

The 3rd and 4th Level Architecture for UTMS of ITS in Korea

-Toward More Efficient Transportation Systems-

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1. Introduction

- Korea's traffic situation is chronic and there is congestion throughout the nation. Due to such chronic and national congestion, Korea experiences a loss of industrial competitiveness due to over 16 trillion Won in traffic congestion cost and excessive transportation cost.
- Financing social overhead cost has reached its limit and traffic accidents rank as the highest in the world, making Korea a less developed country in terms of traffic safety.
- Thus, in order to alleviate the above-mentioned problems, the Intelligent Transport System(ITS) was introduced to Korea.
- ITS is the next generation transport system, which combines the state-of-the-art technology including electronics, control, communications to the conventional transport system of roads, vehicles, and signal control system.
- However, the agencies implementing the various ITS programs vary based on different systems. In other words, it is difficult to establish an efficient ITS because the controllers of roads and traffic differ, the road system is not classified based on function, and ITS is managed by different administrative units.
- Thus, it is necessary to develop an ITS system architecture, which enables coordinated management of various technologies and facilities critical to the ITS system.
- ITS system architecture allows for an efficient coordination of various parts and components, since it provides detailed definition, and information flows.
- Currently, there are fourteen Korean ITS sub-system, of which two have been completed. This paper deals with the third- and fourth-level architecture of the Urban Transportation Traffic Management System(UTMS), which is one of the fourteen sub-systems.
- This paper provides the third-level architecture flow diagram; the fourth-level architecture flow program which shows the information flow among the center, road equipment, vehicle equipment, and the terminator; and the component, equipment package, and functional specification for each center.

2. The Concept and Basic Framework for ITS System Architecture in Korea

- Architecture defines the service and function of each system; defines and expresses the boundary between service and function areas, and the participating actors; and provides plans for the project, defines the extent of the plan, and provides a comprehensive framework for the plan.
- Architecture can be classified into logical architecture and physical architecture. The former refers to the classification based on function and service, and the information flow per unit. The latter refers

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to the information flow among the actual components of the systems including various centers, vehicle equipment, road side and road equipment and physical facilities, and traveler equipment.

- The basic framework for ITS architecture design is as follows:
 - Systematic function establishment among different implementing agencies
 - Establishment of rational relationship among systems
 - System definition
 - Definition of rational law, regulations, and organization
 - Assessment of rational implementation
- The principles of ITS architecture design are as follows:
 - Establishment of detailed information architecture for each level
 - Scattered architecture design and centered on the basic unit, and the establishment of system relations
 - Design of information architecture for the public and private sector
 - A summary for Architecture Model By Level

< Table 2-1 > A Summary of Architecture Models(1st, 2nd Level)

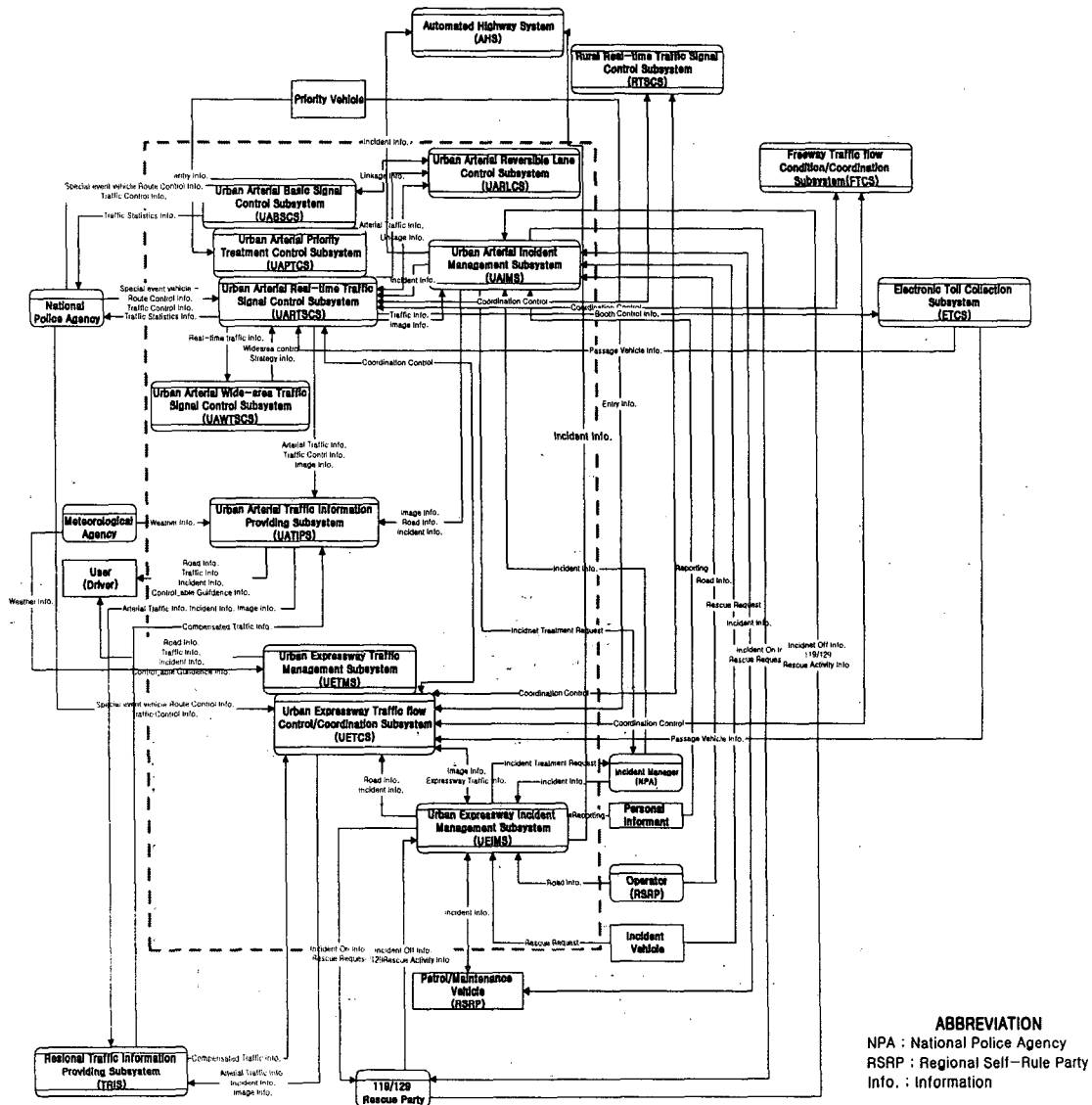
Section	1st Level	2nd Level
Composition Unit	Definition Unit "Service area"	Integrated Unit "System"
Goal	Consideration of Working System	Consideration of Working System
Relative Characteristics	Nation-wide Homonization and Structurization	Logical Functionality (Multi-Functionality)
Relative Organization Type	Authority	Multi-Authority
Responsible Authority	Plan/Management Authority	Integration Authority
Relative Issues	- Mutual Homonization between Service Areas - Rationalization of Basic Structure	-Rationalization of Function of each System -Coordination between Systems -Rationalization of Integration -Rationalization of Control -Functional/Institutional/Technological Complexity
Contents	-Definition of Terminator -Relation Definition with Terminator -Basic frame Definition: Service area Definition Relative Definition among Areas Characteristics Definition for each area (1st Level)	-Environmental Definition of K · ITS -Functional System Definition:{System}14 -Mini-spec by System -Relative Definition among Systems -Data Flow Definition (2nd Level)
	Concept Structure	Logical Structure

