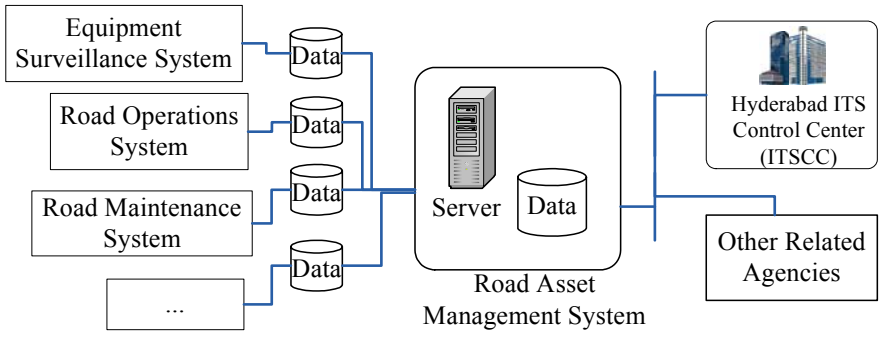
Item	Contents	
ITS Sub-Service Services	5. Enforcement System (5-6 Automated Illegal Parking Enforcement)	
Purpose	Assist efficiency of illegal parking enforcement.	
Effectiveness	To eliminate the illegal parking vehicle which is intervening traffic flow in a city, utilization of ITS technologies can support enforcement.	
Service flow	1. Road administrator requests the traffic police to remove illegally parked vehicle by online communication. 2. ITSC collects the necessary information based on data received by roadside sensor and CCTV and sends it to traffic police. 3. Traffic police start the enforcement based on information received from ITSC. 4. ITSC received the registration No. of illegally parked vehicles and store the data on data base.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Illegally parked vehicles are detected using Illegally parked vehicles detection system. This system uses Closed Circuit Television (CCTV) and sensors for gathering the information. The collected images are processed based on the area parking regulations and then, illegally parked vehicles are detected.	Currently in Hyderabad, no automated system is available for detecting illegally parked vehicles.
Item	**Contents**	
Image (Example)	 Source: http://szfangle.com/en/feifa.html	
Target Area	HYDERABAD City Selected areas	
Implementation Period	Phase - 2	
Related Agency	ITSC, Traffic Police, RTA and GHMC	
Remarks		

(34) 5. Enforcement System (5-7 Automated Overloaded Vehicle Enforcement)

Item	Contents	
ITS Sub-Service Services	5. Enforcement System (5-7 Automated Overloaded Vehicle Enforcement)	
Purpose	Monitoring overloaded vehicle operation.	
Effectiveness	Enforcement of all overloaded vehicles is difficult under the current condition and overloaded vehicle damage the pavement and increases the risk of accident. Application of ITS technologies can help in enforcing overloaded vehicle.	
Service flow	1. Vehicle weight is measured at check post and selected overloaded vehicles. 2. Registration No. of overloaded vehicle forwarded to traffic police and stored in database.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Commonly Overloaded vehicles are detected by Weight in Motion (WIM). WIM Systems screen commercial vehicles on the main highway and vehicles which are identified as over loaded / over weight than the permissible limits are directed into the Vehicle Compliance Stations for further weighing.	Currently in Hyderabad, manual methods are used to identify the overloaded vehicles.
Item	**Contents**	
Image (Example)		
Target Area	HYDERABAD CITY Initially.	
Implementation Period	Phase - 2	
Related Agency	Traffic Police, RTA and GHMC	
Remarks		

(35) 6. Road Asset Management System

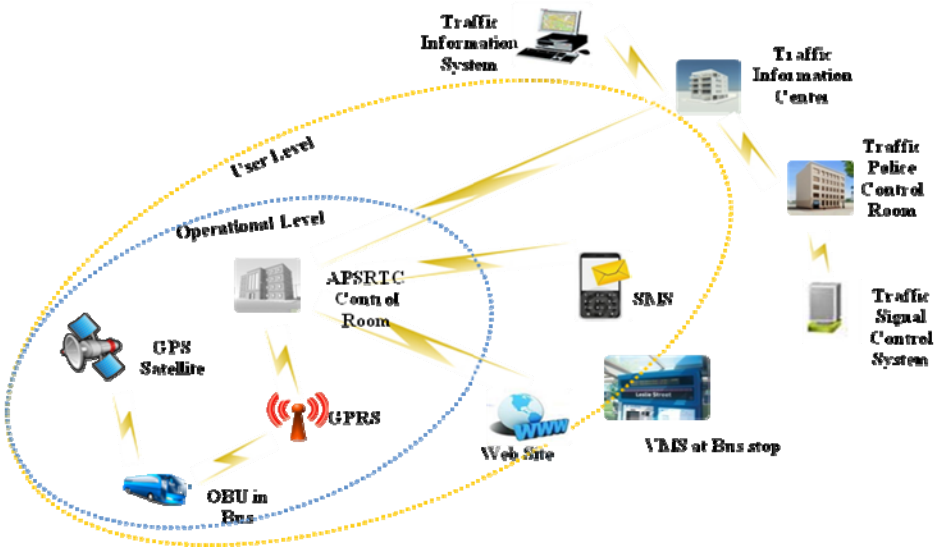
Item	Contents
ITS Sub-Service Services	6. Road Asset Management System
Purpose	Road asset surveillance, operation and maintenance system enable to ease the asset management for road.
Effectiveness	Damaged road surface may cause the accident due to slip or unawareness of adverse road condition ahead. Proper maintenance can be useful in optimum use of roadside facilities and proper installation plan of roadside equipment is also main factor to utilize the road asset.
Service flow	Continuous updating of road inventory. Provide adverse road condition to driver 1. ITSC collects the road condition information by roadside sensor and in-vehicle sensor 2. Traveller receives the information related to road conditions ahead before vehicle reaches the spot/area which can adversely affect driving from ITSC via in-vehicle device. Proper Maintenance 1. Road administrator collects the data by roadside sensor, equipment surveillance system, and informant. 2. Analyze, process and evaluate data and then, implement the inspection, maintenance, repair, adjustment for restoration of equipment. Newly maintenance and inspection plan 1. All data of inspection, maintenance, repairing, adjustment, replacement is stored in the database. 2. Based on database, road administrator establishes the plan for inspection, maintenance and future finance plan.

Item	In the World	In India (Especially Hyderabad)
Current Situation	Maintenance Decisions Support System (MDSS) - All equipments for road management are checked realtime by surveillance system and periodical inspections are conducted to assist making appropriate decisions for best utilization of resources.	Hyderabad does not have advanced road management systems, but the road management is performed by GHMC on day to day basis. It is said that one agency involved in road inventory process.
Image (Example)		

Item	Contents
Target Area	Inside ORR
Implementation Period	Phase I, Phase-2
Related Agency	ITSC, GHMC, R&B, NHAI & HGCL
Remarks	Initial road inventory will be made by JICA SAPI study (1510 km)

(36) 7. Bus Operation System

Item	Contents	
ITS Sub-Service Services	7. Bus Operation System	
Purpose	Provide bus information to travellers and bus operators.	
Effectiveness	Realtime bus information improves travel efficiency to travellers and reduces operating cost to bus companies.	
Service flow	Provision to Travellers 1. Travellers access ITSC to purchase information of destination, expecting travel date and time, fare etc. 2. Bus operating company collect and process the probe data from all vehicles to find the location and time to destination for providing the information to customers at bus stops. 3. ITSC collects the latest information periodically from bus operating company. 4. ITSC analyze and processing the information as per traveller's request and provide. Vehicle Emergency 1. When accident occurs, driver's abnormality or vehicle malfunction happen, in-vehicle device send the information automatically to bus company. 2. ITSC identifies the location, vehicle condition from vehicle ID. 3. ITSC analyzes and process based on the received information and other data, and send fastest route guidance to bus company and traffic police. 4. ITSC display message through VMS, SMS and transmit information on internet and highway radio etc. to users.	
Item	**In the World**	**In** India **(Especially Hyderabad)**
Current Situation	Data is collected using Automatic Vehicle Location (AVL) systems. In these systems, GPS receivers are interfaced with a GSM modems and placed in the buses. They record point locations in latitude-longitude pairs, speed of the buses, direction and the data is transmitted to the Bus Information centre using GPRS. The Bus information centre manages the buses data as per the user request. Buses status is displayed at some bus stations where passengers wait.	Hyderabad Bus services are currently not using this system.

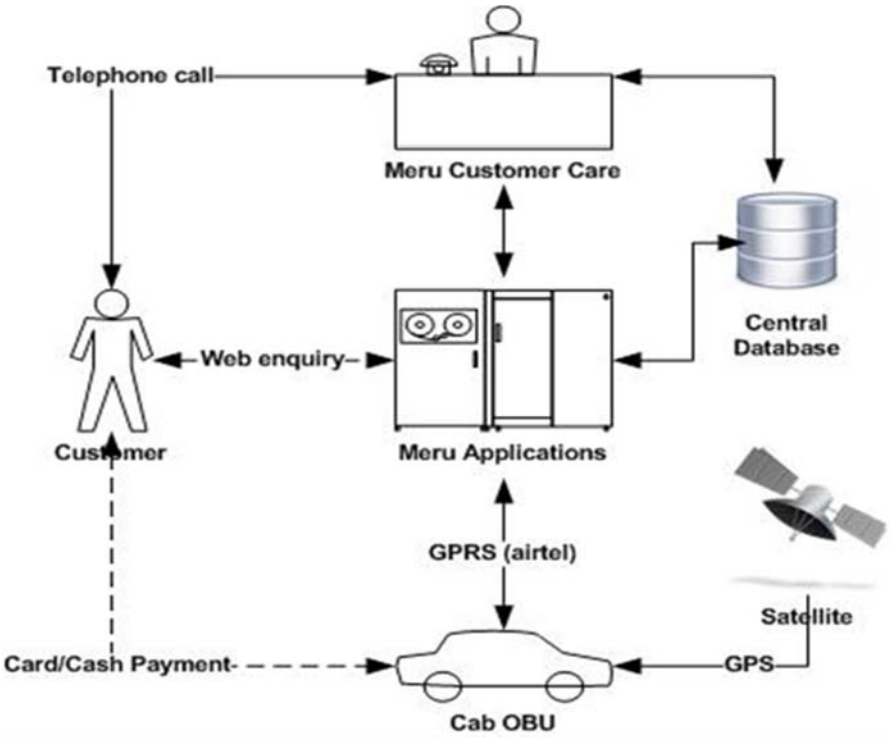
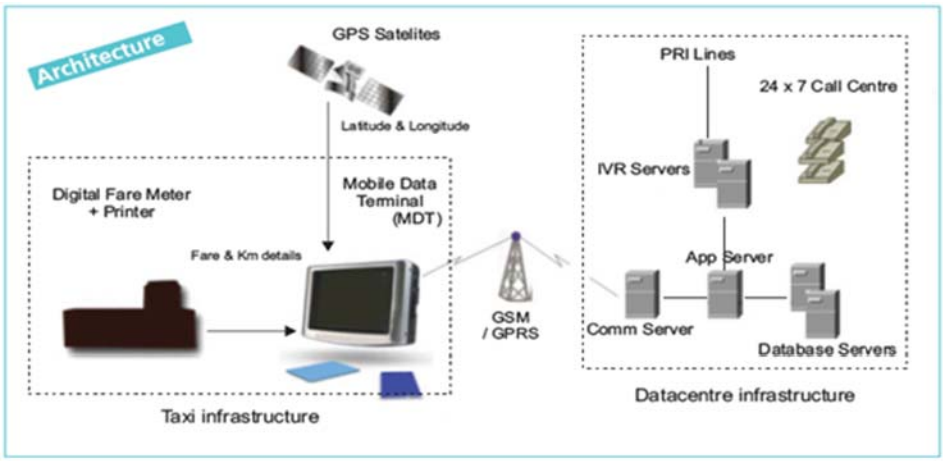
Item	Contents
Image (Example)	

Item	Type	Device	Cost	
			Initial	Running
Outline of ITS sub-system	Probe System	Probe System : 1,000 units	57,700,000 Rs/unit	23,700,000 Rs/year

Item	Contents
Target Area	Inside ORR
Implementation Period	Pilot, Phase I
Related Agency	ITSC, APSRTC, GHMC and Traffic Police
Remarks	APSRTC will install GPS and centralized operation system by themselves. Above cost for Probe System will be used for ITSC

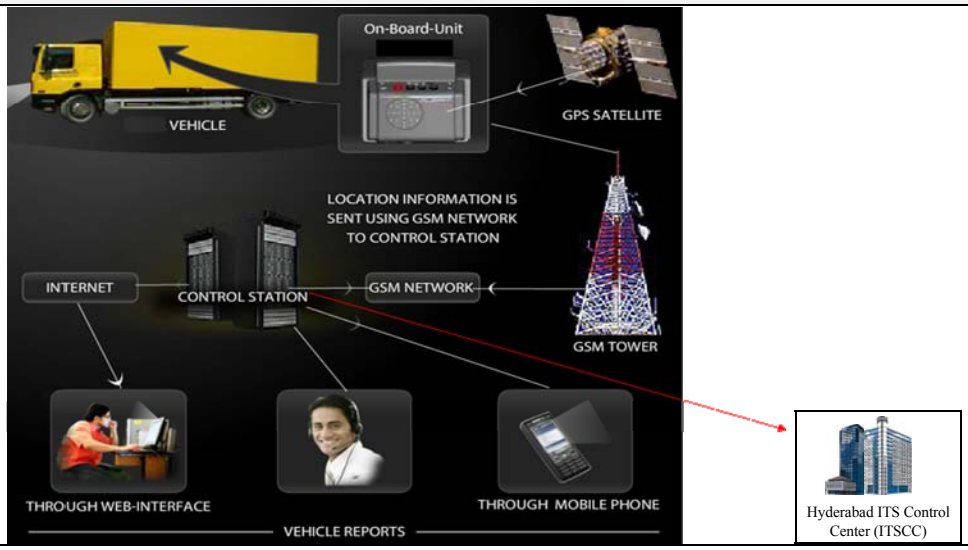
(37) 8. Taxi Operation System

Item	Contents	
ITS Sub-Service Services	8. Taxi Operation System	
Purpose	Provide taxi information to travellers and taxi operators.	
Effectiveness	Taxi Operators system enables to dispatch nearest taxi for passengers who require taxi. So taxi dispatching services will be more efficient and processing data from each taxi by probe systems can find all taxi's track of a day.	
Service flow	1. Passenger access taxi company for booking time, vehicle class, etc. 2. Taxi company request necessary information such as location of taxies, traffic condition to the ITSC. 3. ITSC analyze and processing the data from roadside sensors or in-vehicle sensors and inform to taxi company. 4. Taxi company dispatch the taxi which is most optimum car for time and destination to passengers. 5. Taxi company inform the passenger waiting time and vehicle registration No. and taxi driver takes the most optimum route instructed by in-vehicle device to passenger and to destination of passenger.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Taxis are fitted with GPS & GPRS OBU devices and the system will transmit the location data to the central control room. The central control room can identify the nearest available Taxi when a traveller requested for booking and accordingly intimate the driver to attend the call. Some taxi installed the navigation system and drives accordance with instruction from navigation system by verbally and images.	GPS enabled taxi services are currently available in Hyderabad.

Item	Contents
Image (Example)	 Meru cab operations in Hyderabad  Meru cab architecture
Target Area	Inside ORR
Implementation Period	Already in use (Private Company)
Related Agency	Taxi Company, ITSC
Remarks	

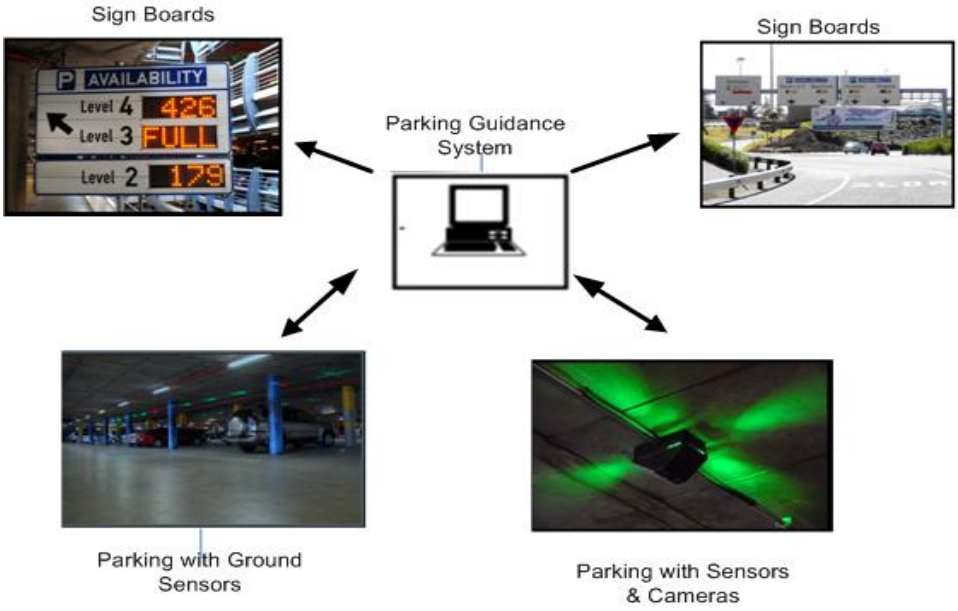
(38) 9. Commercial Vehicle Operation System

Item	Contents	
ITS Sub-Service Services	9. Commercial Vehicle Operation System	
Purpose	Provide the commercial vehicles with road traffic information and commercial vehicle operations. Owner of commercial vehicles receive the information to understand the status of commercial vehicles such as location, prospected time to destination etc.	
Effectiveness	Cargo company and goods manufacturer requires the constant information of cargo and vehicle as per any customer's order.	
Service flow	Provide information constantly 1. Cargo company or manufacturer requests the current status information of trucks with ID. 2. Cargo company or manufacturer collects the information of location and speed of trucks by in-vehicle sensor through GPS navigation provider. 3. GPS navigation provider provides information of trucks with mapping. 4. Cargo company and manufacturer store the travel record of trucks into their database. Emergency Information 1. Any incident such as accidents malfunctioned of vehicle or abnormality of driver is forwarded to ITSC. 2. ITSC specifies the location of trucks from GPS navigation provider. 3. ITSC provides information of optimum route to approaching trucks. Cargo management 1. Cargo company or manufacturer request the current status of cargo with ID, shipment location, destination and truck's ID to GPS navigation provider. 2. Driver sends the information the status of cargo with ID such as arrival, reshipment or on-the-way to GPS navigation provider. 3. GPS navigation provider provides cargo information to cargo company or manufacturer as per their request.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	A realtime vehicle tracking system for fleet management is already practically used by GPS. RFID tag is also used for identification of cargo.	Currently in Hyderabad, no techniques are implemented for commercial vehicle operation.

Item	Contents
Image (Example)	
Target Area	Inside ORR
Implementation Period	Phase-3 (Private Companies)
Related Agency	Traffic Police, GHMC, ITSC, Cargo Company, Manufacturer and GPS Navigation Provider
Remarks	

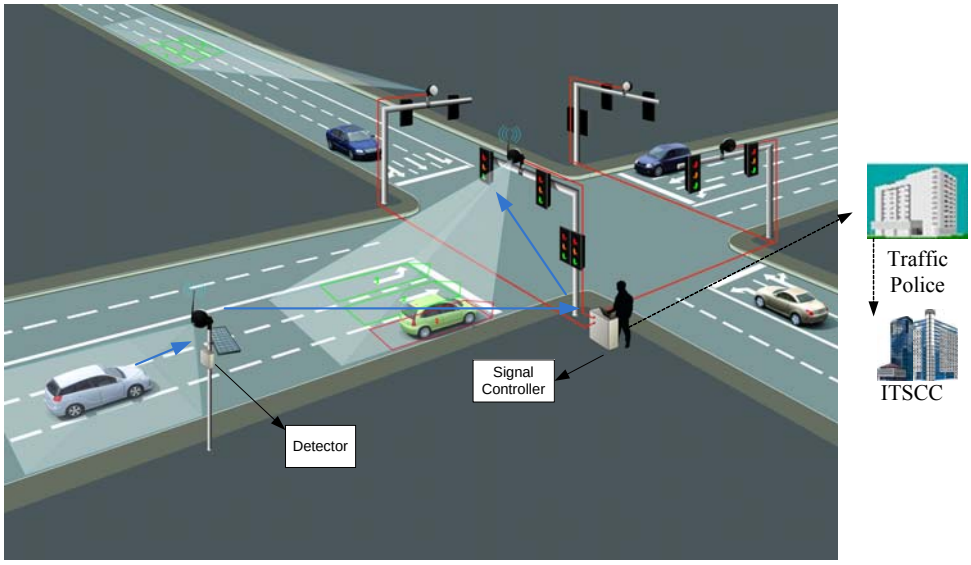
(39) 10. Parking Operation System

Item	Contents	
ITS Sub-Service Services	10. Parking Operation System	
Purpose	Provide parking availability, guidance to parking and electronic parking charge etc.	
Effectiveness	Provide parking availability on pre-trip and on-trip, electronic parking charge, and assist the proper planning based on demand. These technologies can contribute maximum usage of parking, reduce the fraud acts, and assist in proper parking planning based on demand by area.	
Service flow	Parking Availability 1. Driver accesses the ITSC using in-vehicle device. 2. ITSC provides the parking availability information which is collected from parking administrator and informants. 3. ITSC provides the parking information to driver's in-vehicle device. Electronic Parking Charge 1. Driver stops at the entry of parking. 2. Sensor at parking entrance finds whether the vehicle is free-charge or not. 3. If the vehicle is not free-charge, charge according to parking hours at exit. Parking planning 1. ITSC provides the stored data to parking administrator and the parking administrator establish management plan. 2. Road administrator collects the stored data from ITSC and establish public parking plan.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Provide parking availability information by VMS. Some countries implemented Parking guidance systems by: Installing Level counting sensors at each Level of parking Bay using sensors, cameras. Data collected from these sensors / camera is transmitted to central Parking guidance system and the sign boards are updated with realtime information from the central system.	Currently Hyderabad does not use such systems. But, smart card is available in several parking by GHMC

Item	Contents
Image (Example)	
Target Area	Inside ORR
Implementation Period	Phase-2, Phase-3
Related Agency	ITSC, GHMC, Parking Administrator
Remarks	

(40) 11. Traffic Control System
(11-1. Optimization and Coordination System for Signal Control)

Item	Contents	
ITS Sub-Service Services	11. Traffic Control System (11-1. Optimization and Coordination System for Signal Control)	
Purpose	Controlling traffic signal at intersections, arterial roads and wide-area traffic.	
Effectiveness	Current traffic control based on traffic demand cannot handle the sudden increase of traffic such as commuting hours or any incident. Due to the time gap between the detection and sudden increase of traffic. Signal coordination system can be centralized control of signals. But some cases like pedestrian crossing and emergency vehicle operation required independent operation of traffic signal. Therefore, even under the signal coordination system, each traffic signal needs to operate as independent unit.	
Service flow	Vehicle and Pedestrian 1. Roadside sensor detects the pedestrian or approaching vehicle and sends detected information to signal controller. 2. Signal controller analyze optimum signal phase pattern based on received information from detector and start controlling by latest phase and pass the information to traffic police and ITSC. Priority of Public Transport 1. Signal controller receive the information of approaching and access track of vehicles of elderly people, disabled people 2. Signal controller select optimum signal phase pattern based on received information and start controlling by latest phase and forward information to traffic police, ITSC and respective vehicles.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	ITS technology enables the process of traffic signal timing to be performed more efficiently by enhancing data collection and system monitoring capabilities and, centrally controlled or monitored traffic signal systems, interconnected traffic signals, and traffic adaptive signal control.	Currently in Hyderabad, there is no proper coordination between traffic signals and urges the need for optimized coordination among traffic signals.