< Table 2-2 > A Summary of Architecture Models(3rd, 4th Level)

Section	3r Level	4th Level
Composition Unit	Service Deployment Unit	Component, Equipment"Physical Composition frame
Goal	Working & Workable System	Working & Workable System
Relative Characteristics	Logical Functionality	Single function/ Quality, Operational Manageability
Relative Organization Type	Multi-Authority	Single-Authority
Responsible Authority	Supervision Authority	Operational Authority
Relative Issues	<ul style="list-style-type: none"> -Rationalization/Integration of Subsystem -Functional Complexity -Institutional Complexity -Economical Complexity -Operational Complexity -Reliability of System -Operational Manageability 	Availability ; Zone of Autonomy
Contents	<ul style="list-style-type: none"> -Subsystem Definition (Function & System Quality Definition) -Definition of Integration Coordination among Subsystems -Mini-spec of Subsystem -Data Flow Definition (3rd Level AFD & ASD) 	<ul style="list-style-type: none"> -Physical System Definition (Function & System Quality Definition) -Interactional Coordination Definition between Physical System -Mini-spec by Physical System -Data Flow Definition (4th Level AFD & AID, ACD)
	Logical Structure	Physical Structure

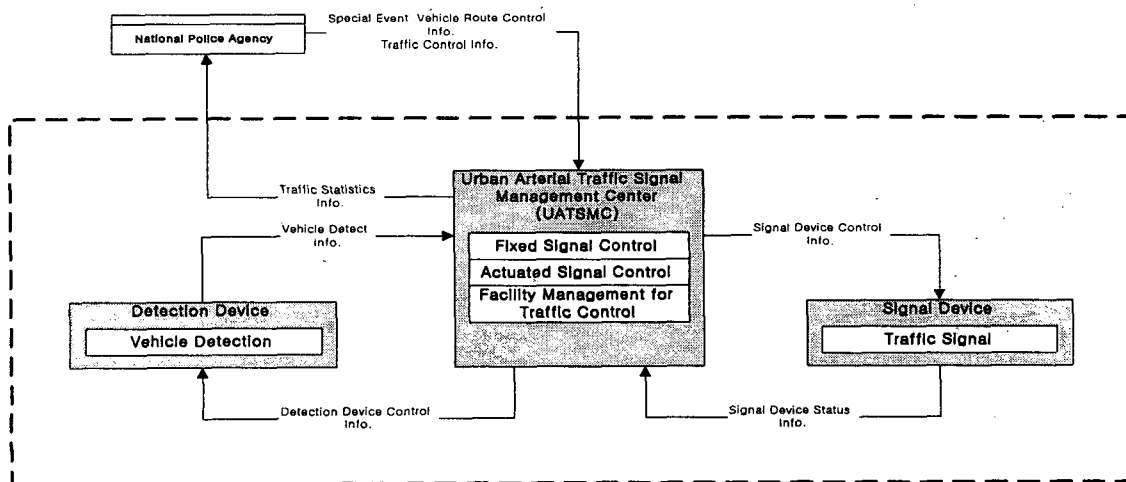
3. The 3rd and 4th Level Architecture for UTMS

3.1 The 3rd Level Architecture Flow Diagram for UTMS



3.2 The 4th Level Architecture Flow Diagram for UTMS

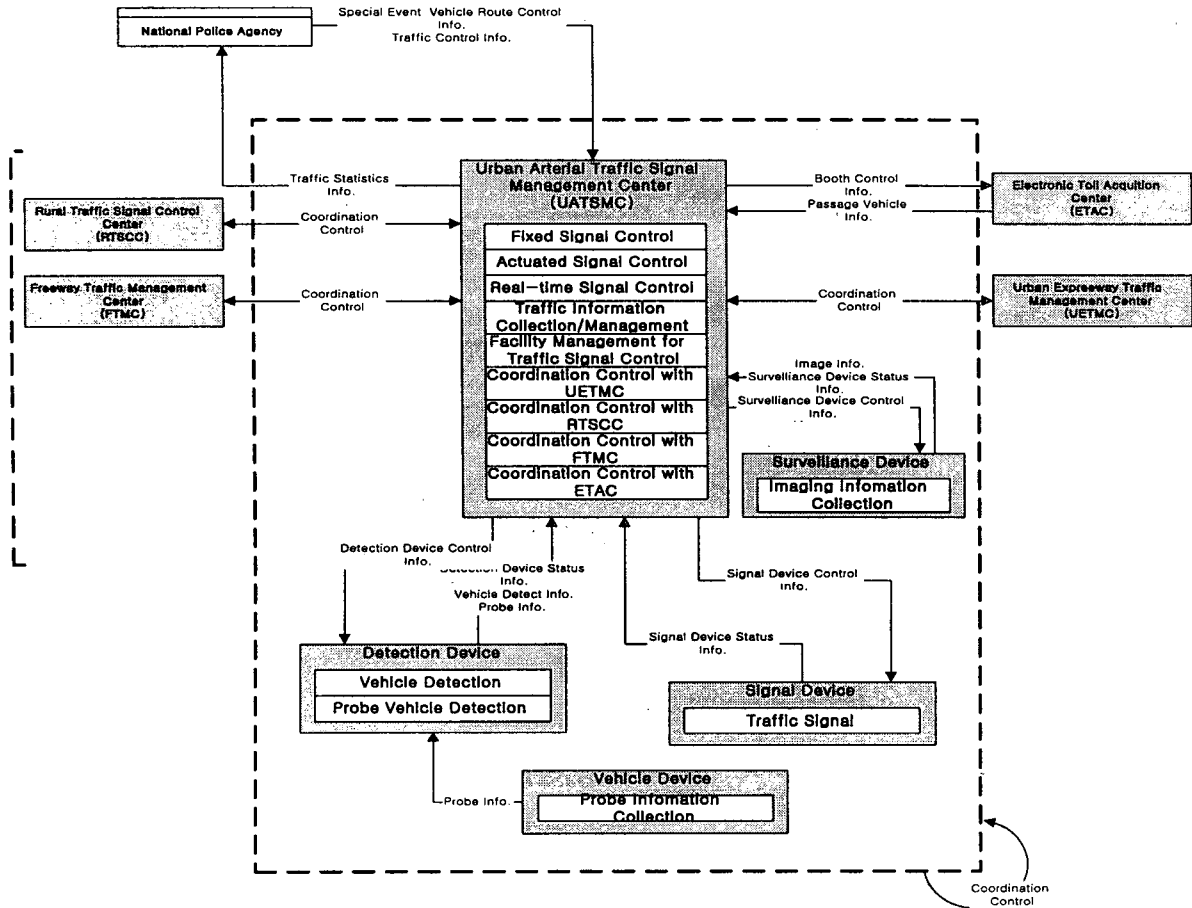
A. Urban Arterial Basic Traffic Signal Control Subsystem



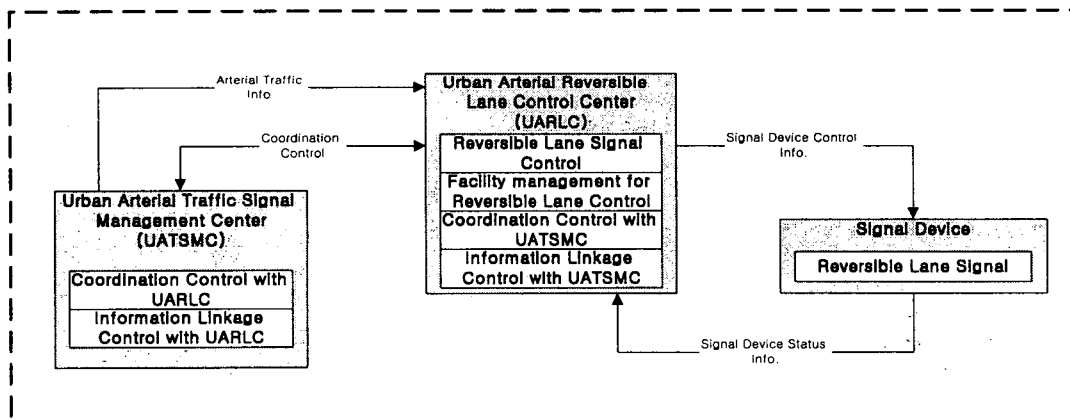
B. Urban Arterial Real-time Traffic Signal Control Subsystem