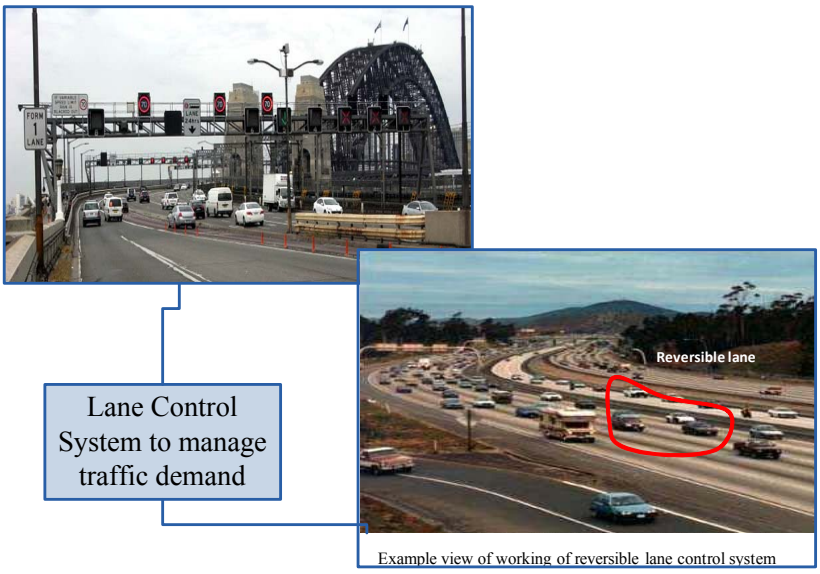
Item	Contents
Image (Example)	 Source: http://www.aldridgetrafficcontrollers.com.au/Products/Video-Detection

Item	Type	Device	Cost	
			Initial	Running
Outline of ITS sub-system	Optimization and Coordination System for Signal Control	Signal Control System : 10 junctions	110,000,000 Rs/System	17,850,000 Rs/year

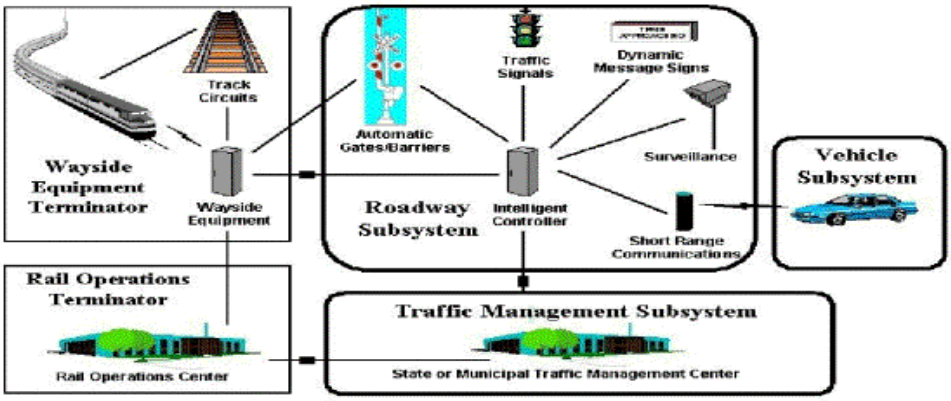
Item	Contents
Target Area	Inside ORR
Implementation Period	Pilot, Phase-I, Phase-2
Related Agency	ITSC, Traffic Police and GHMC
Remarks	

(41) 11. Traffic Control System (11-2. Lane Control System)

Item	Contents	
ITS Sub-Service Services	11. Traffic Control System (11-2. Lane Control System)	
Purpose	Reversible lane control and control one-way driving dynamically for maximum use of road infrastructure.	
Effectiveness	Traffic demands of road become altered depending on time. To utilize the road infrastructure efficiency, shifting the median or change the direction of one-way road can contribute in reduction of traffic congestion.	
Service flow	Reversible Lane Control 1. ITSC collects the necessary information for reversible lane control from road administrator, etc. 2. ITSC analyzes and processes the collected information from road administrator and informants. 3. ITSC sends necessary information to traffic police when road capacity becomes saturate. 4. ITSC displayed information on VMS for notification to driver and start the lane control system as per police's request. 5. ITSC provides information of status of lane to road administrator and related-agencies. One-way Driving Control 1. ITSC collects information of OD and vehicle class through in-vehicle device. 2. ITSC analyzes and processes the collected information from road administrator and informants. 3. ITSC sends necessary information to traffic police when road capacity becomes saturate. 4. ITSC displays information on VMS for notification to driver and start one-way driving control system as per police's request. . 5. ITSC provides information of status of One-way road to road administrator and related-agencies.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Efficient lane control is implemented around the world using advanced Lane control systems. Lane Control System - The system uses traffic control devices such as movable medians, overhead lane use signs, changeable message signs, illuminated pavement lights and traffic signals to implement lane changes depend on traffic demand.	Traffic Police in Hyderabad manually controlling the lane utilization.

Item	Contents
Image (Example)	 Example view of working of reversible lane control system
Target Area	Inside ORR
Implementation Period	Phase 2
Related Agency	ITSC, GHMC and Traffic Police
Remarks	

(42) 11. Traffic Control System
(11-3. Advanced Railway Crossing Operation System for Traffic Flow Optimization)

Item	Contents	
ITS Sub-Service Services	11. Traffic Control System (11-3. Advanced Railway Crossing Operation System for Traffic Flow Optimization)	
Purpose	To automate railway level crossing for traffic flow optimization.	
Effectiveness	At the railway crossing with heavy traffic flow, traffic is stopped by passing train and this situation cause congestion. Coordination with barrier of closing and traffic signal of road can mitigate the traffic congestion.	
Service flow	1. ITSC collects the information of current train operation from the train operation company. 2. Processing unit of barrier for crossing sends the approaching train information through traffic signal controller to ITSC. 3. ITSC analyzes and establishes the information for controlling signals around the railway crossing. 4. Traffic police receives the current condition and the information for controlling signals around the railway crossing. 5. Traffic police start to control the signals at railway crossing. Simultaneously, ITSC inform to train company and road administrator.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Infrared sensor system is installed at both sides of many railways crossing along with the barriers. When sensor detect the something crossing the infrared, warning system start to alert or flash red light and also display warning message on the OBU monitor of a vehicle that is nearing the Rail-Road crossing.	Guards manually operating the railway level crossing gates.
Image (Example)	 Source: http://www.fra.dot.gov/Pages/1241.shtml	
Target Area	Inside ORR	
Implementation	Phase 3	

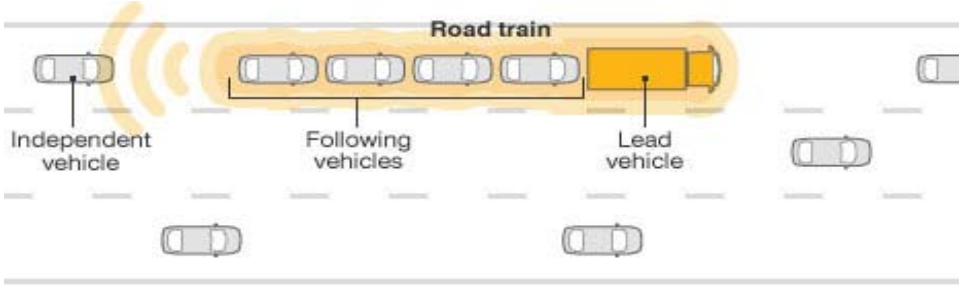
Item	Contents
Period	
Related Agency	ITSC, Traffic Police, Railway Protection Force, Railway Operator & GHMC
Remarks	

(43) 11. Traffic Control System
(11-4. Traffic Management System Based on Road Pricing)

Item	Contents	
ITS Sub-Service Services	11. Traffic Control System (11-4. Traffic Management System Based on Road Pricing)	
Purpose	Collect toll fee automatically without stopping on the road.	
Effectiveness	Can reduce traffic congestion at toll plazas and city by introducing ETC and ERP.	
Service flow	ETC 1. Sensor detects the vehicle with or without ETC before vehicle reaches the toll booth and guide ETC vehicle to ETC lane. 2. At entry lane, antenna read/write information with in-vehicle device such as balance, vehicle ID, time, name of entry interchange, etc. 3. Antenna read/write vehicle information like vehicle ID, remaining balance, time and entry interchange with in-vehicle device. 4. In-vehicle device settle the payment and transmit the successfully payment information to antenna. ERP 1. The sensor mounted on the gantry detects the vehicle with ETC or without. 2. Camera mounted on the gantry capture the No. plate of each and every vehicle. 3. When fraud act happen, Operating company send the violation bill to vehicle owner.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Electronic toll collection centre is implemented using technologies like DSRC, RFID etc. ERP is used for reduction of city traffic congestion or for environmental reason.	Currently in India, Electronic toll tax collection system is installed at National Highway-6 and Delhi Gurgaon Expressway. Currently in Hyderabad, electronic toll collection systems are installed at some location like ECIL.
Image (Example)	 Electronic Road Pricing System Source: http://www.mhi.co.jp/en/technology/business/tsat/its/index.html	
Target Area	Inside ORR	
Implementation	Phase-2, Phase-3	

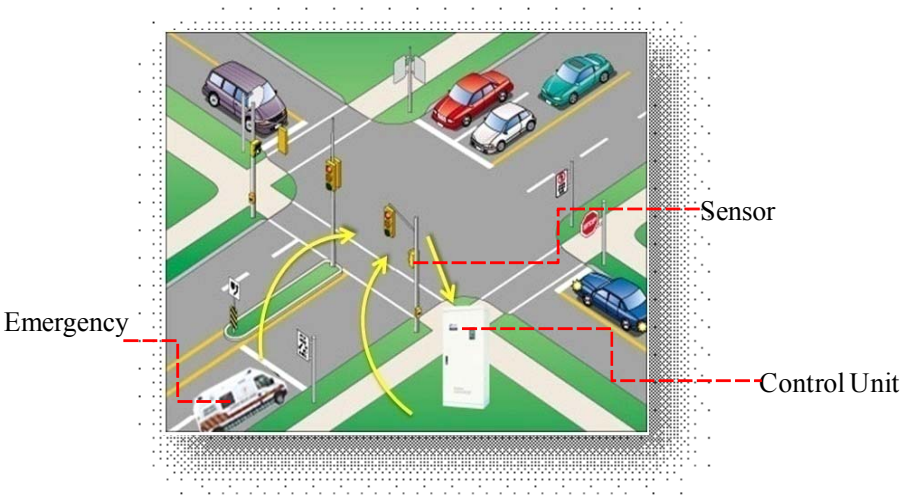
Item	Contents
Period	
Related Agency	ITSC, GHMC, Traffic Police, HGCL, Toll Management company
Remarks	

(44) 11. Traffic Control System (11-5. Fleet Management System)

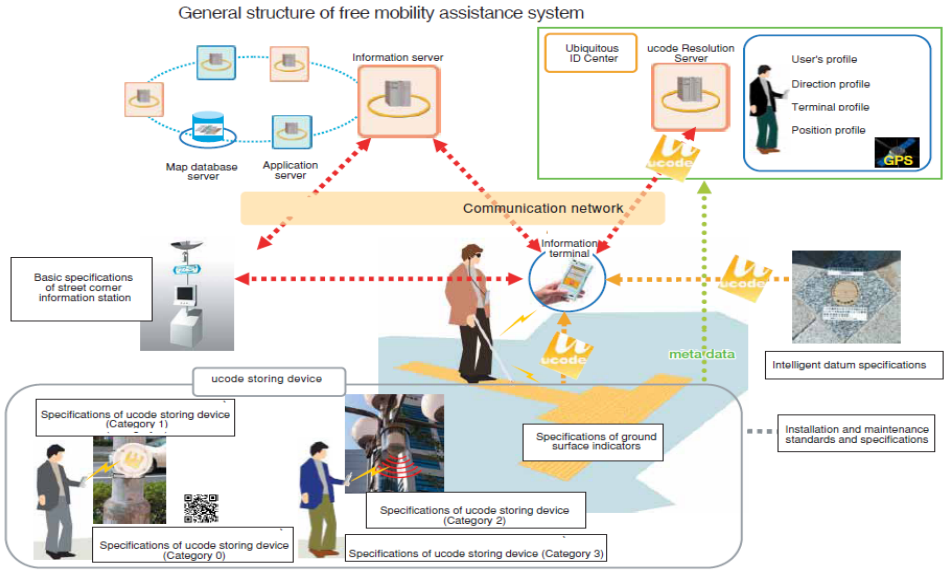
Item	Contents	
ITS Sub-Service Services	11. Traffic Control System (11-5. Fleet Management System)	
Purpose	Provide automatic driving assistance to truck drivers.	
Effectiveness	Platooning of trucks improve the cost effectiveness.	
Service flow	1. Cargo company or manufacture request platooning driving to driver. 2. ITSC gets the details of the lead truck and the trucks following the lead truck. This information is forwarded to Road Administrator. 2. Driver of lead truck starts driving. 3. All trucks are connected through the sensors. 4. All trucks behind communicate with lead truck using in-vehicle sensors and keep the safe distance between each trucks. 5. All trucks follow the lead truck driving behaviour such as accelerating, braking, handling etc.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Truck platooning technologies are still under experiments and not yet used. Due to the size of vehicles and difficulty in implementing these technologies on highway which are not close system. Dedicated lane for truck is also under consideration and it improves safety.	Currently Hyderabad does not have dedicated truck lanes. But measures are taken to avoid traffic congestion and incidents due to truck in IRR region by time restriction for entering truck into IRR region during 7:00AM to 10:00PM.
Image (Example)	 	
Target Area	Inside ORR	
Implementation Period	Phase 3	
Related Agency	ITSC, GHMC, HGCL and NHAI	
Remarks		

(45) 12. Emergency Vehicle Operation System

Item	Contents	
ITS Sub-Service Services	12. Emergency Vehicle Operation System	
Purpose	Dispatching nearest emergency vehicle to the destination along with providing optimum route guidance. Detect the Emergency Vehicle approaching towards signal and provide nonstop optimum route.	
Effectiveness	Reduce traffic congestion delays for emergency vehicle operation and provide quick response in case of incidents. So that, emergency vehicle can quickly reach the incident location and incident clearing will be faster.	
Service flow	1. ITSC constantly collects the information of emergency vehicles, traffic congestion, road condition and road work etc by roadside sensor and in-vehicle sensor. 2. Whenever emergency incident occurs, the emergency information is passed to the nearest emergency vehicle. 3. ITSC requests the specified emergency vehicle to dispatch and provide optimum route guidance using in-vehicle device. 4. ITSC requests traffic police to control the signals to minimize approaching time of emergency vehicle. 5. Traffic police send to the signal controller to change the signal phase for prioritizing emergency vehicles. 6. Whenever signal controller sense the emergency vehicle approaching using roadside sensors, signal controller change the phase for prioritizing emergency vehicles. 7. Signal phase is set back to the normal phase when emergency vehicle passes the signal.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Many Emergency Vehicle Preemption technologies being employed including light-based, infrared-based, sound-based and radio-based emitter/detector systems.	To prioritize the emergency vehicle movement, each vehicle is fitted with emergency horn and announcement system to indicate the road commuters to give way to vehicle.

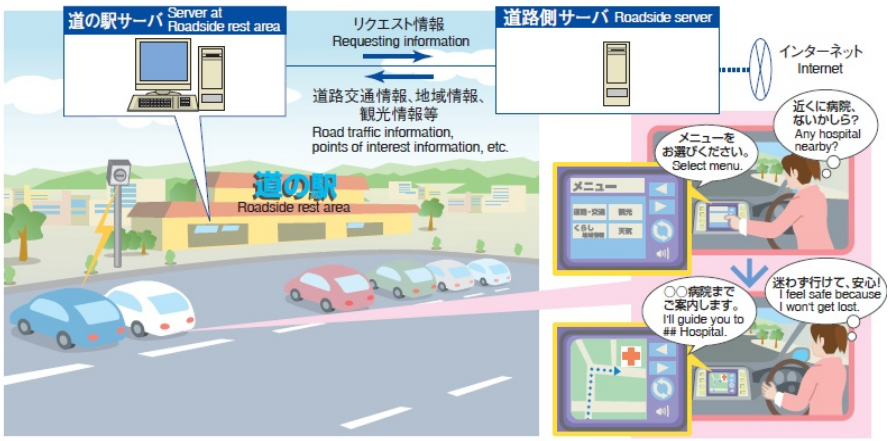
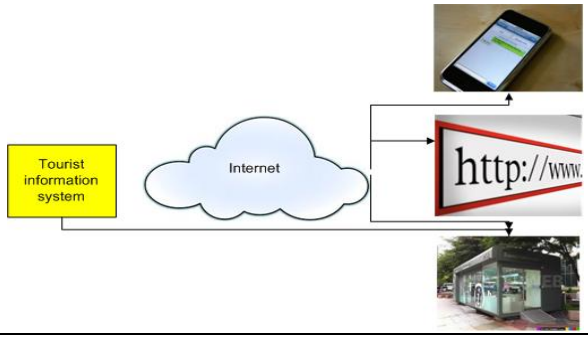
Item	Contents
Image (Example)	
Target Area	Inside ORR
Implementation Period	Phase-1、Phase-2, Phase-3
Related Agency	ITSC, EMRI, Traffic Police and GHMC
Remarks	

(46) 13. Pedestrians/Vulnerable People Guidance System

Item	Contents	
ITS Sub-Service Services	13. Pedestrians/Vulnerable People Guidance System	
Purpose	Providing information on Route and Guidance towards destination to pedestrians and handicapped people.	
Effectiveness	When pedestrians move to unfamiliar places, they may lose the way or take more time than expected. Impaired people and wheel chair users face troubles to find the place or way with least obstructions. As the result these circumstance increase the risk of accident. ITS technology can help in providing route guidance to pedestrians and handicapped people and also guide when departed from guided route.	
Service flow	Guidance for Pedestrian, Visually Impaired People, Wheelchair Users (All information exchange are used by Smart Phone or Portable Device) 1. Users request the ITSC for provision of optimum guidance to destination. 2. ITSC collects the location information of user and warns user not to approach any danger places or obstructions. 3. ITSC guides user to take safe route and warns user whenever user depart from guided route	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Some services like optimum route, time to destination, connection of various modes, information related to current location are provided to pedestrians, elderly people and vulnerable people for route guidance through portable devices or smart phones. This helps users to avoid obstructions.	Printed city maps, route maps are available for travellers. GHMC is providing sightseeing information in HP.
Image (Example)		
Target Area	Inside of IRR	
Implementation	Phase-2, Phase-3	

Item	Contents
Period	
Related Agency	ITSC
Remarks	

(47) 14. Tourist Information Provision System

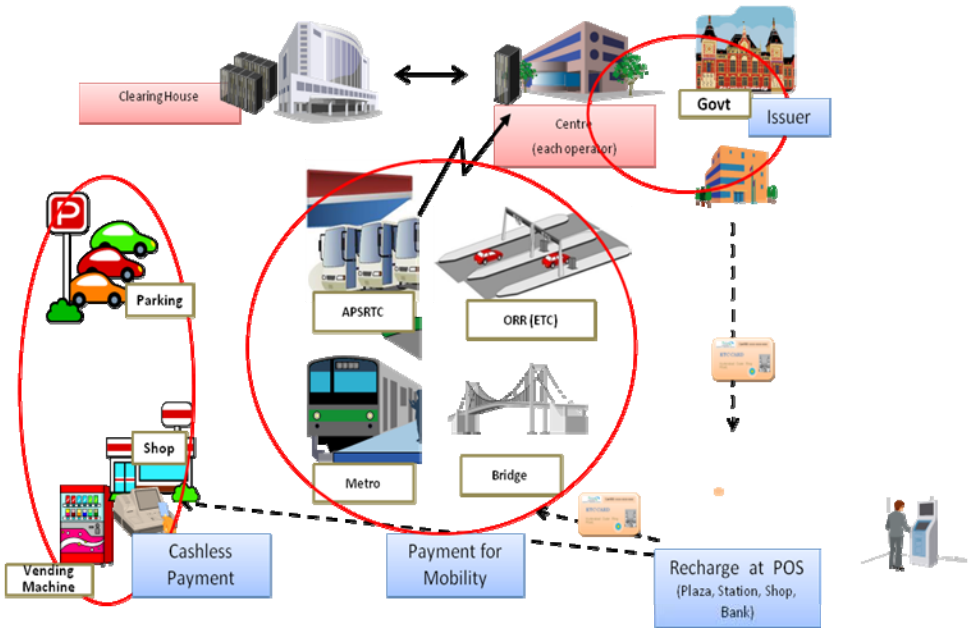
Item	Contents	
ITS Sub-Service Services	14. Tourist Information Provision System	
Purpose	Provide detailed information about facilities, rest areas, and tourist spots to travellers.	
Effectiveness	Beside the route guidance, travellers require variety of information like facilities at destination, tourist spots, on the way rest area, and making reservation at destination, and other transportation etc. Tourist information provision system can contribute improving convenience and enjoyment.	
Service flow	1. User access for information of destination, facilities at destination, tourist spots etc. from internet website or smart phone. 2. On-trip services are provided by GPS Navigation Provider.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Traveller information applications use a variety of technologies, including Internet websites, telephone hotlines, as well as television and radio, to allow users to make more informed decisions regarding trip departures, routes, and mode of travel.	Printed city maps, route maps are available for travellers. GHMC is providing sightseeing information in HP.
Image (Example)	 	
Target Area	In India	
Implementation Period	Phase-1, Phase-2, Phase-3	