ABBREVIATION

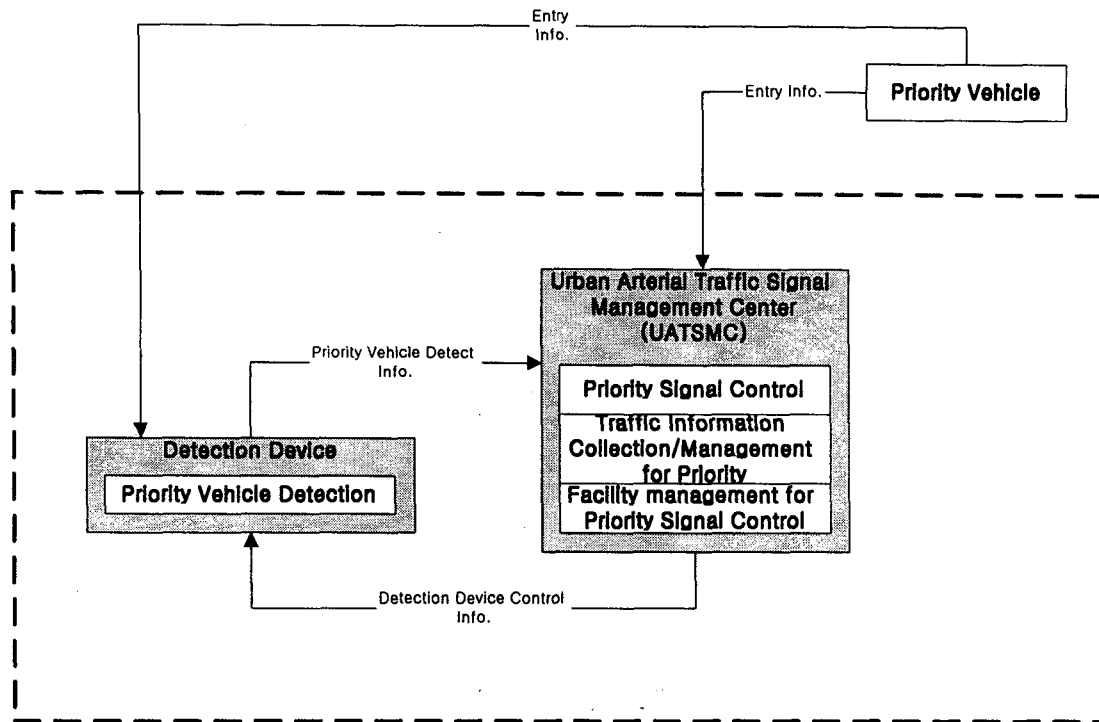
UETMC : Urban Expressway Traffic Management Center
 RTSCC : Rural Traffic Signal Control Center
 FTMC : Freeway Traffic Management Center
 ETAC : Electronic Toll Acquisition Center
 Info. : Information



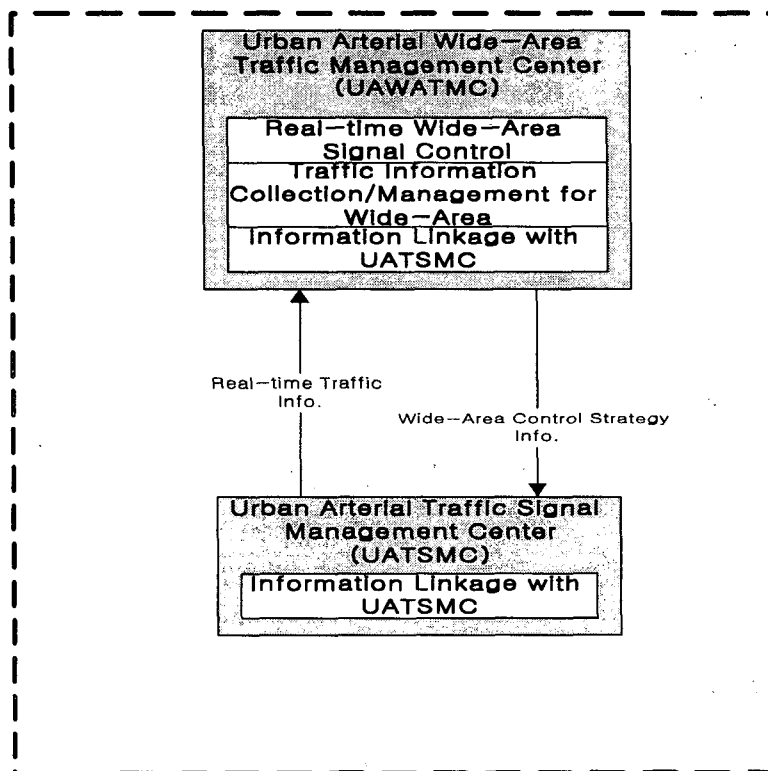
C. Urban Arterial Reversible Lane Control Subsystem(UARLCS)



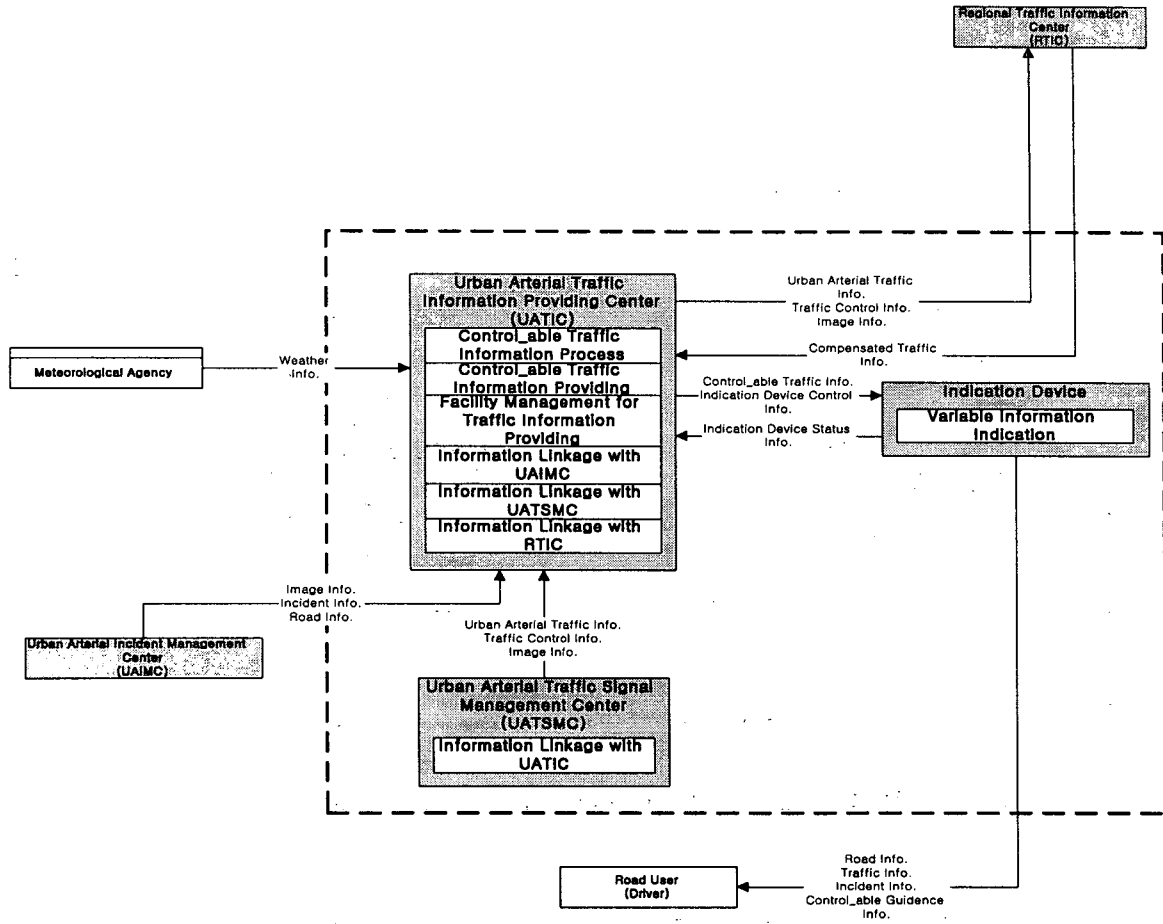
D. Urban Arterial Priority Treatment Control Subsystem(UAPTCS)



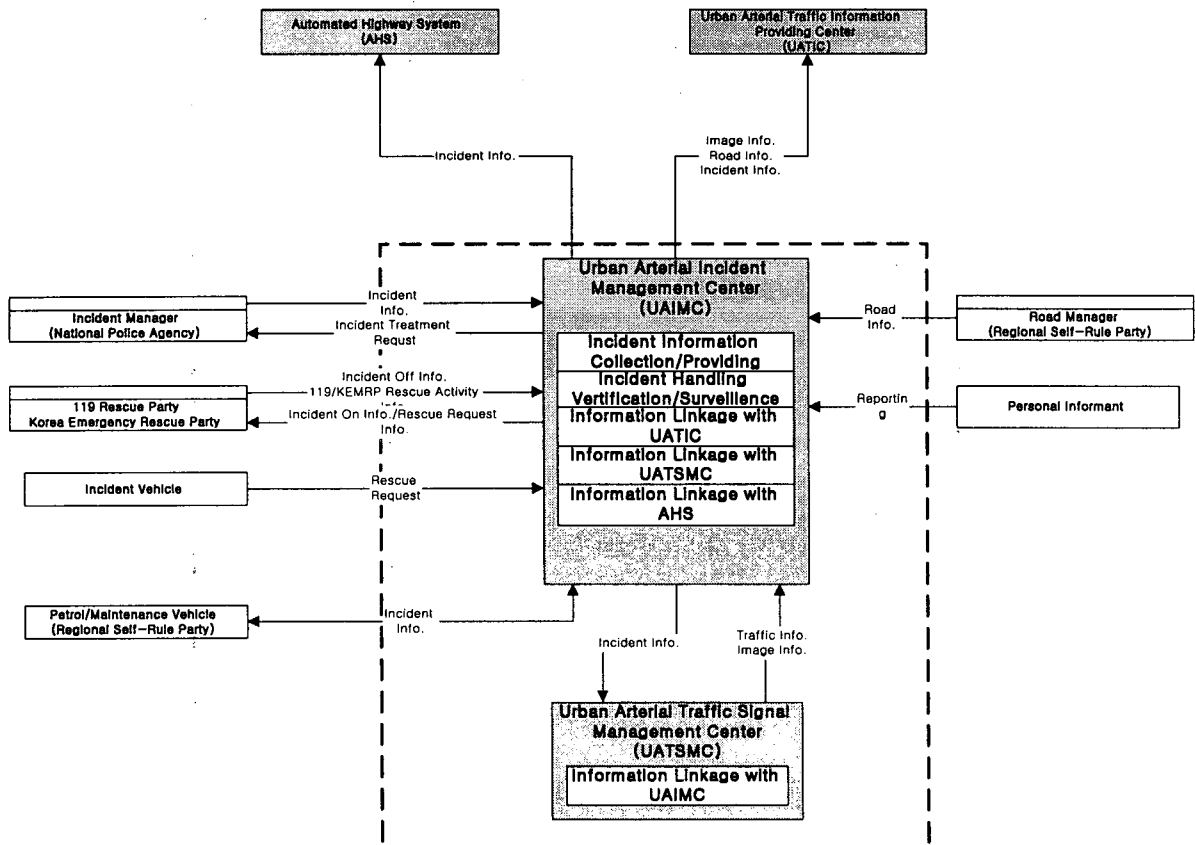
E. Urban Arterial Wide-area Traffic Control Subsystem(UAWTCS)