Item	Contents
Related Agency	ITSC, Tourist spot hotel owner, Road administrators, GPS Navigation Provider
Remarks	

(48) 15. Bicycle Route Information Provision System

Item	Contents	
ITS Sub-Service Services	15. Bicycle Route Information Provision System	
Purpose	Guidance on availability Route for bicycle.	
Effectiveness	Bicyclists are frequently exposed to some risk while they are riding. To reduce the risk, dedicated route guidance for bicyclist is required.	
Service flow	1. Bicyclist access ITSC using smart phone or portable device. 2. ITSC collects bicyclist location information, traffic condition to the destination, existence of bikeway by roadside sensor, in-vehicle sensor and digital map (including slope condition). 3. ITSC provide figured out information regarding optimum route and potential hazard to smart phone or portable device based on bicyclist's requirement. 4. During the driving, ITSC provide required information such as route guidance whenever bicyclists access the information centre.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Bicyclists receive the route guidance information which is prioritized based on bikeway, less slope and avoiding trunk road. In addition, bicyclist can select the way based on his purpose such as physical training or easy route.	Printed city maps, route maps are available for travellers.
Image (Example)		
Target Area	Inside ORR	
Implementation Period	Phase-1, Phase-2, Phase-3	
Related Agency	ITSC, GHMC	
Remarks		

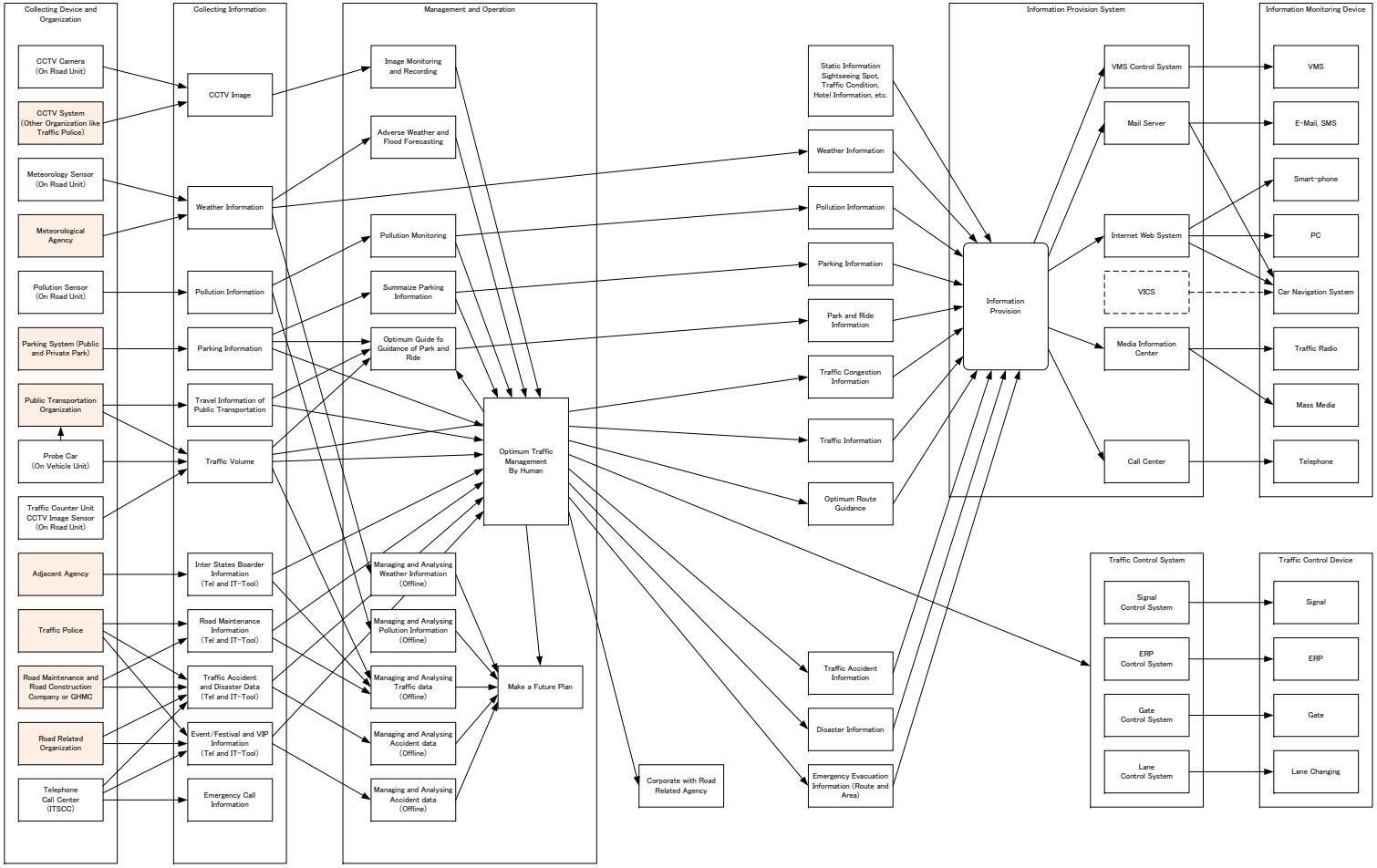
(49) 16. Inter-Modal Smart Card System

Item	Contents	
ITS Sub-Service Services	16. Inter-Modal Smart Card System	
Purpose	Introducing integrated charge system using smart card. So that, a single smart card can be used for multi purposes like transportation, parking and shopping in a city.	
Effectiveness	Unified smart card improves the convenience of users instead of holding many different cards. It also enables to stimulate the economic activities.	
Service flow	1. Users purchase and charge/recharge unified card from Point of Sales (POS) in city. 2. Utilize unified smart card for ETC or Touch & Go of ORR, other various public transport, parking, etc. 3. All payment data collected to clearing house and allocate accordance with used amount of transportation, parking, etc. 4. Before balance of unified card get smaller than minimum for use, users recharge at POS.	
Item	**In the World**	**In India (Especially Hyderabad)**
Current Situation	Contactless smart card system is used for travelling in public and private transport network in countries like USA, Singapore, Japan, etc., In some countries, the same card can be used for various type of transportation or even shopping.	Currently, no smart card is issued in Hyderabad. Government of India introduced the Common Mobility Card named as "More". But specifications are not yet issued.
Image (Example)		
Target Area	India	
Implementation Period	Phase -1, Phase-2, Phase-3	

Item	Contents
Related Agency	ITSC, Railway Operator, APSRTC, GHMC, R&B, NHAI, HGCL and Taxi Operators
Remarks	

4-2-8 Outline of Logical Architecture

The outline-level logical architecture is prepared based on the major ITS Services to be prepared in short-term and mid period as shown below. This identifies the relations and basic data flow among the sub-systems. It should be noted that it was prepared as an outline.

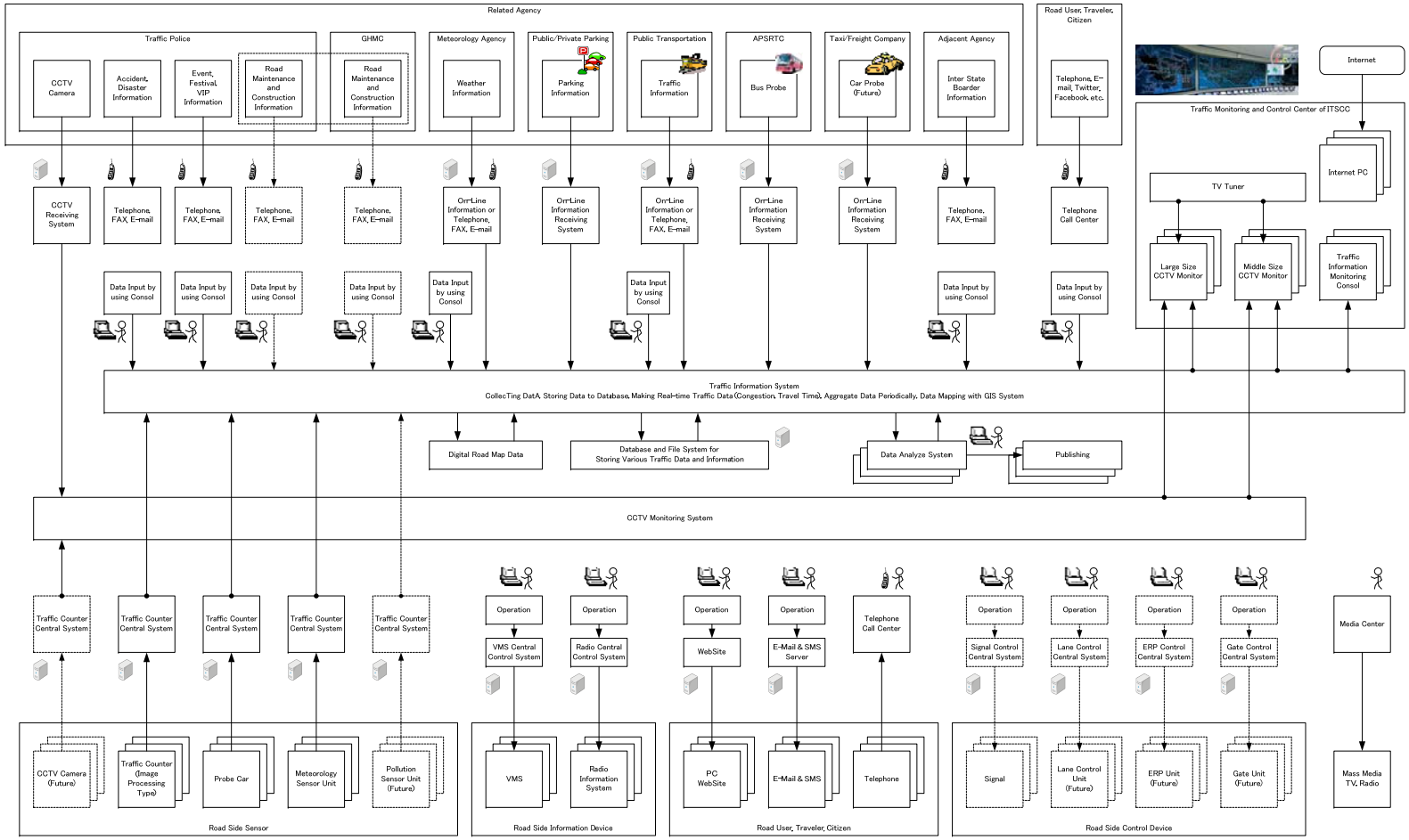


Source: JICA Study Team

Figure 133 Logical Architecture (Draft)

4-2-9 Outline of Physical Architecture

The outline-level physical architecture is prepared based on the major ITS Services to be prepared in short-term and mid period as shown below. This shows the physical components of the sub-systems and their inter-connections. It should be noted that it was prepared as an outline.



Source: JICA Study Team

Figure 134 Physical Architecture (Draft)

4-3 Implementation Schedule

The implementation schedule shown in the clause 3-10-6 Implementation Schedule is shown below again.

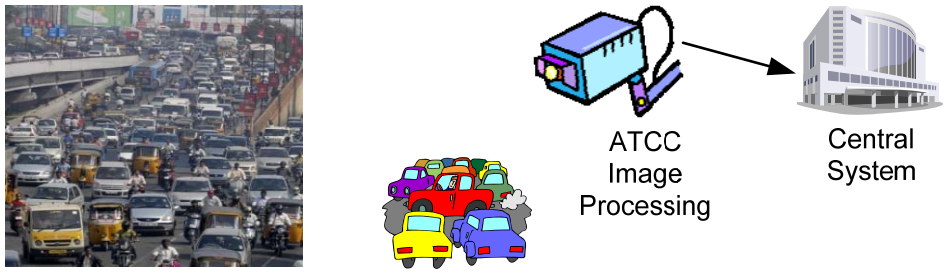
Table 56 Master Plan Implementation Schedule

Items	Phase-1	Phase-2	Phase-3
Installation Priority	- Major road: NH-44 (old NH-7), NH-65 (old NH-9), NH-163 (old NH202), IRR, SH - Other important locations in city	- Distribute road: radial road - Link road: the road linking between above roads - Other important locations	- Link road: the road linking between major junctions - Residential road - Important locations on colony road
	Installation shall be postponed to avoid re-working on the sections with planned civil construction/improvement which includes e.g.: ・ Widening/Extension on Radial Road ・ Sections along Planned Metro Construction		
ITSC	- ITSC establishment - Organisation setup - Preparation of 1st phase systems	- Expansion of system in 2nd phase.	- Expansion of system in 3rd phase.
	ITSC Roles: ・ Traffic monitoring and analysis, traffic information provision, traffic control ・ Planning, implementation, evaluation of ITS ・ System integration, ITS development initiative		
Collection Method	CCTV, ATCC, Probes, related information from agencies and citizens	Expansion of those left	Expansion of those left and Human Probes
Provision Method	VMS, Website, SMS, E-Mail and Call Centre	Expansion of those left	Expansion of those left
Traffic Control Method	Signals on the Road VMS on the road	• Expansion of those left • Variable Lane System • Park & Ride Guidance • Multi modal transport guidance • Parking information guidance	• Expansion of those left • ERP (Electronic Road Pricing)
	To be expanded in 2nd and 3rd phases in line with preparation of • Public & Lane Parking, Public Based Multi Modal Transportations		

4-4 Overview of Systems to be deployed

(1) ATCC (Automatic Traffic Classifier and Counter)

ATCC measures the traffic volume speed and occupancy by section. The measured data is utilised for traffic control and road management. It will also be utilised for traffic congestion information provision to the users. There are several types of ATCC. The figure below shows one of examples of ATCC.

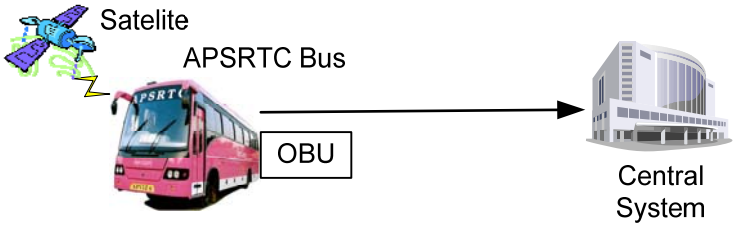


Source: JICA Study Team

Figure 135 Example: Image of ATCC

(2) Probe Car System (Floating Car)

Probe Car measures area-wise traffic conditions. The GPS unit mounted on the vehicle records the travel history of the vehicle. The recorded data is transmitted to the centre. The collected data at centre is aggregated and the congestion level by section is identified.

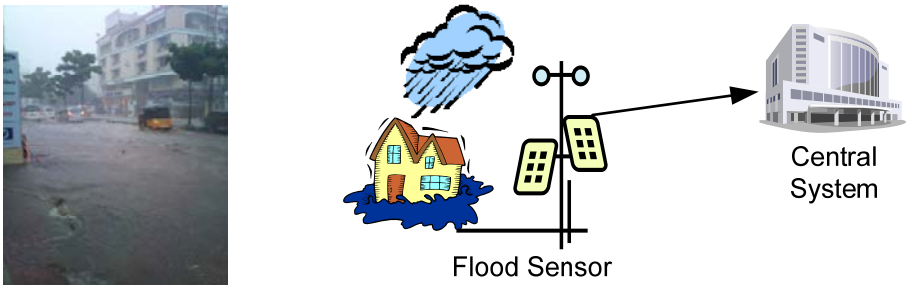


Source: JICA Study Team

Figure 136 Example: Image of Probe Car System

(3) Flood Sensor

Flood Sensor measures flooding situations on roads and its data is used for providing warning alert to the drivers through VMS and other information devices, and is also accumulated for analysis. It will be installed at the flood-prone areas in the city.

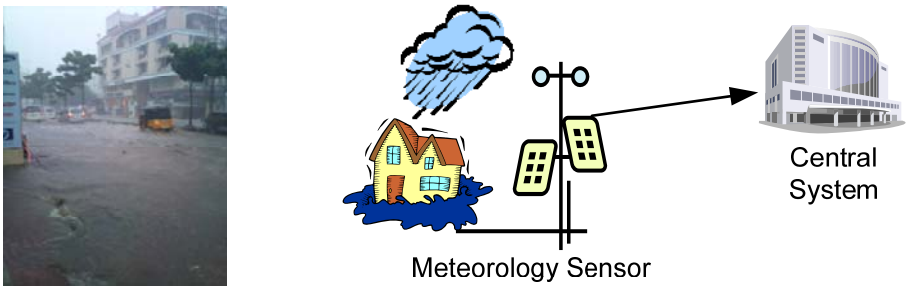


Source: JICA Study Team

Figure 137 Example: Image of Flood Sensor

(4) Meteorological Sensors

Meteorological Sensor measures the weather conditions on roadside and its data is used for providing warning to the drivers through VMS and other information devices and is also accumulated for analysis. The measured data includes rainfall, temperature, wind velocity/direction and visibility.

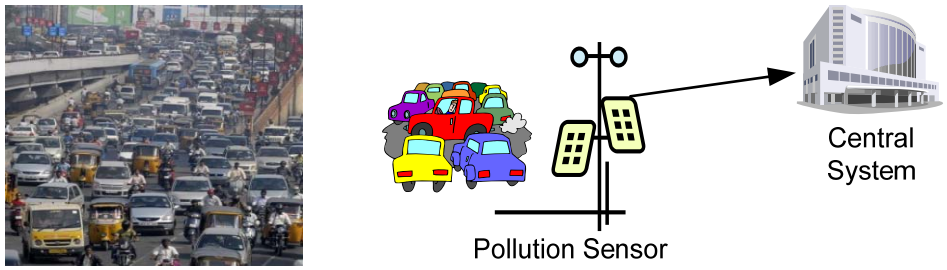


Source: JICA Study Team

Figure 138 Example: Image of Meteorological Sensors

(5) Air Pollution Sensors

Air Pollution Sensor measures the air pollution conditions and its data is used for providing measured information to the drivers and citizens. The measured data includes NOx, SOx, COx and others. The measured pollution data will be utilized for evaluation of effect of reduction of traffic congestion and taking required countermeasures.

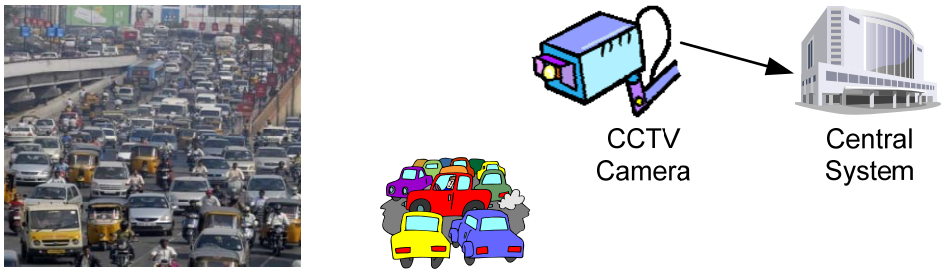


Source: JICA Study Team

Figure 139 Example: Image of Pollution Sensors

(6) CCTV Camera

CCTV captures video images of roadside conditions and provides the images to the centre. The images are used as a supporting method at the centre to visually confirm the road condition at site for taking necessary action.

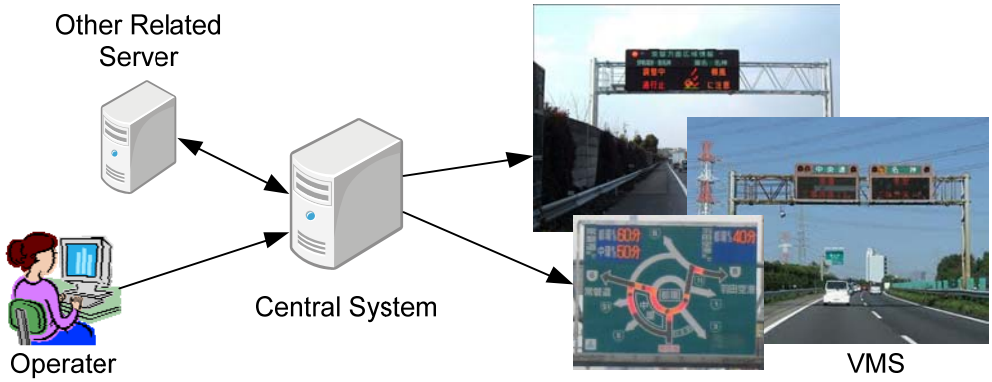


Source: JICA Study Team

Figure 140 Example: Image of CCTV

(7) VMS

VMS provides drivers with information of road, traffic and weather conditions on the road so they have the possibility to divert to a better route.



Source: JICA Study Team

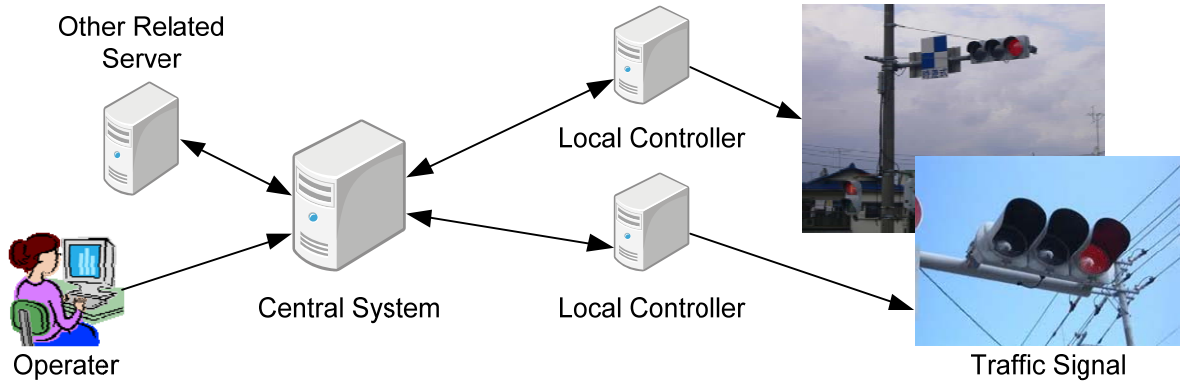
Figure 141 Example: Image of VMS

(8) Signal System

Signal System controls the traffic at junction/intersection in the city. The signal phase can be adjusted from the centre when required.

The signals will be prepared as a part of the scope of the HTRIMS by the Traffic Police. Hence, the installation of the signals by the ITS Master Plan is included in Phases -2 and -3.

It is necessary for there to be enough linkage between HTRIMS and ITSC to assure exchange of signal status information (including fail status) in a well-coordinated manner.



Source: JICA Study Team

Figure 142 Example: Image of Traffic Signal

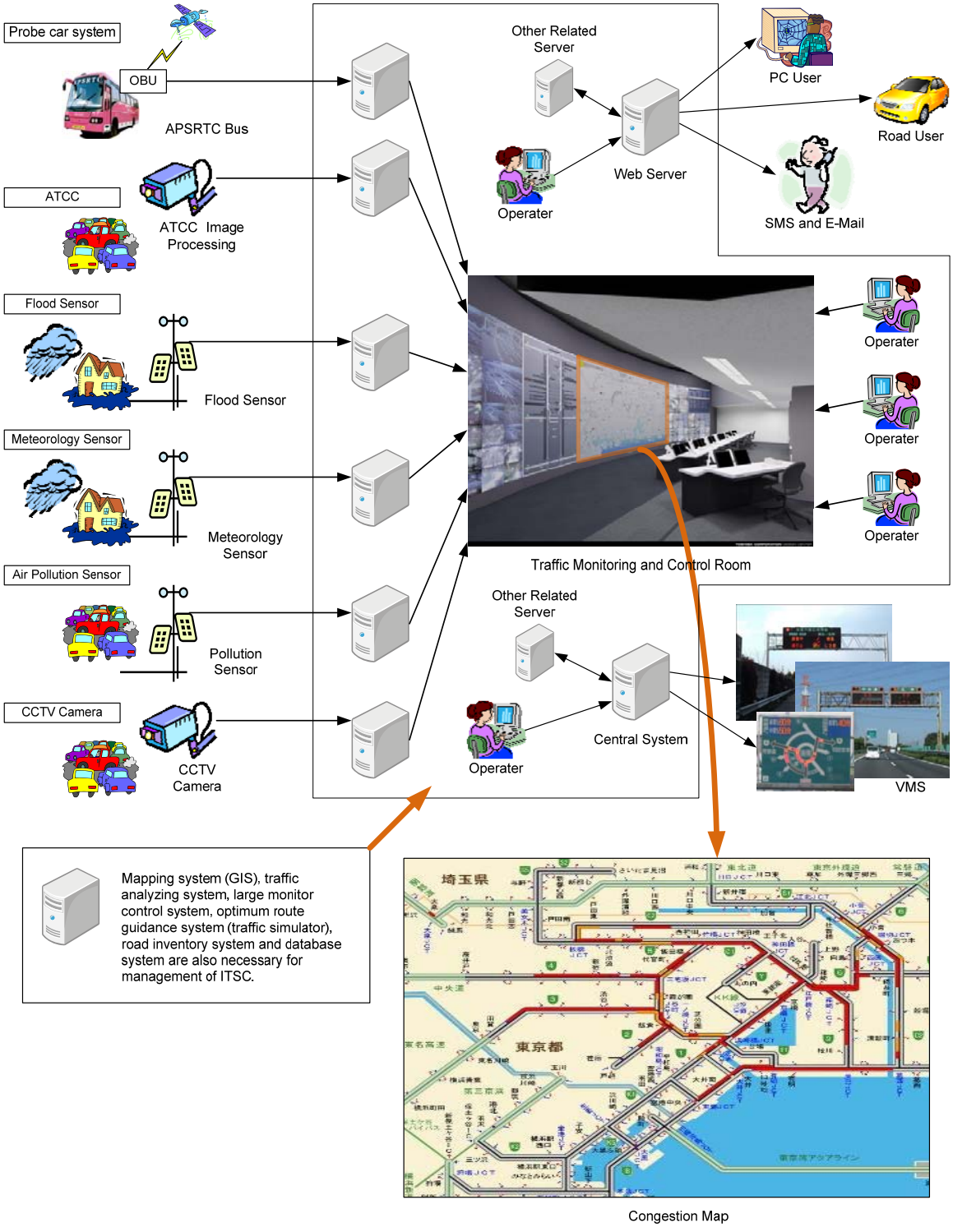
(9) Centre System

The Centre System will be prepared in order to monitor the traffic condition on the road, and control the traffic and manage the roadside equipment. It includes:

- Centre systems for the data collection which are broadly divided into measurement equipment and CCTV.
- Central processing units which include analysis of the traffic, mapping system which maps the collected data and Geographical Information System (GIS).
- Centre systems for information provision which includes SMS, Internet and VMS and etc.
- Diagnostic and control system for the road-side equipment. A video wall system is prepared for monitoring, by the large display board, the status of the congestion in the city which is measured by the sensors and conditions at site which is captured by the CCTV along the roadside. The monitor is used for sharing the information amongst the staff at

the centre.

The figure below shows the image of the centre side system of ITSC. (It should be noted that the figure does not include the components which are to be prepared in Phases -2 and -3.)



Source: JICA Study Team

Figure 143 Example: Image of Centre System

(10) Other System which will be deployed in the future

(a) ERP

ERP is a method for electronically collecting toll charge for the purpose of traffic demand management. It is a usage-based taxation mechanism.

In the case of Singapore, approximately eighty (80) ERP gantries were installed in the city. Additional gantries are installed on the locations where congestion becomes severe, including expressways and other roads depending on the condition.

It consists of ERP gantries located on all roads linking to central areas. They are also located along the expressways and arterial roads with heavy traffic to discourage the road usage during the peak hours if necessary. ERP includes sensors on 2 gantries: one is in front and the other in back. Cameras are also attached at the gantries to capture the rear license number plate of the passing vehicles.

The ERP system is proposed in Phase-3 in the ITS Master Plan.

Source: LRT Website, Singapore

Figure 144 Example: Image of ERP

(b) Lane Control System (A Reversible Lane)

Traffic demand of the road changes depending on time of day. Reversible lane control is used to dynamically maximise the capacity of the road infrastructure. It shifts the median or changes the direction of one-way road in accordance with the traffic demand to reduce the congestion.

The lane control system is proposed in Phase-3 in the ITS Master Plan.

Figure 145 Example: Image of Reversible Lane

(c) Parking System

Parking System provides information on parking availability to drivers before and during their

trip. It also electronically collects the parking charge and stores a usage record of the parking. This contributes to the maximum usage of the parking, preventing fraud and assisting proper parking planning based on area-wise demand.

The parking system is proposed in Phase-3 in the ITS Master Plan.

Figure 146 Example: Image of Information Board of Parking System

(d) Kiosk Terminal

Kiosk terminal is an information terminal equipped with interactive screen. Users can access and retrieve their necessary information by touch panel. It is recommended to install the kiosk terminals at major key locations in the city in the near future.

The kiosk terminal would be installed at locations such as traffic node, metro and railway stations, airport, shopping centres, tourist locations and major public spaces. The purpose of the kiosk terminal varies depending on where it is introduced. It usually provides information such as sightseeing, travel routes, time to destination, office locations and floors in the building, etc.

In general, the kiosk terminal is equipped with the touch panel. The software which controls the touch panel and retrieves the enquired information is installed in the terminal.

The kiosk may be a standalone type, but generally, it is composed of the terminal device, communication line and central monitoring and control system. In this case, central control is possible and managing becomes easier. For example, the central control can remotely monitoring the operation status of the kiosk terminals, retrieving the enquired information from the central server.

(Source: JICA Study Team)

Figure 147 Example: Image of Kiosk Terminals

The kiosk terminal is generally located indoors. This is for assuring the visibility of the monitor to avoid the direct sunlight, protecting the terminal device from rainfall, outside temperature, theft, etc.

The photo show above is a example of Kiosk terminal installed in the Hyderabad Rajiv Gandhi International Airport.

4-5 Deployment Policy for Individual Equipment

The deployment policies for individual equipment are based on the studies so far. The purposes for equipment, installation policies and proposed location maps by phase are described in this section.

It should be noted that the number and location of the equipment in this section may be further adjusted and changed based on more detailed studies in the design stage of the pilot project.

4-5-1 ATCC

(1) Purpose

ATCC will be installed to measure, at cross sections, the traffic volume by vehicle-size, speed and occupancy. The measured data will be utilised for proper traffic management and road operation such as planning/evaluation of road-widening/bypass construction, etc. It will be also utilised for traffic congestion information provision to users.

There are mainly three different types of traffic counters: i) ultra-sonic type, ii) loop-coil type, and iii) image processing type. Due to the absence of lane-keeping discipline in Hyderabad, the image processing type is recommended to be introduced. However, the counting of motorcycles is still difficult for any of these sensors. Thus, the registered number of the motorcycles shall be utilized, and periodic survey be additionally carried out as supplement for proper comprehension of traffic volume.

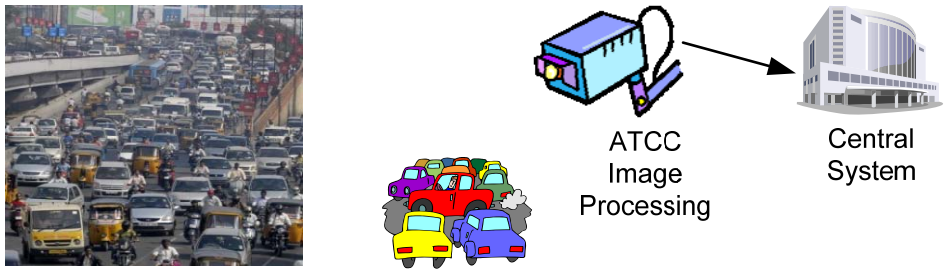


Figure 148 Example: Image of ATCC

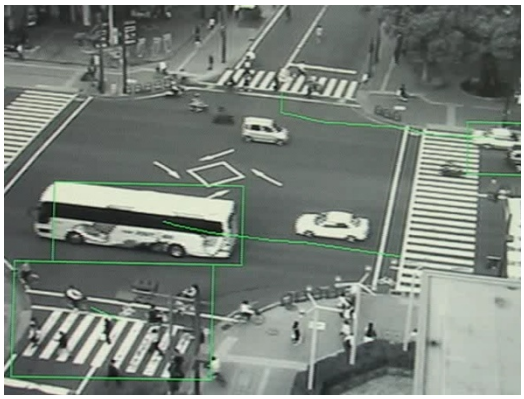


Figure 149 Example: Image of Processing Analysis for Traffic Measurement

(2) Installation Policy

(a) Phase-1

ATCC will be placed in the middle of each “section” of the Principal Roads of the city, which are: National Highway NH-44 (old NH-7), NH-65 (old NH-9) and NH-163 (old NH-202) within Hyderabad Metropolitan Area), IRR and State Highways (SH-1, SH-2, SH-4, SH-5 and SH-6). The

section is the length between the junctions of these major roads. By placing the counters in accordance with this policy, it will be possible to measure the traffic condition by section. The major roads are selected because of their scale of traffic volume in the Hyderabad Metropolitan Area.

(b) Phase-2

ATCC will be placed in the middle of each section of the Distribute Roads, which are Radial Roads, and Major Link Roads connecting the principal roads and distribute roads. This will cover the traffic on the secondary level road network in the Hyderabad Metropolitan Area.

(c) Phase-3

1) Inside IRR:

ATCC will be placed in the middle of each section of the Link Roads, which have not been covered in Phase-2 and major Residential Roads.

2) Outside IRR:

ATCC will be placed in the middle of each section of Radial Roads, which have not been covered in Phase-2, and Link Road connecting these radial roads. This will cover almost all traffic in the Hyderabad Metropolitan Area.

3) Note:

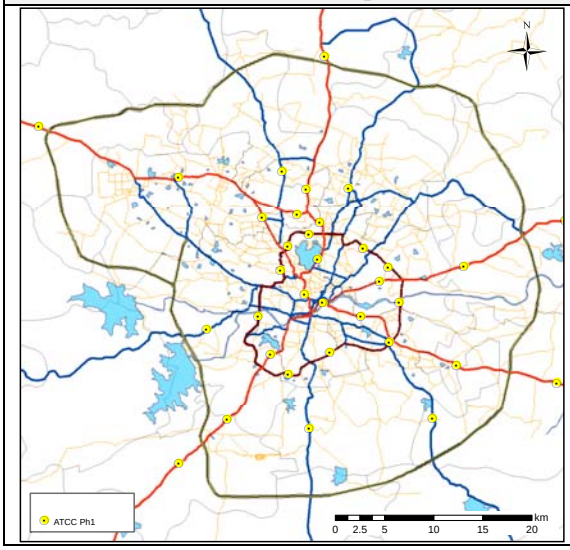
It is required to place the counters at the interval of 500 m in order to measure the congestion length in more detail. However, it would not be appropriate to simply apply this policy across the entire stretch in the Hyderabad Metropolitan Area for the following reasons:

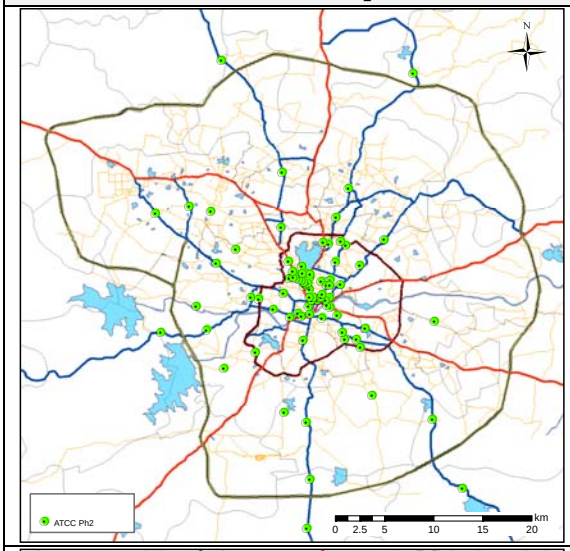
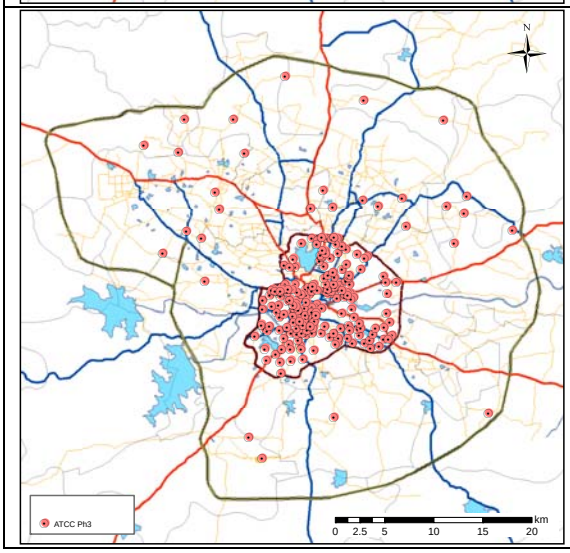
- Road infrastructure is not properly constructed and the installation may not be possible at many of the locations.
- The cost will become unnecessarily high. Thus, the installation span shall be further identified in Phases -2 and -3 after proving certain level of effectiveness after Phase-1.

(3) Location Plan

The proposed location maps by phase are as shown below.

Table 57 Proposed Location Map of Roadside Equipment (ATCC)

Location Map	Policy
	<PHASE-1> ATCC will be placed in the middle of each section of the National Highway NH-44 (old NH-7), NH-65 (old NH-9) and NH-163 (old NH-202), IRR and State Highway to measure the traffic condition by section. 34 locations will be identified and 2 sets at one location will be placed. Thus, 68 units at 34 locations will be placed in Phase-1.

Location Map	Policy
	<PHASE-2> ATCC will be placed in the middle of each section of the State Highway, the Radial Road and Major Link Roads connecting the principal roads. It will cover the traffic on the secondary level road network in the Hyderabad Metropolitan Area. ATCC of 170 units at 85 locations will be placed in Phase-2. The cumulated number is 238 units.
	<PHASE-3> Inside IRR: ATCC will be placed on the Link Roads, which have not been covered in the Phase-2, and major Residential Roads. Outside IRR: It will be placed on the Radial Roads, which have not been covered in the Phase-2, and Link Road connecting these radial roads. / These will cover almost entire traffic inside ORR Area. / ATCC of 454 units at 227 locations will be placed at Phase-3. The cumulated number is 792 units.

(4) Example Configuration

The example configuration of equipment is as follows:

- Assuming 2 sets of ATCC at each location for monitoring both inbound and outbound traffic
- 2 image sensors for 1 place
- 2 processing units for 1 place
- 1 local control unit including control switch and communication unit for 1 place
- 1 backup power supply system for 1 place
- 1 central monitoring system at ITSC
- 1 supporting pole and foundation for 1 place
- Use optical fibre cable and/or GPRS for communication

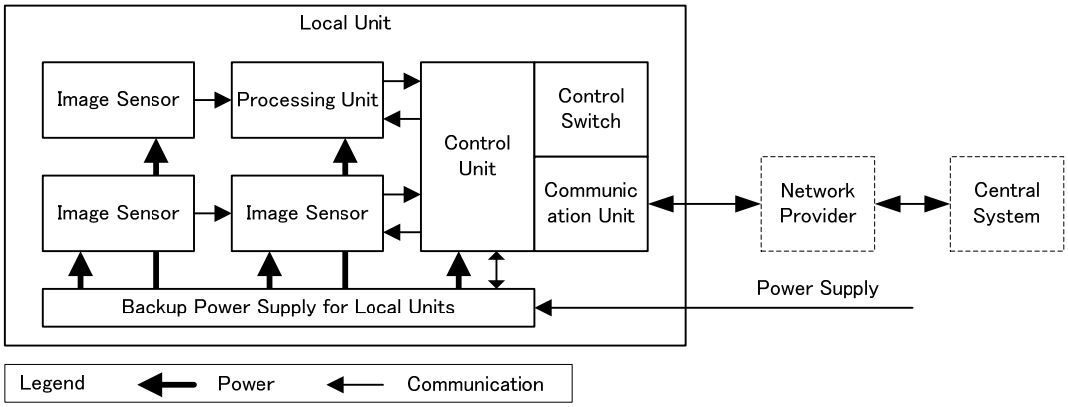


Figure 150 Example: Image of ATCC Local Unit

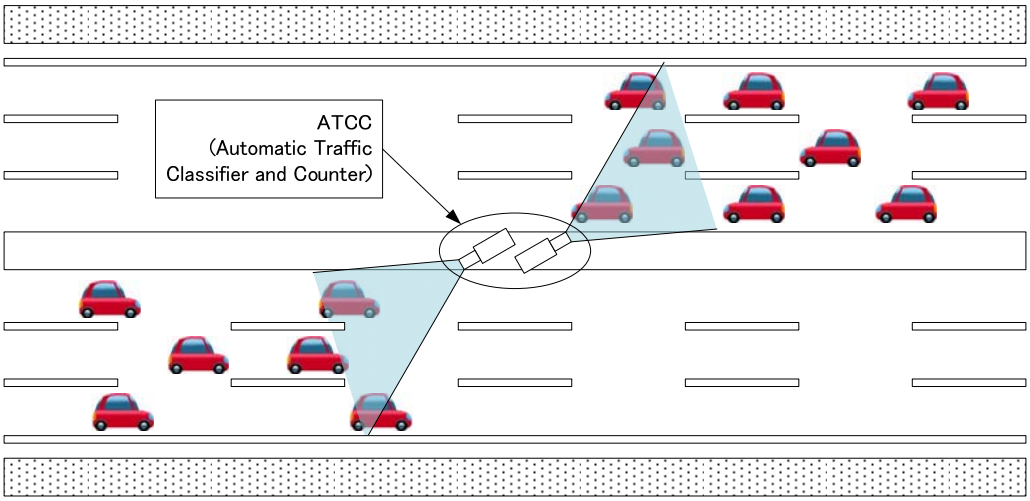


Figure 151 Example: Image of ATCC Installation Image

4-5-2 Probe Car System (Floating Car)

(1) Purpose

Probe car (floating car) system will be introduced for area traffic measurement. The GPS unit mounted on the vehicle measures the location of the vehicle (i.e., latitude, longitude, altitude and time stamp of the record). The measured data is transmitted to the centre via GPRS network. It will allow comprehending the average traffic speed, in turn, the level of congestion by section by aggregating the data obtained from each of the vehicles.

It is not economically viable to install the traffic counter over large area on roadside in the city. However, the probe system can be prepared at much lower cost because the roadside equipment is not required. However, the traffic volume at cross sections cannot be measured by the probe system. Thus, the traffic will be measured by combination of the probe system and traffic counter.

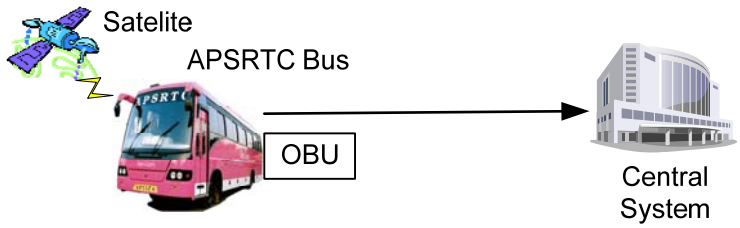


Figure 152 Example: Image of Probe Car System

(2) Particular Condition to Be Noted

The more vehicles are mounted with GPS device (called probe car), the more accurate congestion information will be obtained. However, it is difficult to specifically identify how many vehicles are required. In theory, it would be sufficient to refresh every 5 minute from the data recorded every 10 seconds on the vehicle which is sent to the centre every 1 minute. For example in case of 1000 vehicles, the traffic to be measured covers 30,000 data points (60 sec/10sec*5min=30 data points. 30 data points*1000 vehicles=30,000 data points). In practice, the accuracy depends on the number of the vehicles which are in every road section, and the existence of the probe cars to evenly cover all the areas.