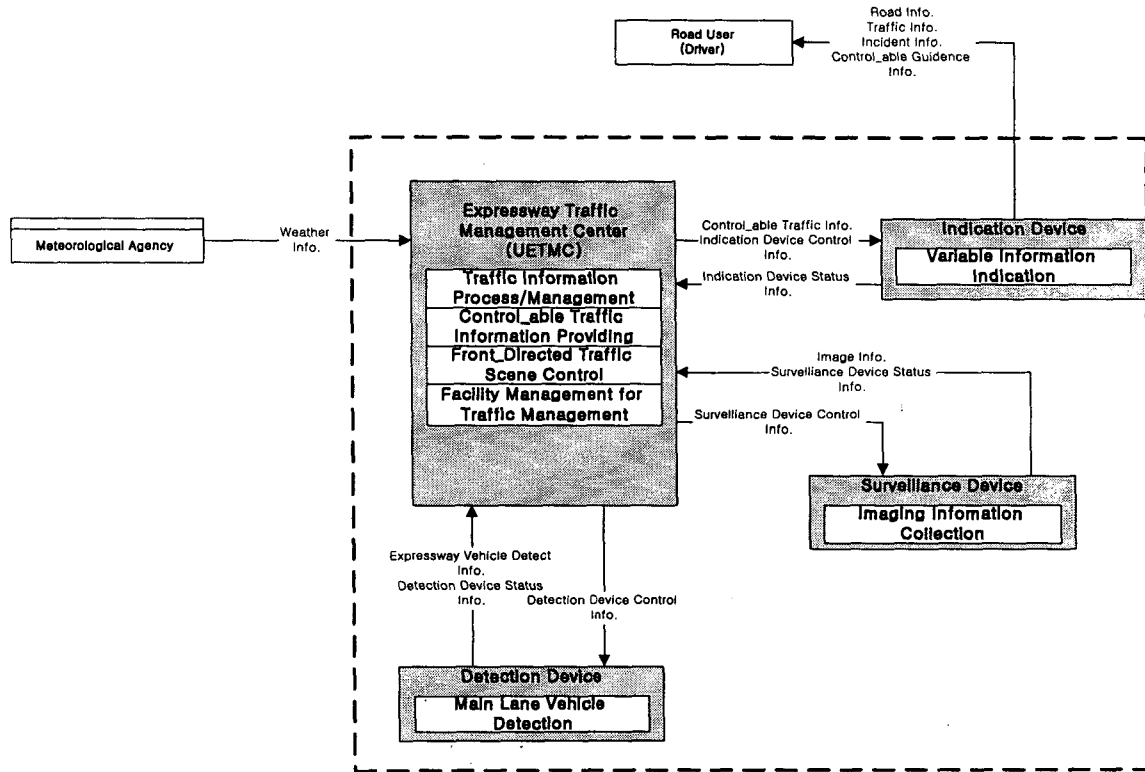
F. Urban Arterial Traffic Information Providing Subsystem(UATIS)