(3) Installation Policy

(a) Phase-1

In consideration of above, the public buses operated by APSRTC are selected for the Phase-1. Approximately 1,347 buses are in operation in the city and their service areas cover nearly all areas of the Hyderabad Metropolitan Area. APSRTC is planning to prepare the bus location system installing the GPS devices together with other equipment (e.g. information board at the bus stops) under the JNNURM scheme. The GPS devices will be installed on 1,347 for city buses.. It will be prepared within one year. Thus, the probe data collected from each bus by APSRTC will be transmitted to ITSC and utilized as input data.

(b) Phases -2 and -3

As described above, the measurement result will become more accurate as the number of probe cars increases. Thus, the type of probe car will be expanded to other modes of transport which include: taxies, commercial vehicles (trucks, DHL cars), public owned cars, etc.

Table 58 Proposed Policy of Roadside Equipment

Phase-1	Phase-2	Phase-3
・ 1,347 Units by APSRTC Bus	・ Remaining APSRTC buses ・ Taxi Probe ・ Freight / Commercial Vehicle Probe ・ Public Car Probe	・ Extension of Phase-2 (Taxi, Freight / Commercial Vehicle and Public Car Probe) ・ Mobile based human tracking system in future

(4) Example Configuration

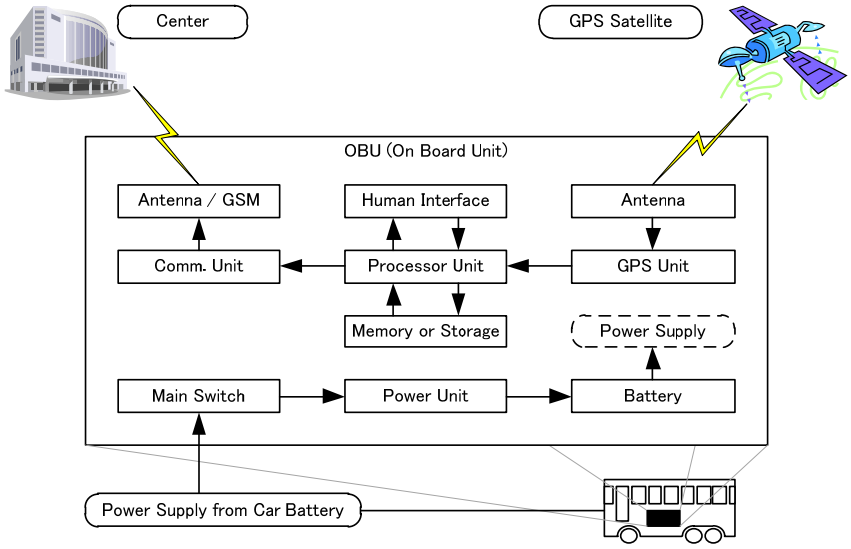


Figure 153 Example: Image of Car Probe Installation Image

The example configuration of equipment is as follows:

- Assuming 1 set of OBU (On Board Unit) at 1 Vehicle for monitoring Vehicle Location
- 1 GPS sensor in 1 OBU
- 1 communication unit in 1 OBU
- Man-Machine interface for operation of OBU
- DC12/24V power supply available
- WAAS available
- Time based measurement and distance based measurement available
- Local memory for buffering and measuring data
- Availability of data transmission
- Self-check available
- Battery for maintaining stored memory

4-5-3 Flood Monitoring System

(1) Purpose

The flood monitoring system is to measure flooding situations on the roads and provide warning alert to the drivers through VMS and other information devices. The system will be introduced in the Project with following objectives:

- To detect and measure flooding situations on the roads in Hyderabad Metropolitan area
- To provide waterlogged information and alerting signals to road users so that drivers can avoid such flooding area
- To utilize measured data for road facility improvement planning such as road drainage rehabilitation, etc.
- To share the above waterlogged information with road planning agencies (GHMC, R&B and HGCL/HMDA), road operators and traffic police.

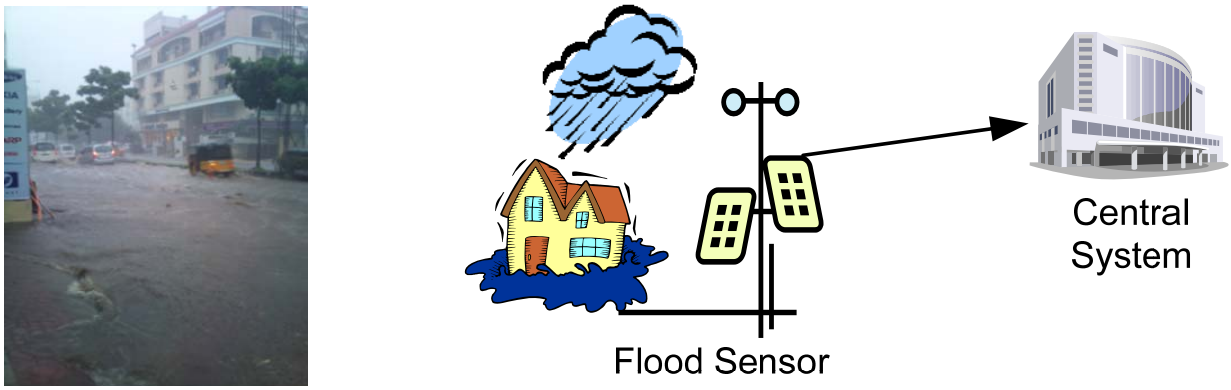


Figure 154 Example: Image of Flood Sensor

(2) Installation Policy

The flood monitoring sensors will be located at waterlogged areas in Hyderabad Metropolitan Area identified by Hyderabad Traffic Police.

(a) Phase-1

According to the website of Hyderabad Traffic Police, around 125 flooding prone spots in the city are identified. In the newspaper on 29th May 2011, 14 areas among them were shortlisted as the most troublesome and demanding immediate action. Thus in Phase-1, the flood monitoring sensors will be installed at 14 water logging spots mentioned above.

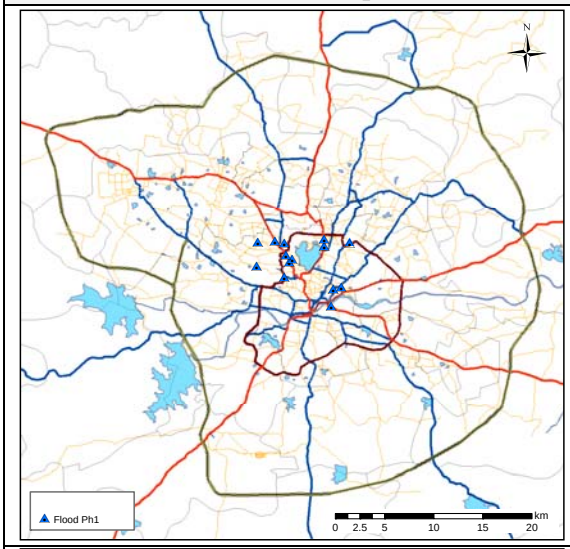
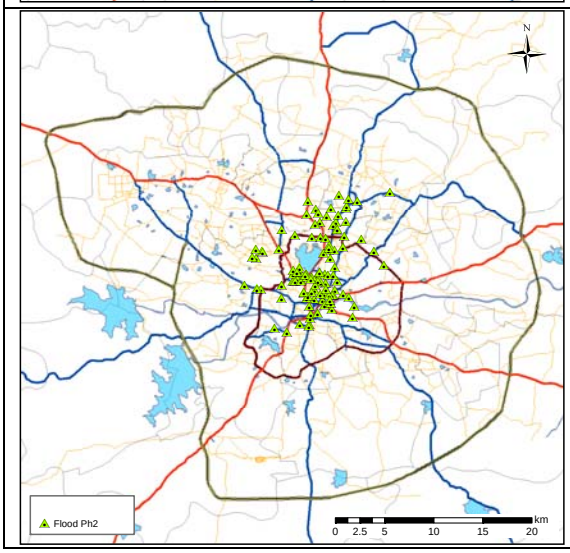
(b) Phase-2

In phase-2, installation of flood monitoring sensors will be expanded over all of 125 waterlogging spots identified by Hyderabad Traffic Police.

(3) Location Plan

The proposed location maps by phase are as shown below.

Table 59 Proposed Location Map of Roadside Equipment (Flood Sensor)

Location Map	Policy
	<Phase-1> According to the Traffic Police, 125 flood points in total including 14 serious points were identified and provided by the website. The flood monitoring sensors will be installed at 14 serious water logging locations in Phase-1.
	<Phase-2> The flood monitoring sensors will be installed at the remaining 111 water logging locations identified by Hyderabad Traffic Police. The cumulated number is 125 units.

(4) Example Configuration

The example configuration of equipment is as follows:

- Assuming 1 flood sensor (water depth gauge) for each place
- 1 alarm local control unit including control switch and communication unit for 1 place
- 1 backup power supply system for 1 place
- 1 central monitoring system at ITSC
- 1 supporting pole and foundation for 1 place
- Use optical fibre cable and/or GPRS for communication

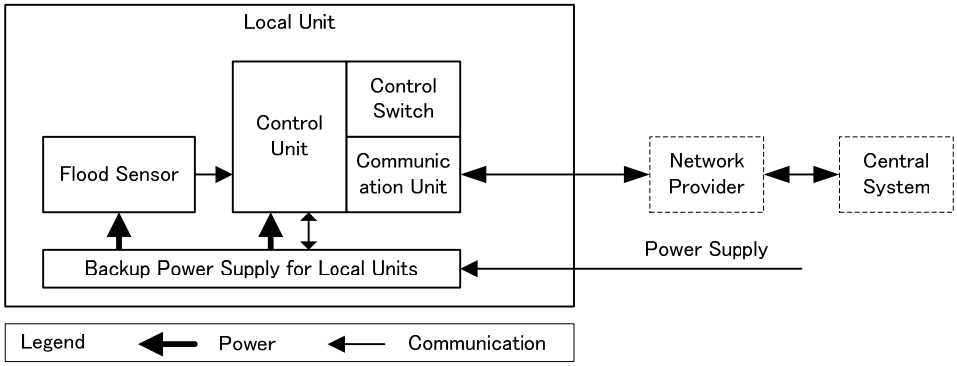


Figure 155 Example: Image of Flood Sensor Local Unit

4-5-4 Meteorological Sensors

(1) Purpose

The meteorological monitoring system is an indispensable system to measure weather conditions, take appropriate countermeasures in bad weather conditions, and provide warning information to drivers. The system shall be introduced in the Project with following objectives:

- To measure weather conditions including rainfall, temperature, wind velocity/direction and visibility on the roads in Hyderabad Metropolitan area.
- To utilise measured meteorological data as a parameter for taking appropriate countermeasures such as road closure, etc. in case hazardous weather condition is detected.
- To provide the weather information to road users through information provision systems in order for them to take necessary precautionary measures.
- To share measured meteorological data with alerting signals among road operators and traffic polices, etc.

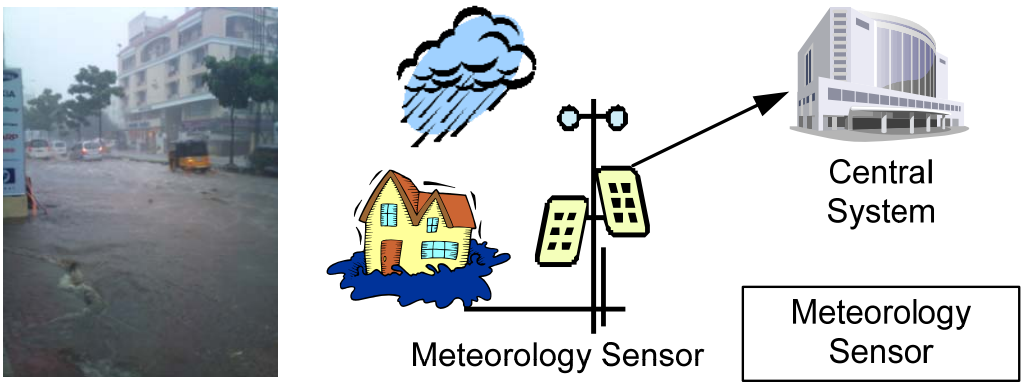


Figure 156 Example: Image of Meteorological Sensors

(2) Installation Policy

The meteorological monitoring sensors will be located at roadside in accordance with following criteria to meet the system objectives and requirements above.

- Generally the meteorological sensors must be located to cover a certain catchment area for measurement and identification of localized torrential rain. According to practices and experiences in Japan, the catchment area is normally set up around 300 sq. kilometres (equal to radius of 10 km). Thus, it is assumed that 10 meteorological sensors would be

placed to cover entire Hyderabad Metropolitan Area.

- Four (4) meteorological sensors will be prepared by the ORR ITS Project, as one of the components of the Highway Traffic Management System (HTMS). These locations are excluded from the scope of this Project. Thus, six (6) sensors will be prepared by the project.

It is planned to cover all HMA area by which every sensor covers the circle of 20 km diameter. Thus, 10 sensors will be necessary including 4 sensors which will be prepared by the ORR ITS Project. The proposed location maps are shown below.

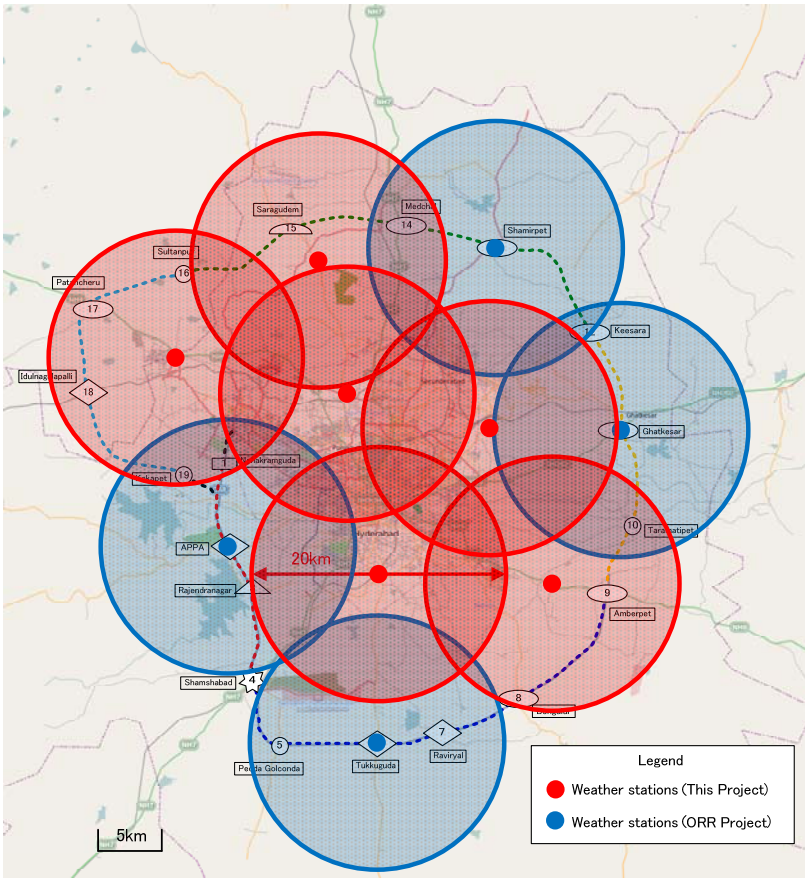


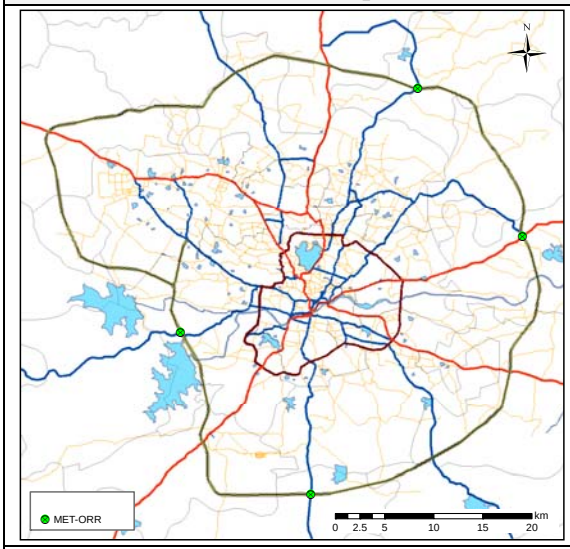
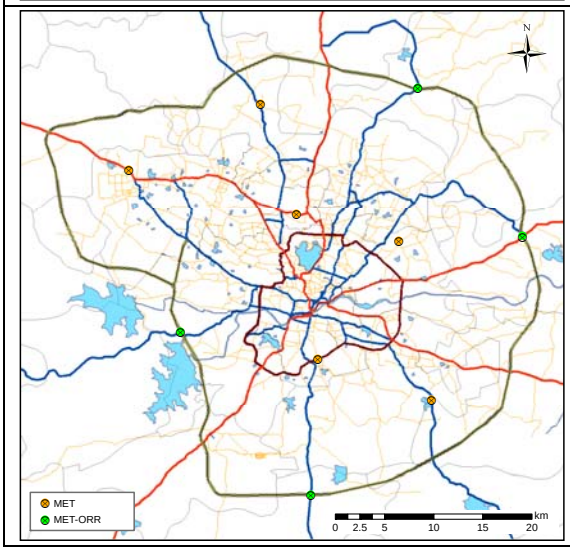
Figure 157 Example: Image of Concept of Location Plan for Meteorological Sensors

Note: After meteorological data received from the related agencies is evaluated, the installation policy may be altered.

(3) Location Plan

The proposed location maps by phase are as shown below.

Table 60 Proposed Location Map of Roadside Equipment (Meteorological Sensor)

Location Map	Policy
	<Prepared by ORR ITS Project> 4 units will be prepared by ORR ITS Project, as one of the components of Highway Traffic Management System (HTMS). These locations are shown in the figure left.
	<Phase-1> It is planned to cover all HMA area by which every sensor covers the circle of 20 km diameter. 10 sensors will be necessary including 4 sensors which will be prepared by ORR ITS Project. Thus, 6 units will be placed by this Project in Phase-1. These locations are shown in the figure left.

(4) Example Configuration

The example configuration of equipment is as follows:

- Assuming 1 meteorology unit including following 5 sensors at each place
  - ✓ 1 thermometer sensor
  - ✓ 1 rain gage sensor
  - ✓ 1 rainfall detector sensor
  - ✓ 1 vane anemometer sensor
  - ✓ 1 visibility meter sensor
- 1 meteorological observation station including local control switch and communication unit for 1 place
- 1 backup power supply system for 1 place
- 1 central monitoring system at ITSC
- 1 supporting pole and foundation for 1 place
- Use optical fibre cable and/or GPRS for communication

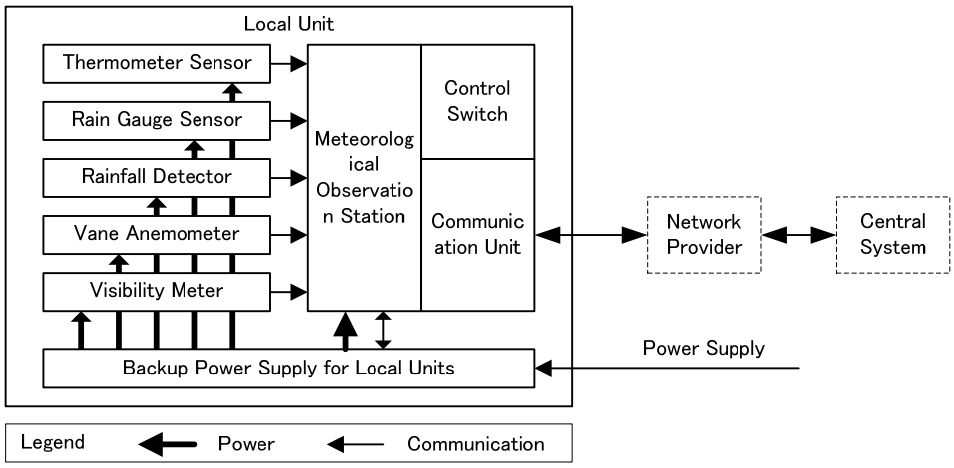


Figure 158 Example: Image of Roadside Unit of Meteorological Sensor

4-5-5 Air Pollution Sensor

(1) Purpose

The air pollution sensor is an important component. There are two main concepts of measurement of air pollution. One is to comprehend overall condition of pollution covering wide area. The other is to measure local pollution level in the locations such as pollution-sensitive places, road side, etc. The air pollution sensor in ITS Master Plan for HMA is proposed based in the former concept. The system will be introduced in the Project with the following objectives:

- To measure air pollution conditions including NOx, SOx, COx in Hyderabad Metropolitan area.
- To utilise measured pollution data as a parameter for taking appropriate countermeasures.
- To provide the pollution information to road users through information provision systems in order for them to take necessary precautionary measures.
- To share the measured pollution data for alerting signals among the road operators and traffic police, etc.
- To evaluate improvement of the condition of air pollution by alleviating traffic conditions.

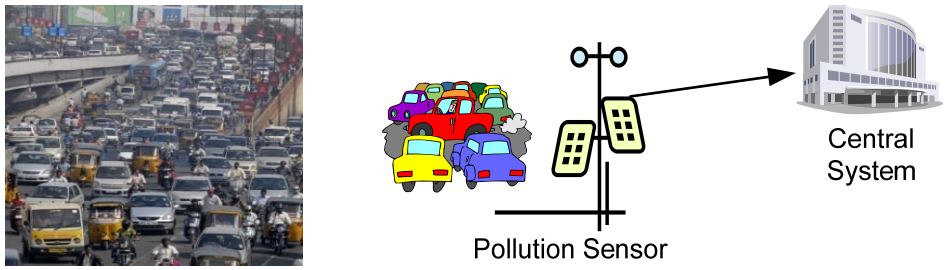


Figure 159 Example: Image of Pollution Sensors

(2) Installation Policy

Air pollution sensors will be located at same location as the meteorological sensors. Thus 10 meteorological sensors will be placed to cover the entire Hyderabad Metropolitan Area.

(a) Phase-1

It is proposed to prepare 10 units in Phase-1 to cover the entire Hyderabad Metropolitan Area.

(b) Phase-2

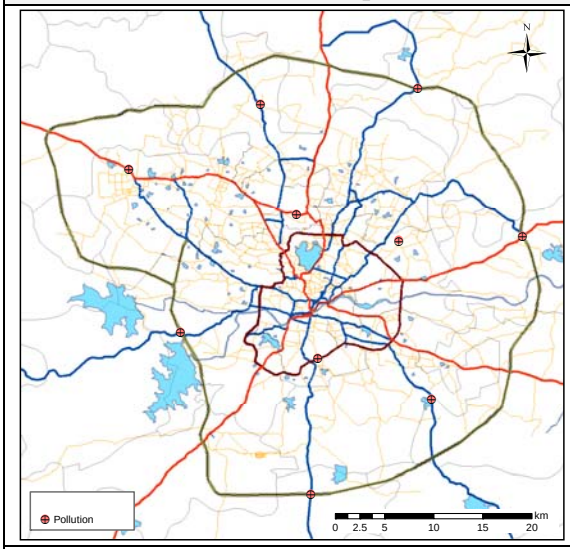
No more air pollution sensors are planned in Phase-2.

Note: After pollution data is received from the related agencies, it will be evaluated and the installation policy may be altered.

(3) Location Plan

The proposed location maps are as shown below.

Table 61 Proposed Location Map of Roadside Equipment (Air Pollution Sensor)

Location Map	Policy
	<Phase-1> It is proposed to prepare 10 units in Phase-1 to cover the entire Hyderabad Metropolitan Area.
	<Phase-2> It is not planned to prepare more air pollution sensors in Phase-2.

(4) Example Configuration

The example configuration of equipment is as follows:

- Assuming 1 pollution unit including 5 pollution sensor (NOx, SO2, CO, CO2, O2) for each place
- 1 local control unit including control switch and communication unit for 1 place
- 1 backup power supply system for 1 place
- 1 central monitoring system at ITSC
- 1 supporting pole and foundation for 1 place
- Use optical fibre cable and/or GPRS for communication

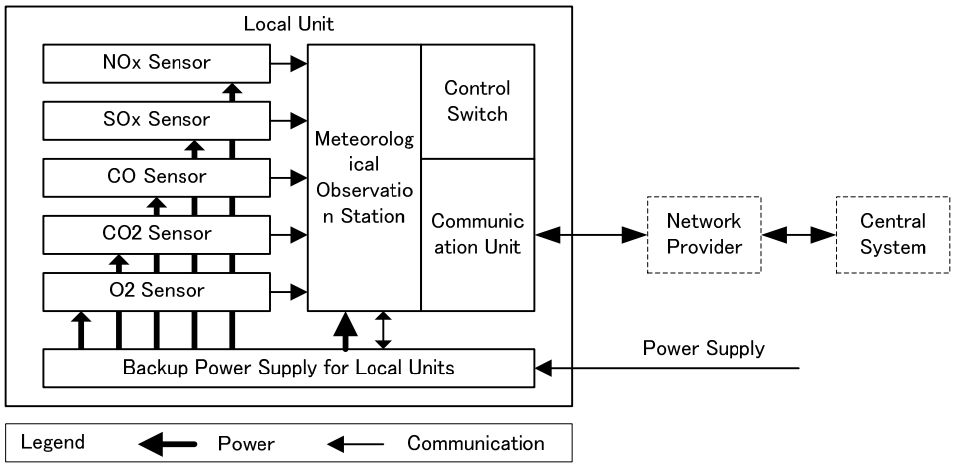


Figure 160 Example: Image of Roadside Unit of Air Pollution Sensor

4-5-6 CCTV Camera

(1) Purpose

CCTV cameras will be introduced for confirmation of conditions at site for traffic and road management with the following purposes:

- To visually monitor road, traffic and weather conditions on major roads in Hyderabad Metropolitan Area from ITSC
- To detect abnormal conditions on the roads within the coverage of CCTV in order to take necessary actions such as lane control, in case of the incidents.
- To confirm the traffic flow on the road using live video images to regulate the traffic by instructing the police at site, providing information to drivers.
- To share live video images among the road operators and traffic police, etc.

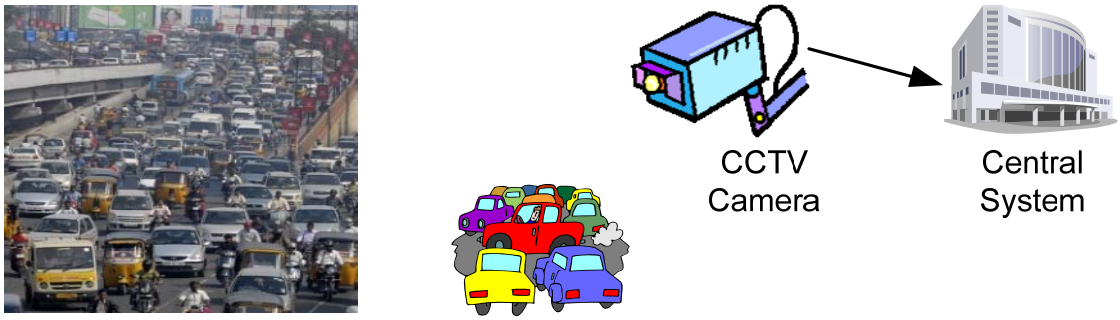


Figure 161 Example: Image of CCTV Camera

Figure 162 Example: Image of CCTV Camera

(2) Installation Policy

(a) Phase-1

It is planned, by Hyderabad and Cyberabad traffic police, to prepare 334 CCTV cameras at the junctions; this work is expected to be completed within one year. Hence the CCTV camera by this project will be prepared at the different locations to fulfil the above purpose as follows:

- They will be placed at the same locations with the traffic counters, which is between junctions, to visually monitor the actual traffic flow.
- They will be placed at the same locations with the flood monitoring sensors to confirm the water logging condition by image.

- Above both are on the assumption that one unit will be placed at one location because the CCTV will have pan, tilt and zoom functions.

(b) Phase-2 and Phase-3

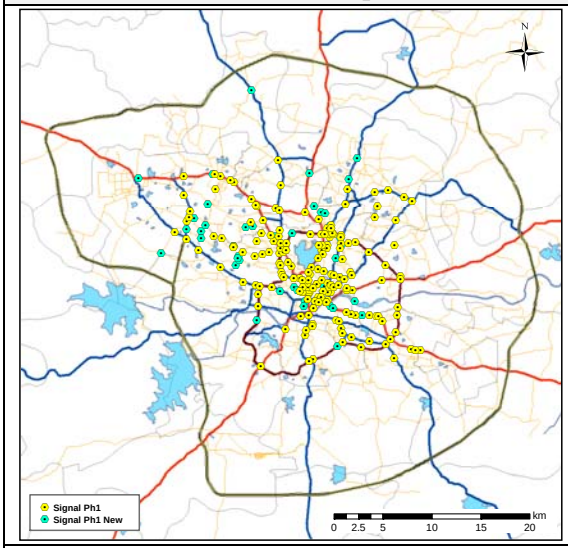
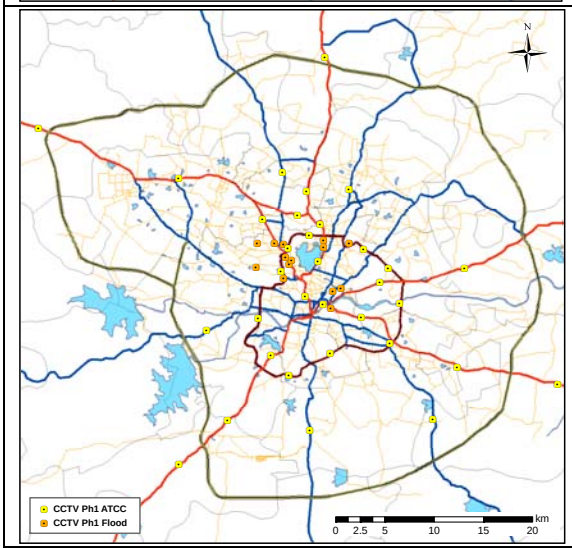
The CCTV cameras will be installed with the following policies:

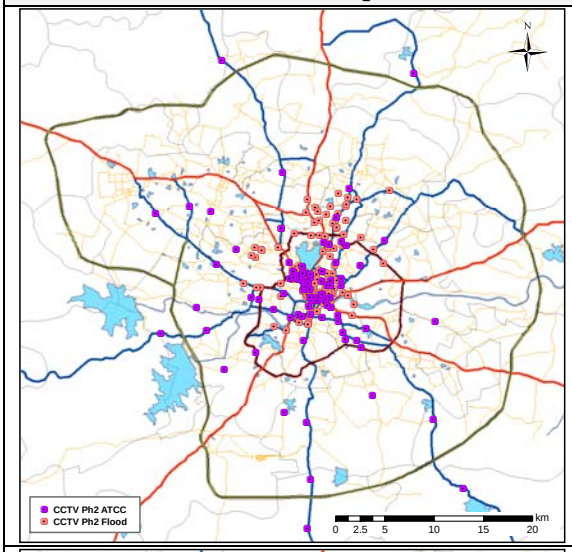
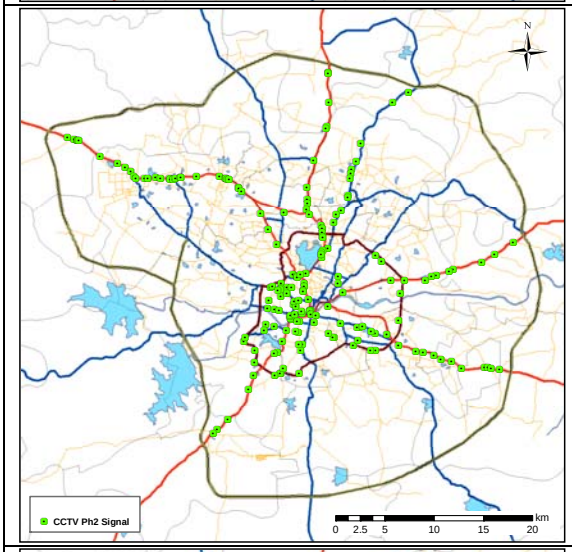
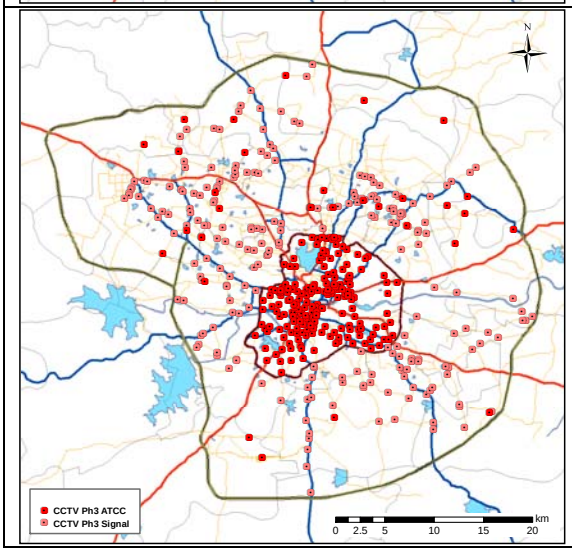
- They will be placed at the same location with the traffic counters prepared in Phase-2/Phase-3.
- They will be placed at the same location with the flood sensors prepared in Phase-2/Phase-3.
- They will be placed at the same location with the traffic signals prepared in Phase-2/Phase-3.
- All items above assume that the CCTV will have pan, tilt and zoom functions to view a wide area.

(3) Location Plan

The proposed location maps by phase are shown below.

Table 62 Proposed Location Map of Roadside Equipment (CCTV)

Location Map	Policy
	<CCTV Prepared by Traffic Police> According to the Traffic Police, 334 CCTV will be prepared by the project of the Traffic Police. They will be placed at the junctions. The exact locations are not clear at the time of preparation of ITS Master Plan. The left figure shows the location of the junctions where the traffic signals will be prepared by the Traffic Police as part of HTRIMS. It is assumed that some of the CCTV may be placed at the locations shown in the left figure.
	<Phase-1> 55 units in total will be prepared by this Project in Phase-1. The breakdown of 55 units is: - 41 units at the same locations with ATCC between junctions to monitor the traffic condition. - 14 units at the same locations with flood sensors to monitor the flood condition.

Location Map	Policy
	<Phase-2> 196 units will be prepared by the Project in Phase-2. The breakdown of 196 units is: - 85 units at the same locations with ATCC between junctions to monitor the traffic condition. - 111 units at the same location with flood sensors to monitor the flood condition.
	<Phase-2> Another 179 units will be prepared by the Project in Phase-2. They will be placed at the same locations with traffic signals to be prepared by the project. This is on the assumption of CCTV with pan, tilt and zoom functions.
	<Phase-3> 449 units in total will be prepared by the Project in Phase-3. The breakdown of 449 units is: - 227 units at the same locations with ATCC between junctions to monitor the traffic condition. - 222 units at the same locations with traffic signals

(4) Example Configuration

The example configuration of equipment is as follows:

- Assuming 1 CCTV camera for each place (pan, tilt and zoom remote operation and auto focus)
- 1 local control unit including control switch and communication unit for 1 place
- 1 backup power supply system for 1 place
- 1 central monitoring system at ITSC
- 1 supporting pole and foundation for 1 place
- Use optical fibre cable and/or GPRS for communication

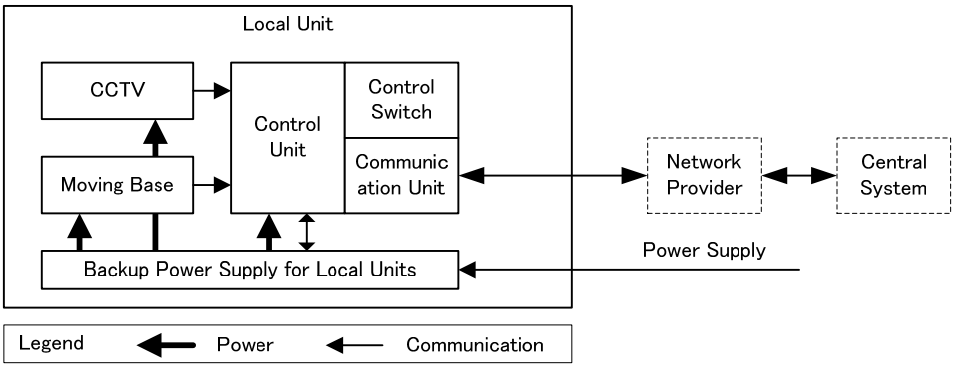


Figure 163 Example: Image of CCTV Local Unit

4-5-7 Variable Message Signboard (VMS)

(1) Purpose

VMS system is to provide the information of road, traffic and weather conditions on the road to the driver. VMS is one of the most effective measures for the information provision since the information can be provided to every road user even when the vehicle and driver has no other devices to collect the information. VMS system is introduced in the Project with following objectives:

- To provide road users with information of road, traffic and weather conditions on the major roads in Hyderabad Metropolitan Area (i.e., National Highways, IRR, etc.)
- To utilize VMS information for diverting driver's travelling route from congested places or the areas under bad weather condition inside the city by providing such information to the drivers in advance who are intending to enter inside the city.
- To control the VMS at ITSC, where all information related to road, traffic and weather conditions are collected, for realizing the objectives mentioned above.
- To apply to VMS to provide the information to every road user without any special user devices.

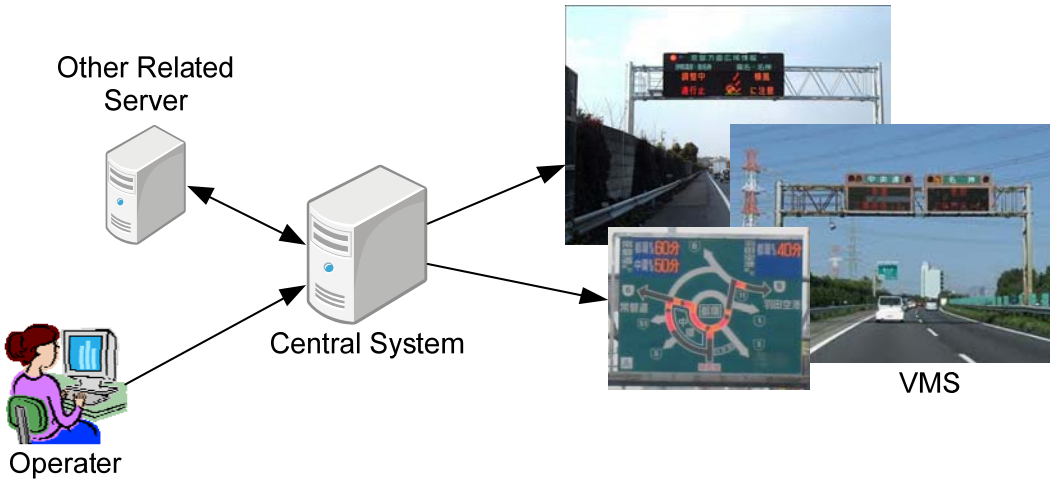


Figure 164 Example: Image of VMS

(2) Installation Policy

The VMS board will be located on the roadside at the location of diversion in accordance with the following criteria to meet the objectives above.

(a) Phase-1

- VMS will be placed at upstream decision location of major junctions and intersections on National Highways in the city area to provide road, traffic and weather information to drivers moving toward the city.
- VMS will be located at upstream decision location of major junctions and intersections on IRR, as well.
- VMS will be located at upstream decision location of all junctions and intersections on radial roads crossing the IRR to provide the information to drivers entering the IRR.
- Installation of VMS on ORR will be excluded from this project since the VMS board on ORR will be prepared within the scope of ORR project. However, road, traffic and weather data exchange between ITSC and Highway Traffic Management System (HTMS)

from ORR project shall be made for realisation of flexible and interactive VMS information provisions each other.

- VMS will be placed at upstream decision location of junctions and intersections on major roads inside Hyderabad Metropolitan Area including road No.2 connecting with IRR and High-Tech city.
- VMS will be located at upstream decision location of junctions and intersections in front of flooding prone areas so that drivers can divert to alternative travelling route when flooding occurs.
- Apart from VMS being planned by this project and ORR project, traffic police will implement 20 sets of VMS under the HTRIMS project. Location of those VMSs implemented by traffic police is not currently clarified. After identifying the locations of VMSs provided by the HTRIMS project, VMS may be cancelled from this project when the locations are overlapping with HTRIMS project.

(b) Phase-2

VMS will be located at upstream decision location of all junctions and intersections on the radial roads crossing ORR to provide road, traffic and weather information on ORR to drivers.

VMS will be basically placed at all upstream decision location of junctions and intersections on the radial roads crossing ORR. However, VMS installed at upstream decision location of junctions and intersections on the National Highways crossing ORR is being implemented by the ORR project. Thus, those VMSs are excluded from the scope of this project.

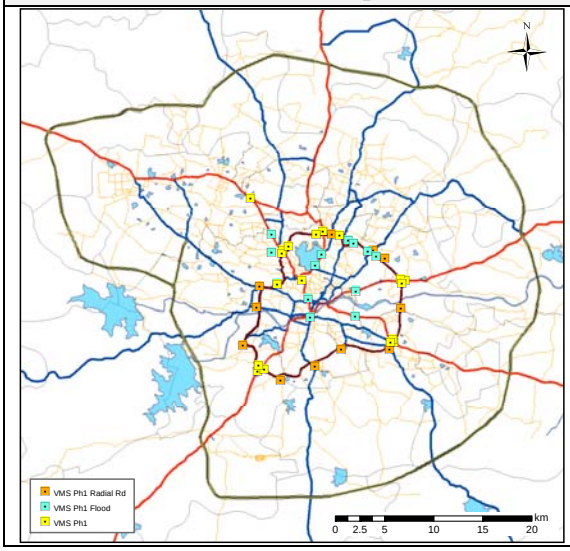
(c) Phase-3

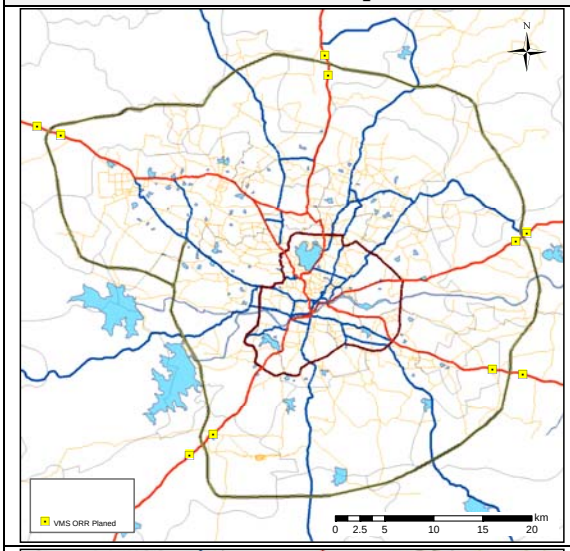
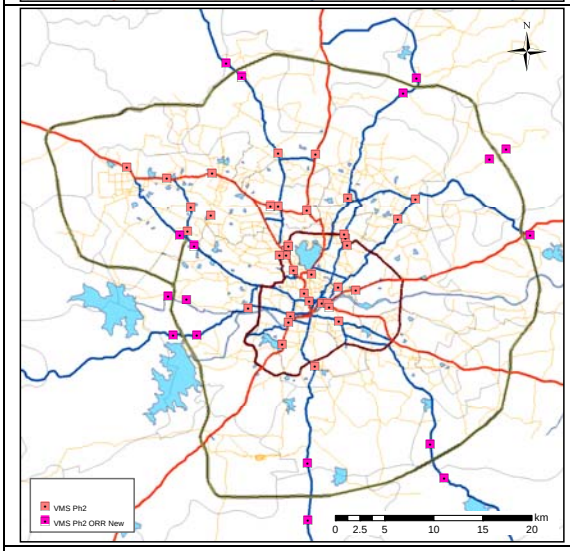
VMS may be further located inside the city for the purpose of information provision related to parking area information, detailed traffic information, or others.

(3) Location Plan

The proposed location maps by phase are shown below.