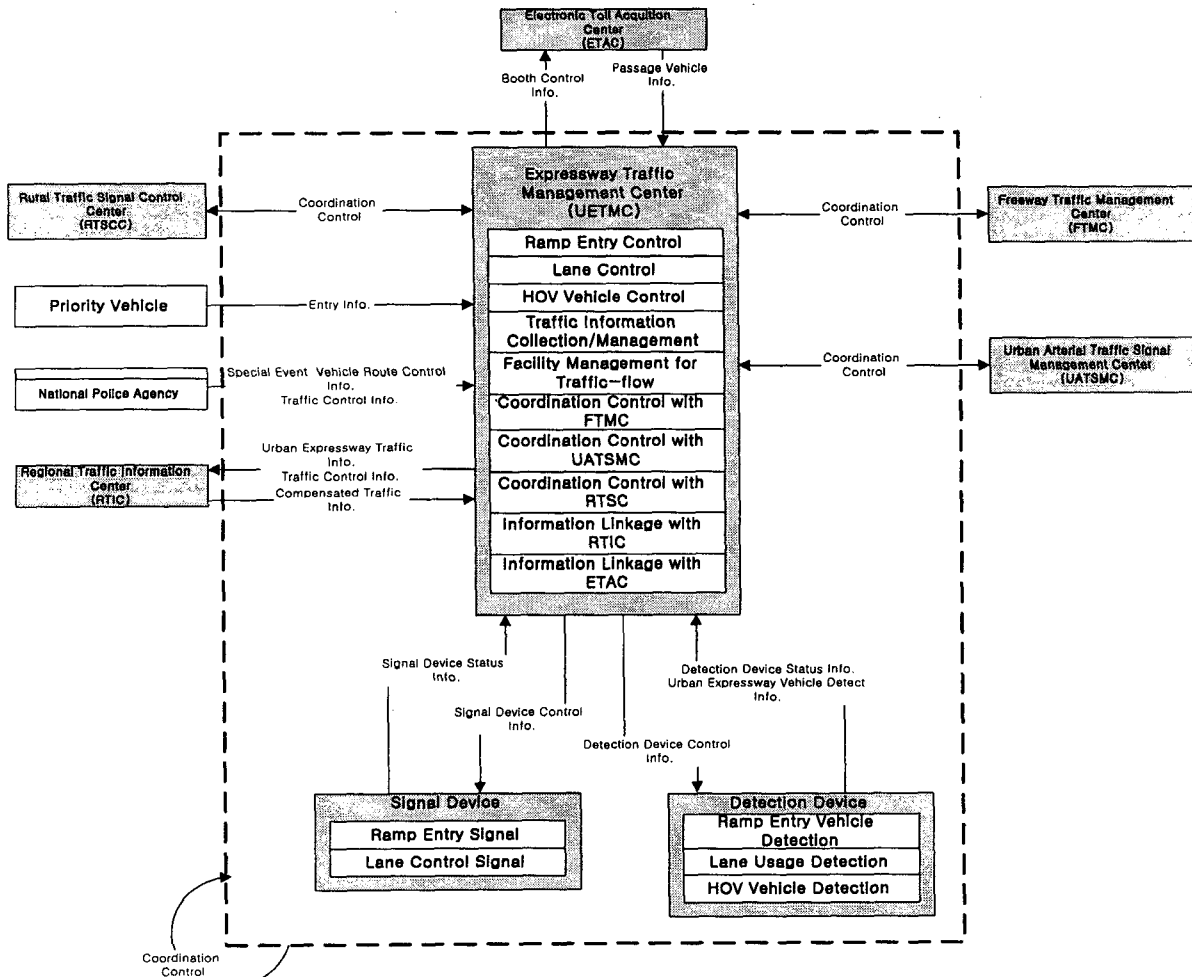
G. Urban Arterial Incident Management Subsystem(UAIMS)



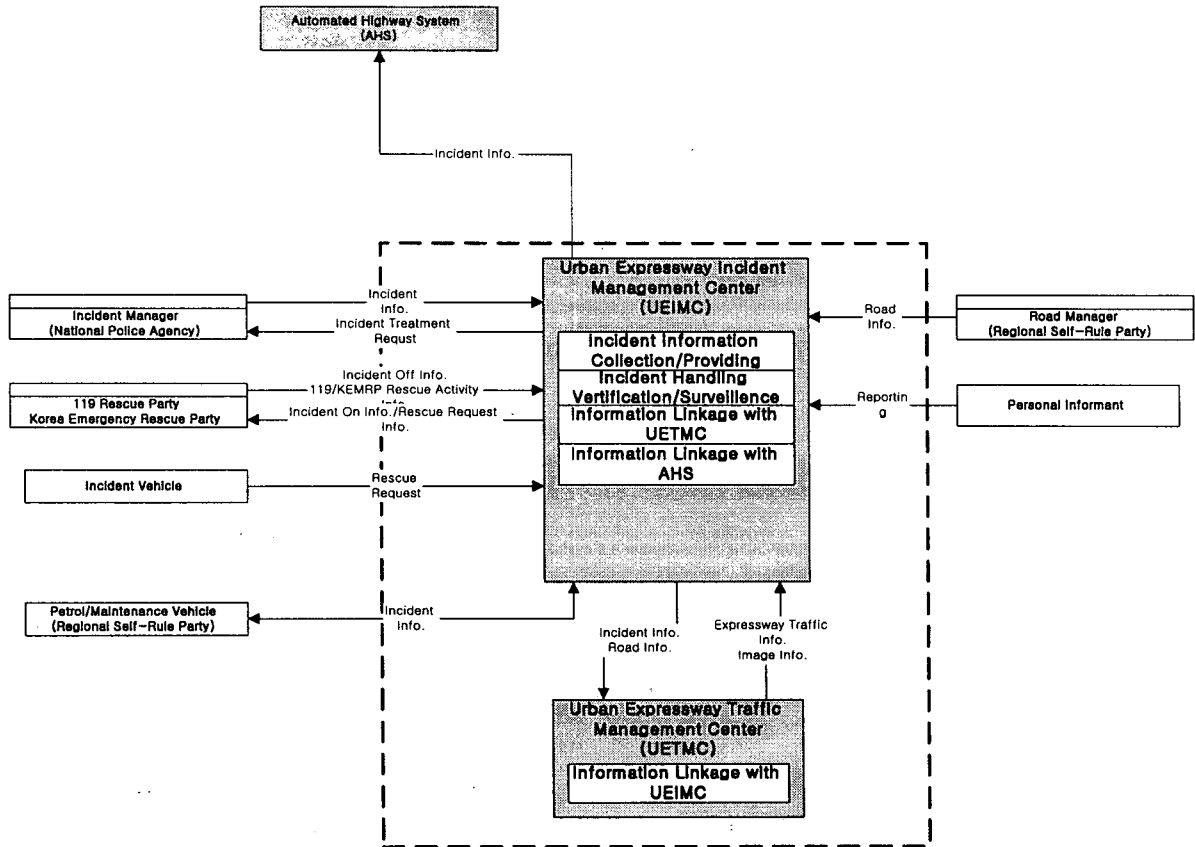
H. Urban Expressway Traffic management Subsystem(UETMS)