Table 63 Proposed Location Map of Roadside Equipment (VMS)

Location Map	Policy
	<Phase-1> 42 units in total will be prepared by the Project in Phase-1. The breakdown of 42 units is: - 18 units at the locations of diversion according to the installation policy - 13 units at the locations of diversion before flood prone areas - 11sunits at the locations of diversion of the radial roads

Location Map	Policy
	10 VMS will be prepared by the ORR ITS Project as shown in the left figure. These numbers are excluded from above. Also 20 VMS will be prepared by HTRIMS. The above number (42 units) may be further adjusted and changed, after coordinating with HTRIMS Project.
	<Phase-2> 54 units will be prepared by the Project in Phase-2. The cumulated number is 96 units.
	<Phase-3> It is assumed that approximately 100 units would be prepared in Phase-3. However, the locations of VMS in Phase-3 shall be further investigated in the future because it may include information provision for parking, more detailed traffic information, etc.

(4) Example Configuration

The example configuration of equipment is as follows:

- Assuming 1 VMS board for each place
- Cantilever structure for small VMS and gantries for large VMS
- 1 local control unit including control switch and communication unit for 1 place
- 1 backup power supply system and stabilizer for 1 place
- 1 central monitoring and control system at ITSC
- 1 supporting pole and foundation for 1 place
- Use optical fibre cable and/or GPRS for communication

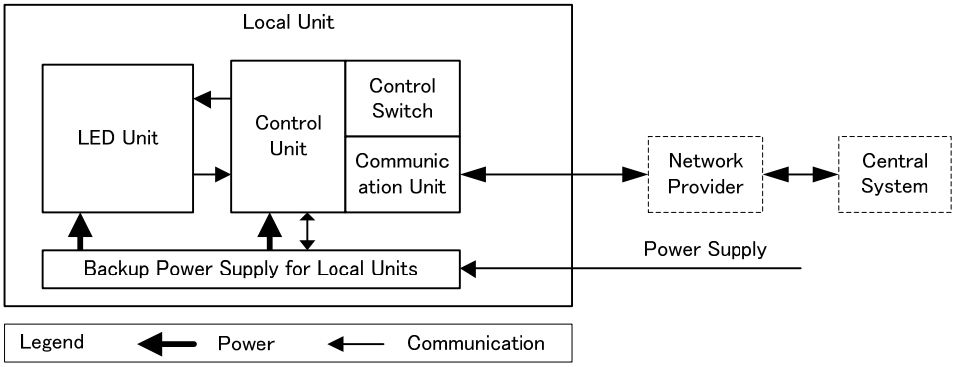


Figure 165 Example: Image of VMS Local Unit

4-5-8 Signal System

(1) Purpose

Traffic signals are used to assure the orderly movement of vehicular and pedestrian traffic, and to prevent excessive delay of traffic flows. They are installed with the objectives of:

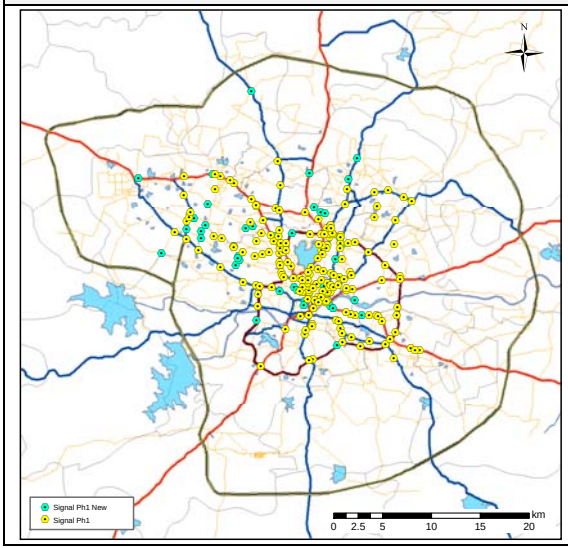
- Assuring the traffic in an orderly manner
- Minimizing delay of the vehicles and pedestrians
- Reducing conflicts with accidents, obstacles, etc.
- Maximizing the capacity of the intersection in each direction

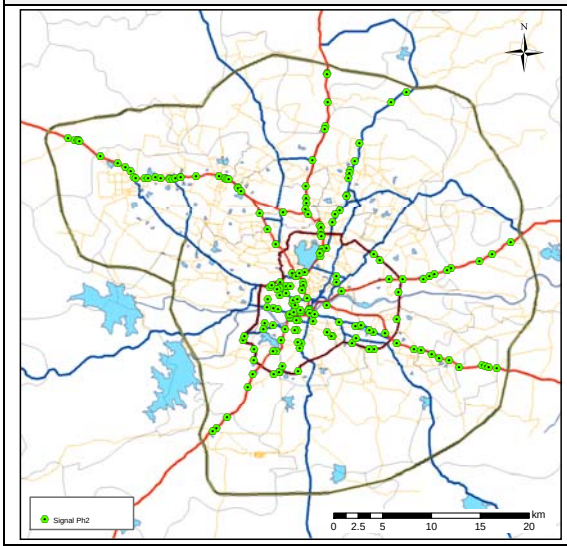
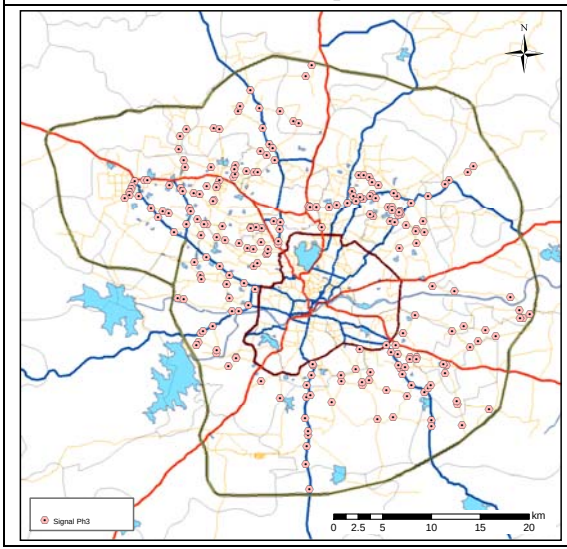
Note: Well-designed junctions are required before the traffic signals are installed to properly utilise the signals and achieve the above objectives. There are a number of such junctions, in Hyderabad Metropolitan Area, which need proper structures constructed to maximise the capacity of the junction and assure the smooth traffic flow by the signals.

(2) Location Plan

The proposed location maps by phase are shown below.

Table 64 Proposed Location Map of Roadside Equipment (Signal)

Location Map	Policy
	<Phase-1: Prepared by HTRIMS> Signals at 221 junctions in total will be prepared by HTRIMS Project. The breakdown of 221 junctions is: - 180 junctions: Replacing the existing signals - 41 junctions: Installing new signals Thus, no signals will be prepared by this project in Phase-1.

Location Map	Policy
	<Phase-2> The location plan for the traffic signal is basically based on the installation policy of the Master Plan described earlier. In this sense, the signals in Phase-2 will cover the important locations on the roads for the installation policy for Phases -1 and -2, which are not covered by the above HTRIMS. Signals at 179 junctions in total will be prepared in Phase-2.
Note: Road and intersections structures such as proper u-turn point, modification of round-about intersections, etc. will be improved as basic conditions for preparation of the traffic signals.	
	<Phase-3> Other major locations in accordance with the installation policy of the Master Plan will be covered in Phase-3. Signals at 222 junctions will be prepared in Phase-3.

(a) Note for pedestrian signals:

The approximate road length in the city is 1,500 km. If pedestrian signals are to be prepared every 1 km at least, 1,500 units will be necessary. handoff these, 622 traffic signals in total from Phases -1 to -3 will be prepared. On the condition that pedestrian signals will be prepared together with traffic signals at these locations, the required remaining number of pedestrian signals will be approximately 900 (1500 – 622).

It is not be practical to prepare these 900 pedestrian signals in the Phase-1, particularly concerning the current conditions of the road infrastructure and the structures of the existing intersections. Thus, they shall be placed in Phases -2 and -3 in accordance with improvement of the infrastructure with around 400 in Phase-2 and 500 in Phase-3 respectively.

(3) Example Configuration

The example configuration of traffic signals is as follows:

- Assuming 4 ways junction
- 2 vehicle signals for 1 way

- 4 lamps for 1 signal (Green, Amber, Red and Right Turn)
- 1 countdown timer for 1 way
- 2 pedestrian signals for 1 way
- 2 lamps for 1 pedestrian signal (Red and Green)
- 2 Vehicle detectors for 1 way
- 1 Local control unit including control switch and communication unit for 1 junction
- 1 backup power supply system for 1 junction
- 1 central monitoring and control system at ITSC
- Use optical fibre cable and/or GPRS for communication

The example configuration of pelican signals is as follows:

- Assuming pelican crossing on a road (not a junction)
- 2 vehicle signals for each place
- 3 lamps for 1 signal (Green, Amber and Red)
- 2 pedestrian signals for 1 place
- 2 lamps for 1 pedestrian signal (Red and Green)
- Local control unit including push button and communication unit for 1 place
- 1 central monitoring and control system at ITSC
- Use optical fibre cable and/or GPRS for communication

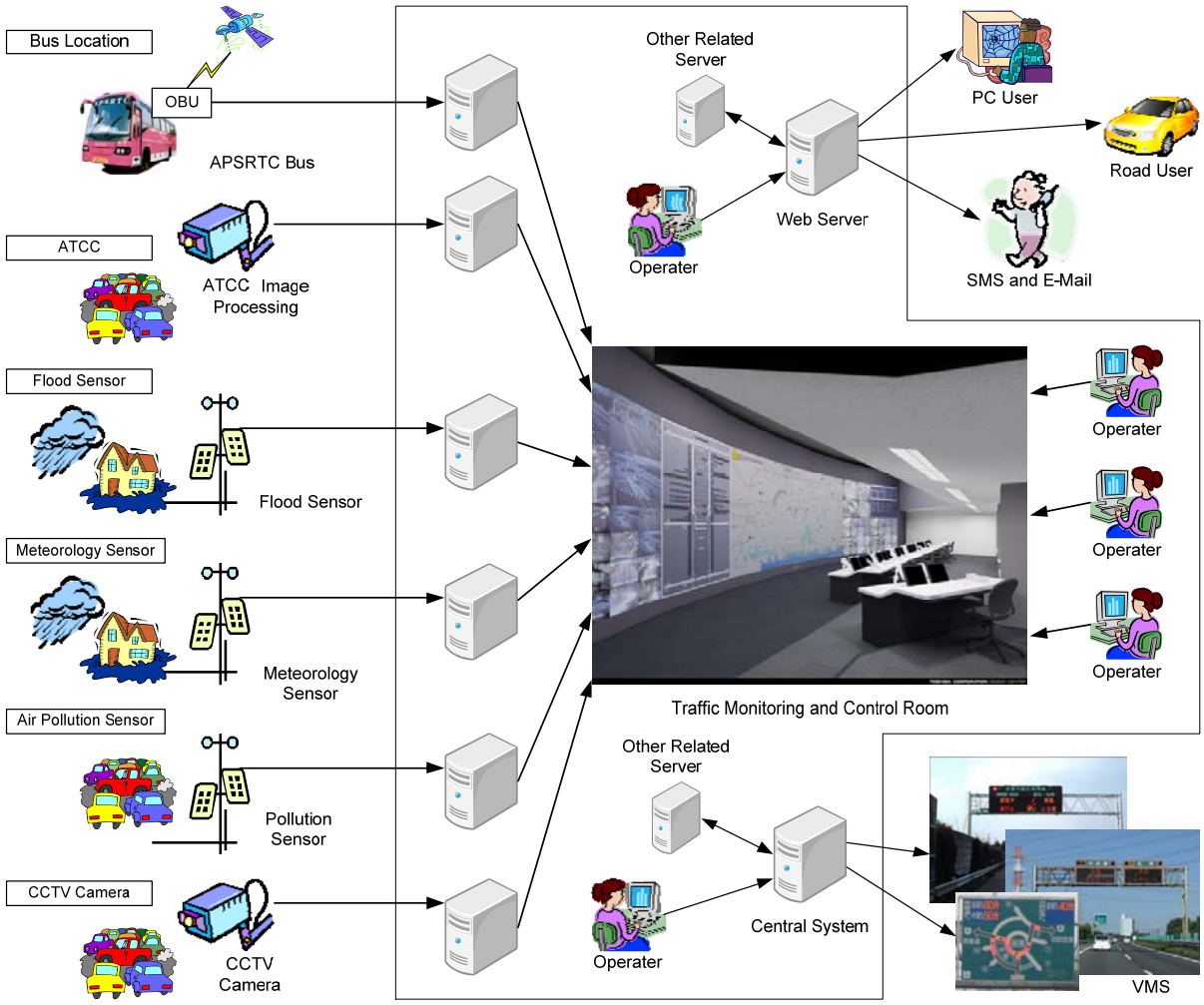
4-6 Centre System

4-6-1 Purpose

The centre system is prepared to encourage data exchange between the sub-system components and manage the total system to realise their functions and achieve the following objectives:

- To collect, manage and integrate all data related to road and traffic conditions, incidents, weather condition and any other necessary data,
- To process, store, record and analyse the necessary data for effective road planning, operation and maintenance,
- To provide the collected and processed information to the road users in order to take notice of the road conditions and/or detour drivers route from the congested area hazardous area,
- To display and monitor the above collected and processed information on realtime basis, and share the information with road planning agencies (e.g. HGCL, HMDA), road operators and traffic police in the Centres, and
- To monitor and manage the sub-system component.

The centre system is divided into the systems for (i) Data Collection Units, (ii) Analysis, (iii) Information Provision Units, and (iv) Traffic Control Units. The image of the central system is illustrated in the Figure below.



Source: JICA Study Team

Figure 166 Example: Image of Central System

The outlines of central system are as follows.

4-6-2 Centre System for Data Collection

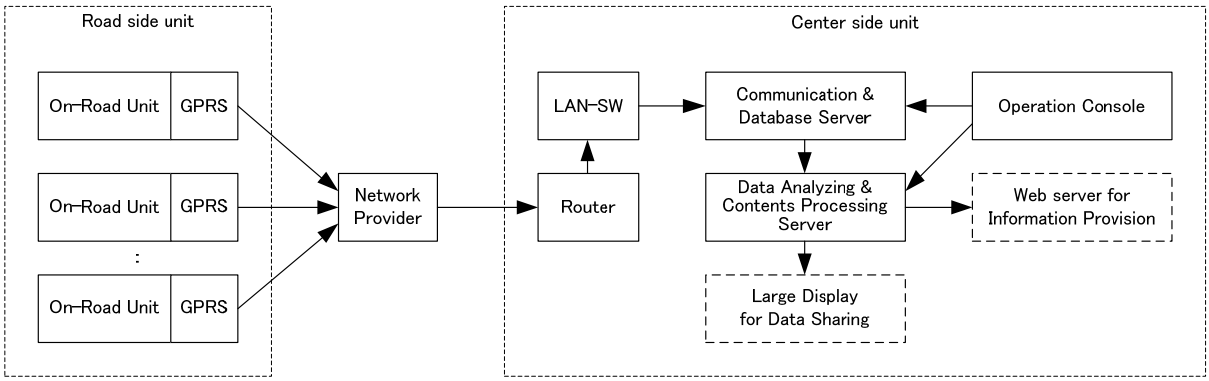
(1) Outline

The centre system for data collection units is prepared to collect the data from the devices and remotely monitor the operation conditions of these devices from the centre. It includes the following devices:

- ATCC
- Probe Car System
- Flood Sensor
- Meteorological Sensor
- Pollution Sensor
- CCTV

(2) System Diagram

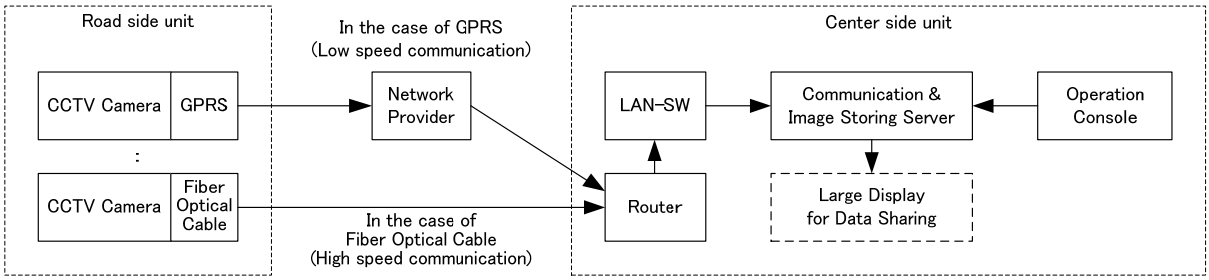
The processor for communicating (data collecting), data storing, data analyzing and contents processing for display are necessary as the centre system of 1-5.



Source: JICA Study Team

Figure 167 Example: Image of Centre System for Data Collecting

The processor for communicating, image storing and displaying are necessary as the centre system of 6.



Source: JICA Study Team

Figure 168 Example: Image of Centre System for CCTV

The network equipments and display units are necessary as common units. The routers and LAN switches for CCTV shall be installed independently from other data collecting system because of high traffic of image data communication.

(3) Example Configuration

The typical specification of the equipment is as follows:

- Assuming 1 router for data communication units and 1 router for CCTV units. Both routers have functions of connecting internet and firewall.
- Assuming 2 LAN switches for the network of data communication and CCTV network.
- Independent servers for each functional unit such as ATCC and flood sensor.
- Several functions are required such as communication, database, data analyzing, contents processing for each functional unit. One or more servers will be required according to its capability. Assumed server is windows server and Linux server.
- UPS and power stabilizers are required.
- Operation console is required.

Table 65 Example: Configuration of Cenre System

Items	Central System	Rough Specification	Remarks
Common System	Network Router: 1	1 Internet port 3 LAN ports	Firewall
	Network Switch: 4	24 port	

ATCC	Server: 1 (*1)	Windows or LINUX (*2)	With operation console.
Probe Car	Server: 1 (*1)	Windows or LINUX (*2)	
Flood Sensor	Server: 1 (*1)	Windows or LINUX (*2)	
Meteorological Sensor	Server: 1 (*1)	Windows or LINUX (*2)	
VMS	Server: 1 (*1)	Windows or LINUX (*2)	
Signal	Server: 1 (*1)	Windows or LINUX (*2)	
CCTV Camera	Server: 1 (*1)	Windows or LINUX (*3)	
	Console: 1	Windows latest version	

*1: The number of the servers will be changed according to their abilities.

*2: The server shall have enough ability to process the required functions such as communication, data collection, data processing, data analysing and contents processing. The console with keyboard and mouse is required. The devices of USB and LAN are required. Enough storage is required for OS, application and data storing.

*3: The server shall have enough ability to process the required functions such as communication, image data storage and image provision.

4-6-3 Centre System for Information Sharing (Video Wall)

The large monitor and associate equipment will be installed for monitoring the status of congestion in the city, which are measured by the sensors, and conditions at site which are captured by the CCTV which is newly installed at critical site. The video wall system is used for sharing the collected information amongst the staff at the centre.

The Figure below shows the image of the video wall system at traffic control centre.

Figure 169 Example: Image of Video Wall System

The typical specifications of the video wall system are as follows:

Table 66 Example Configuration of Video Wall System

Items	Central System	Rough Specification	Remarks
Video Wall System	Large Monitor 20 (=4x5)	55’ HDTV	
	Matrix Switch: 1	Input: more than 16 ports Output more than 16 ports	Full Matrix

Items	Central System	Rough Specification	Remarks
	Image Controller: 1	Input: more than 16 ports Output more than 16 ports	With operation console.

The Figure below shows a basic component of the video wall system with the associated units.

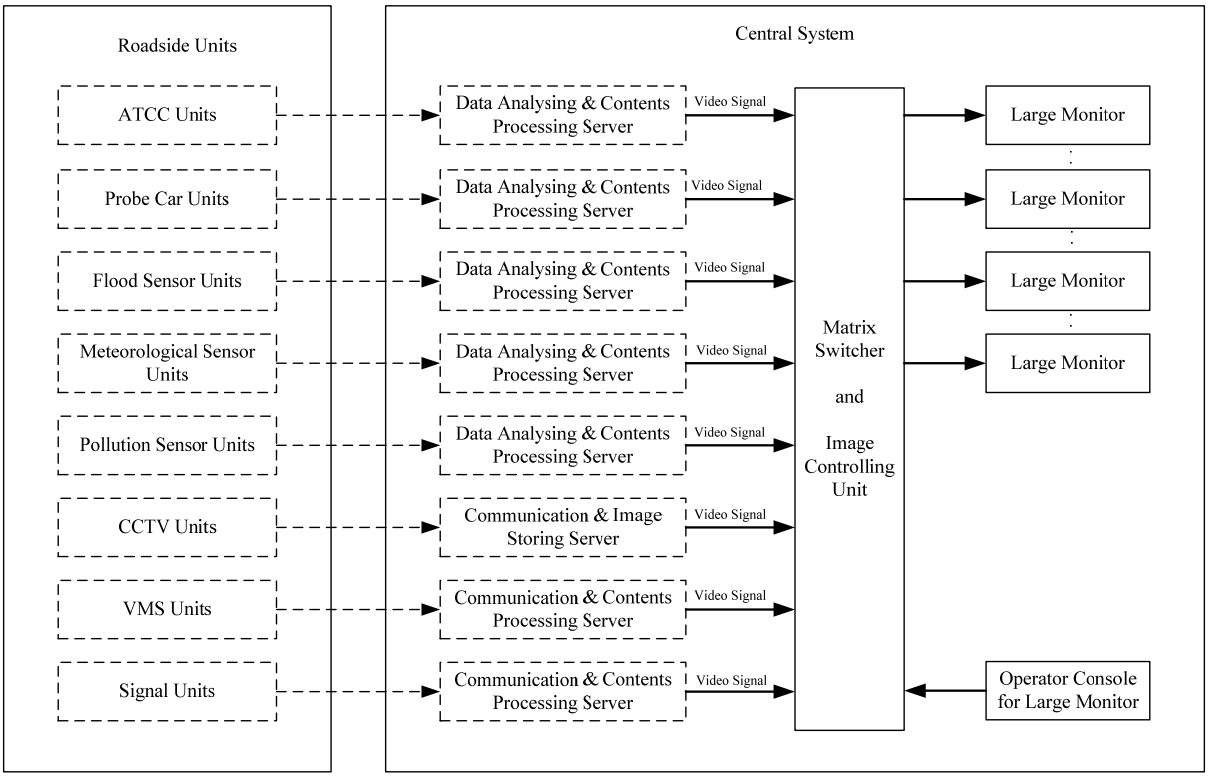


Figure 170 Example: Basic Components of Video Wall System

4-6-4 Centre System for Analysis

The centre system for analysis is prepared for processing the collected data, mapping onto the digital road map on the video wall or console, analysing the traffic related data, storing and reporting.

The GIS, Geographical Information System, is a tool for displaying the map and some information to be placed on the map. The GIS will be prepared for storing and analysis for the collected data such as accident, event, festival and disaster and traffic congestion. It is necessary to prepare several licenses of GIS.

In addition to the GIS, the system for data analysis shall be prepared as follows:

- Traffic Analyser
- Road Inventory
- Optimum Route Guidance as Simulator
- Database System for Storing and Analysing Traffic Data, Accident Data and Other Collected Data which includes Flood, Air Pollution, Meteorology, etc.

The Figure below exemplifies the image of the congestion map. It shows the congestion level by the section of the road, by mapping the processed data onto the simplified city road map.

Figure 171 Example: Image of Congestion Map

4-6-5 Centre System for Information Provision

The centre system for information provision units are prepared to provide the collected and processed traffic related information to the users. The traffic related information will be provided to the users through the website and SMS/E-mail. The traffic information and traffic event such as flooded point, accident, and lane closure will be plotted on the simplified map and provided in the form of the website. The major traffic event will also be provided in the form of the simplified message through SMS/E-mail.

- Website
- SMS, E-mail

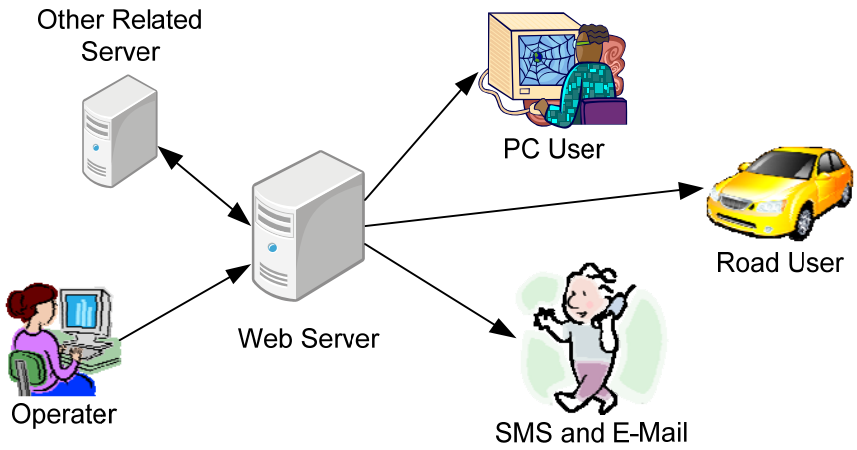


Figure 172 Example: Image of Information Provision System by Website

4-6-6 Centre System of Traffic Control

The centre system for traffic control units are prepared to control and monitor the following devices. The component for VMS will be prepared at centre in Phase-1. Others will be prepared in the following phases in accordance with expansion of the functions of the ITS Centre, as described in the earlier sections.

- VMS
- Signal

- ERP
- Lane Control System
- Parking System

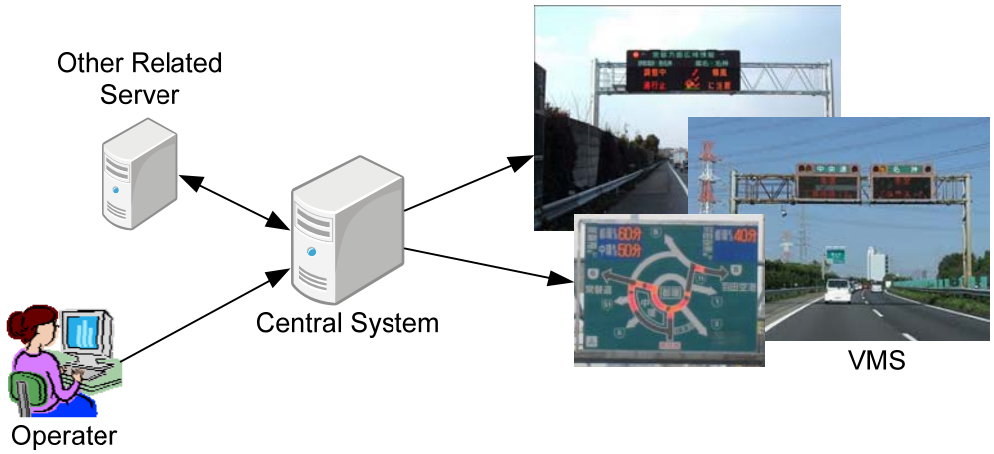


Figure 173 Example: Image of VMS System

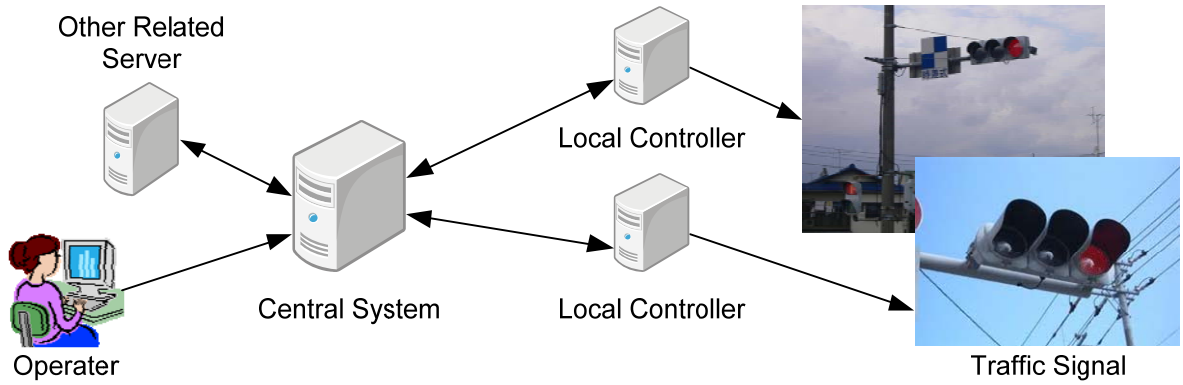


Figure 174 Example: Image of Traffic Signal System

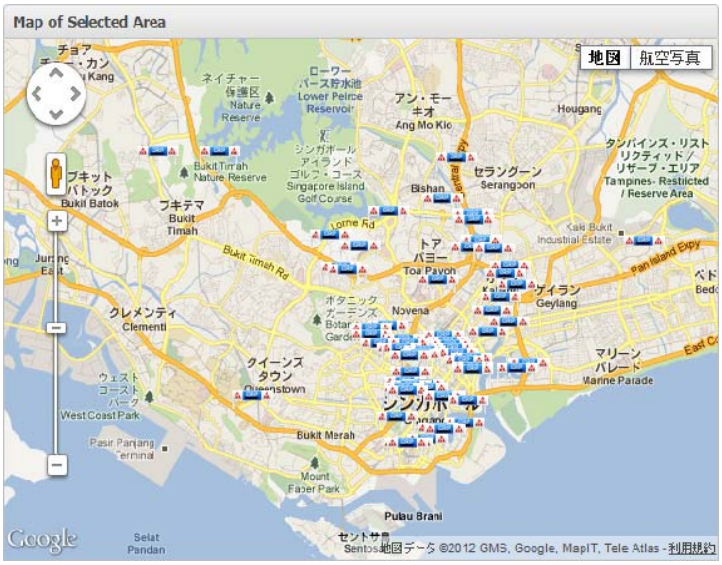
4-7 Other ITS

4-7-1 ERP System

(1) Purpose

The Electronic Road Pricing System, which is referred as ERP system is used for electronically collecting the toll charge from the passing vehicles. The toll charge is dynamically adjusted according to the traffic demand and time. The transport administrator regulates the traffic flow, incoming into the central area of city by imposing the charges on motorists. This is called as 'Traffic Demand Management' (TDM) in transportation terms. This is also introduced for the purpose of fund generation. The ERP is being implemented in the different countries for transportation sector (e.g. road infrastructure development, ITS management etc).

The Figure below exemplifies the locations of the gantries of ERP installed in the city of Singapore.



Source: http://www.sgcarmart.com/news/carpark_index.php?LOC=all&SRH=&TYP=erp

Figure 175 Example: Good Practice of ERP locations at Singapore

(2) Example Configuration

The example configuration of the equipment is as follows:

- Assuming 3 lanes road and only targeted for in-coming vehicle
- 1 local server for 1 place
- 2 Antennas for 1 lane
- 1 CCTV camera for 1 lane
- 1 vehicle detector for 1 lane
- 3 barrier gates for 1 lane
- 1 signal with 2 lamps (red and blue) for 1 lane
- 1 local control unit including control switch and communication unit for 1 lane
- 1 backup power supply system for 1 place
- 1 central monitoring and control system at ITS Centre
- Excluding communication media such as optical fibre cable and GPRS

4-7-2 Lane Control System

(a) Purpose

The traffic demand of the road changes depending on time a day. The lane control system is used to dynamically maximise the capacity of the road infrastructures. It shifts the median or changes the direction of one-way in accordance with the traffic demand to reduce the congestion.

The necessary information for conducting the lane control is exchanged between the ITS Centre and related agencies such as the road administrators and traffic police. The information for the notification of the lane control is provided to the drivers through VMS from the ITS Centre. The lane shift is controlled by the ITS Centre. The historical record of shifting the lane is also cumulated in the server in the ITS Centre and utilised for analysis and planning for improvement of the traffic demand control.

(b) Service Flow

The overall service flow becomes as follows:

1) Reversible Lane Control

- The ITS Centre collects the necessary information for reversible lane control from the road administrators, etc.
- The ITS Centre analyses and processes the collected information from road administrators.
- The ITS Centre sends necessary information to the traffic police when the road capacity becomes saturated.
- The ITS Centre displays the information on VMS for notification to the driver and start controlling the lanes as per police's request.
- The ITS Centre provides the information of the status of the lane to the road administrators and related-agencies.

2) One-way Driving Control

- The ITS Centre collects information of OD and vehicle class through in-vehicle device.
- The ITS Centre analyses and processes the collected information from road administrators.
- The ITS Centre sends necessary information to the traffic police when road capacity become saturated.
- The ITS Centre displays the information on VMS for notification to the drivers and start controlling one-way driving as per police's request. .
- The ITS Centre provides the information of the status of the one-way road to the road administrators and related-agencies.

(c) Example Configuration

The example configuration of the equipment is as follows:

- Assuming 1 shared lane on 1 flyover
- 2 sets for 1 lane (both sides of flyover)
- 2 signals with 2 lamps (red and blue) for both sides of flyover
- 2 information boards for both sides of flyover
- 2 barrier gates for both sides of flyover
- 1 local control unit including control switch and communication unit for 1 flyover
- 1 backup power supply system for 1 flyover
- 1 central monitoring and control system at ITS Centre
- Excluding communication media such as optical fibre cable and GPRS

4-7-3 Parking System

(a) Purpose

It provides the information on the parking availability before and during the trip. It also electronically collects the parking charge and stores the usage record of the parking. This contributes the maximum usage of the parking, preventing the fraud acts and assisting the proper parking planning based on the demand by area.

The parking usage is monitored by the ITS Centre and the data on the parking usage record is collected and stored in the ITS Centre and utilised for planning for the improvement of parking facilities.

(b) Example Configuration

1) Parking System (Basic System)

The example configuration of the equipment is as follows:

- Assuming a monitoring system which monitors vehicles at entrance and exit only
- 2 vehicle actuators at 1 entering lane and 1 exit lane
- 2 barrier gates at 1 inlet entering lane and 1 exit lane
- 1 outside information board for 1 parking area
- 1 local controller including control switch and communication unit for 1 parking area
- 1 local server for monitoring and operation for 1 parking area
- 1 backup power supply system for 1 parking area
- 1 central monitoring system at ITS Centre
- Excluding communication media such as optical fibre cable and GPRS

2) Parking System (Advanced System)

The example configuration of the equipment is as follows:

- Assuming a monitoring system that monitors each vehicle at each parking space
- 100 vehicle spaces for parking
- 100 vehicle actuators for each parking space
- 2 barrier gates at 1 entering lane and 1 exit lane
- 1 outside information board for 1 parking area
- 5 inside information boards for 1 parking area
- 1 local controller including control switch and communication unit for 1 parking area
- 1 local server for monitoring and operation for 1 parking area
- 1 backup power supply system for 1 parking area
- 1 central monitoring system at ITS Centre
- Excluding communication media such as optical fibre cable and GPRS

4-8 Number of Proposed Devices to be Installed

The proposed numbers of devices are listed below.

Table 67 Number of Proposed Devices to be Installed

Device	Phase-1	Phase-2	Phase-3
ATCC	68	170	454
MET SENSORS	6	-	-
FLOOD SENSORS	14	111	-
CCTV	55	375	449
VMS	42	54	100
SIGNALS	221 (Part of HTRIMS)	179 (400 for Pedestrians)	222 (500 for Pedestrians)
POLLUTION SENSORS	10	-	-
ERP	-	-	10
LANE CONTROL	-	-	20
PARKING SYSTEM	-	-	30

Note: Number of ERP, Lane Control and Parking System is roughly estimated.

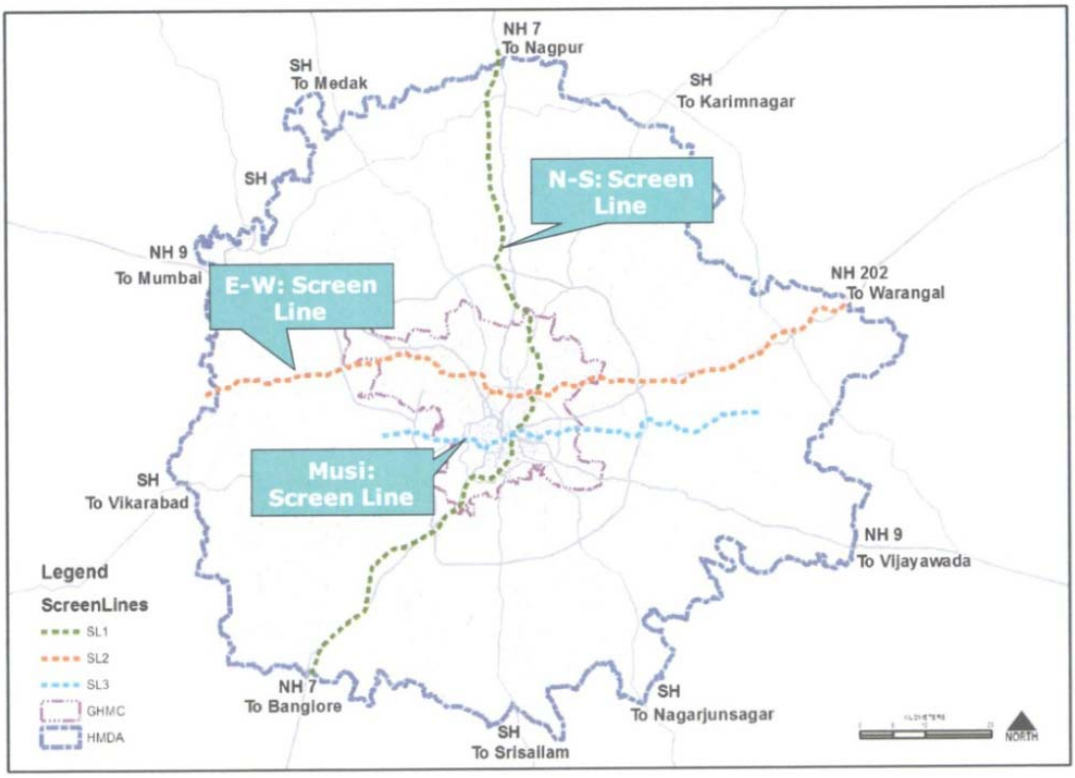
- It should be noted that the number of the devices shown above in Phase-3 is approximate base. Those figures need to be re-examined in the future again.

4-9 Traffic Volume Coverage by ITS Implementation based on CTS Field Survey Report

The traffic volume survey was conducted by CTS. It identified 3 screen lines and 61 survey locations on these 3 screen lines, including 26 survey locations on screen line-1, 18 on screen line-2 and 17 on screen line-3.

The screen lines identified by CTS are:

- Screen Line-1: N-S Railway Line
- Screen Line-2: E-W Railway Line
- Screen Line-3: Musi River



Source: CTS Field Surveys Report, May 2012

Figure 176 CTS Survey Screen Line

The result of the traffic survey of CTS is used to verify the traffic volume which is covered by ITS equipment. The figures shown below are traffic volume which is covered by ITS equipment in Phase-1 proposed by ITS Master Plan in Hyderabad and HTRIMS.

Table 68 Traffic Volume Identified by CTS and Covered by ITS

Screen Lines	Number of Survey Locations (CTS)	Traffic Volume (CTS)	Number of Locations Covered by ITS Hyderabad and HTRIMS	Traffic Volume Covered by ITS Hyderabad and HTRIMS
SL - 1	26	12,01,722	19	10,67,085
SL - 2	18	13,09,881	17	11,78,264
SL - 3	16	9,56,421	12	9,28,688
Total	60	34,68,024	48	31,74,037

As shown above, the traffic volume on three screen line was identified at 34,68,024 by CTS. 91.52% of the traffic volume will be covered by ITS equipment in Phase-1 of ITS Mater Plan and HTRIMS.

The above figures are drawn based on the traffic volume on the screen line. Thus it shall be constructed as overall indicative figure to be covered by ITS equipment, in terms of traffic volume.

The traffic volume by traffic composition to be covered is shown below.

Table 69 Traffic Volume by Traffic Composition: Screen Line-1

Traffic Composition	Traffic Composition Ratio (CTS)	Traffic Volume by Composition (CTS)	Traffic Volume by Composition by ITS and HTRIMS
2-Wheeler	56.80%	6,82,578	6,06,104
3- Wheeler	13.1%	1,57,426	1,39,788
4-Wheelr	18.7%	2,24,722	1,99,545
Bus	3.2%	38,455	34,147
NMT	1.9%	22,833	20,275
Others	6.3%	75,708	67,226
Total	100%	12,01,722	10,67,085

Table 70 Traffic Volume by Traffic Composition: Screen Line-2

Traffic Composition	Traffic Composition Ratio (CTS)	Traffic Volume by Composition (CTS)	Traffic Volume by Composition by ITS and HTRIMS
2-Wheeler	58.50%	7,66,280	6,89,284
3- Wheeler	11.30%	1,48,017	1,33,144
4-Wheeler	21.10%	2,76,385	2,48,614
Bus	3.3%	43,226	38,883
NMT	1%	13,099	11,783
Others	4.80%	62,874	56,556
Total	100%	13,09,881	11,78,264

Table 71 Traffic Volume by Traffic Composition: Screen Line-3

Traffic Composition	Traffic Composition Ratio (CTS)	Traffic Volume by Composition (CTS)	Traffic Volume by Composition by ITS and HTRIMS
2-Wheeler	61.80%	5,91,068	5,73,887
3- Wheeler	12.30%	1,17,640	1,14,220
4-Wheeler	14.10%	1,34,885	1,30,995
Bus	2.80%	26,780	26,011
NMT	2.50%	23,911	23,215
Others	6.50%	62,167	60,360
Total	100%	9,56,421	9,28,688

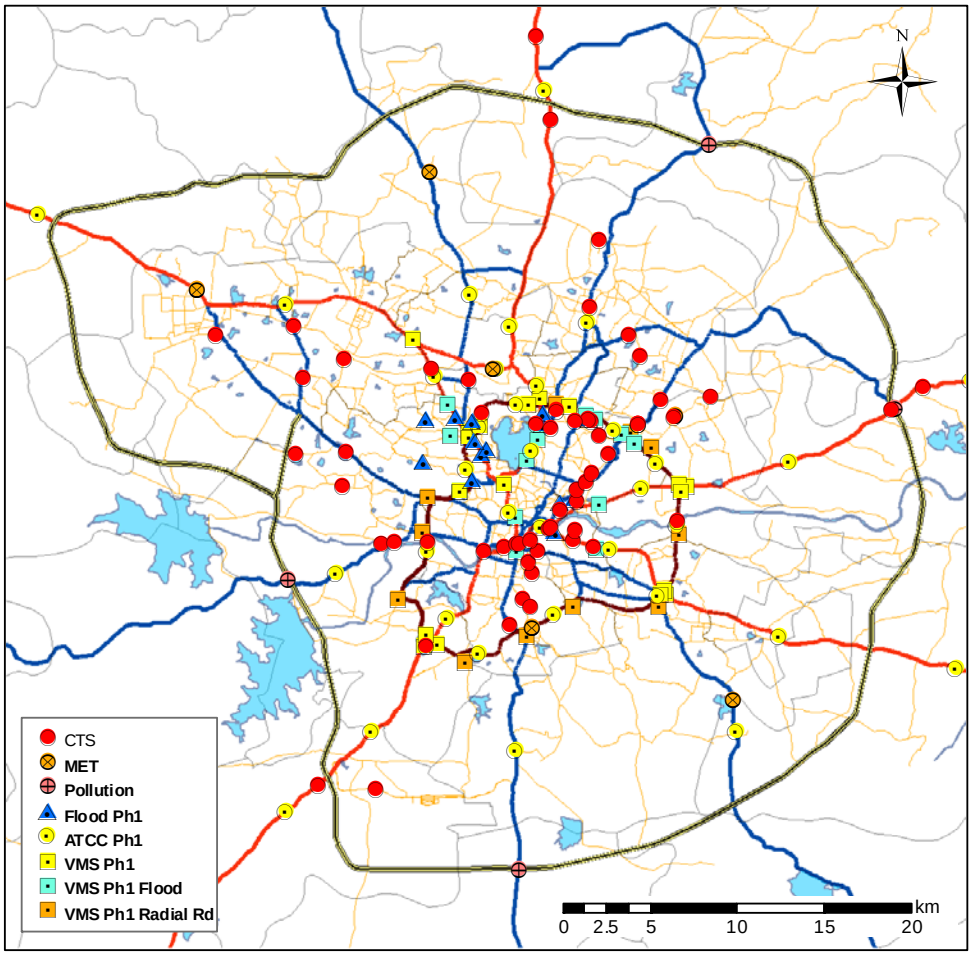


Figure 177 ITS Equipment in Phase 1 on Screen Lines