I. Urban Expressway Traffic-flow Control/Coordination Subsystem(UETCS)



J. Urban Expressway Incident management Subsystem(UEIMS)



4. Basic Functional Specification

Urban Traffic Management System : UTMS				
Component Type	Component	Equipment Package (EP)	Relative Subsystem	Functional Specification
Urban Traffic Management System' Center Type at ATMS	Urban Arterial Traffic Signal Management Center	Fixed time Signal Control	Urban arterial basic signal control Subsystem	-Pretimed signal control -TOD control -DOW control
		Actuated Signal Control		-Semi-actuated control -Full-actuated control
		Facility for traffic signal control		-Signal devices -Detectors -Traffic Controller
		Fixed time Signal Control	Urban arterial real-time traffic signal control Subsystem	-Pretimed signal control -TOD control -DOW control
		Actuated Signal Control		-Semi-actuated control -Full-actuated control
		Real-time traffic signal control		-Regional computer signal control -Field terminal control
		Traffic info. collection/management		-Collect point/spatial traffic info. -Collect probe vehicle traffic info. -Process traffic info. -Forecast traffic info. -Construct & update DB for traffic info. -Verify traffic situation
		Facility management for traffic signal control		-Signal devices -Detectors -Traffic Controller
		Info. linkage with Electronic Toll Acquisition Center		-Info. linkage I/F with Electronic Toll Acquisition Center -Construct & update DB for Info. linkage
		Coord. control with Urban Expressway Traffic Management Center		-Coord. control I/F Urban Expressway Traffic Management Center -Construct & update DB for Coord. control
		Coord. control with Rural Traffic Signal Management Center		-Coord. control I/F with Rural Traffic Signal Management Center -Construct & update DB for Coord. control
		Coord. control with Freeway Traffic Management Center		-Coord. control I/F with Freeway Traffic Management Center -Construct & update DB for Coord. control
		Priority Treatment Control		Urban arterial Priority treatment control Subsystem
		Traffic info. Collection/Management for Priority	-Collect traffic Info. for priority vehicle -Construct and Update DB of traffic info.	
Facility management for priority signal control	-Detect and handle automatically working status of detector and controller			

Urban Traffic Management System : UTMS				
Component Type	Component	Equipment Package (EP)	Relative Subsystem	Functional Specification
Urban Traffic Management System' Center Type at ATMS	Urban arterial Wide-area Traffic Control Center	Wide-area signal control	Urban arterial Wide-area traffic signal control Subsystem	-Strategy for Wide-area control -Metering -Simulation
		Info. linkage with Urban arterial Traffic Signal Management Center		-Info. linkage I/F with Urban arterial Traffic Signal Management Center -Construct and Update DB of Linkage info.
	Urban arterial reversible lane control Center	Reversible lane signal control	Urban arterial reversible lane control Subsystem	-Manual reversible signal control -Actuated reversible signal control
		Facility management for priority signal control		-Detect and handle automatically working status of detector and controller
		Coord. Control with Urban arterial Traffic signal management Center		-Coord. Control I/F with Urban arterial Traffic signal management Center -Construct and Update DB of Control info.
	Urban arterial real-time traffic signal control Center	Info. linkage with Urban arterial reversible lane control	Urban arterial reversible lane control Subsystem	-Info. linkage I/F with Urban arterial reversible lane control -Construct and Update DB of Linkage info.
		Coord. Control with Urban arterial reversible lane control		-Coord. Control I/F with Urban arterial reversible lane control-Construct and Update DB of Control info.
	Urban arterial Traffic Providing Center	Control_able Traffic Info. Process	Urban arterial Traffic Info. Providing Subsystem	-Traffic info. process · saving · forecasting
		Control_able Traffic Info. Providing		-Alternative guidance -Incident information providing -Providing Info.. highway control -Providing Info. Lane closure
		Facility for Traffic Info. Providing		-Detect and handle automatically Indication Malfunction -Detect and handle automatically Malfunction of WIS & other device
		Info. linkage with Urban arterial Traffic signal management Center		-Info. linkage I/F with Urban arterial Traffic signal management Center -Construct and Update DB of Linkage info.
		Info. linkage with Urban arterial Incident management Center		-Info. linkage I/F with Urban arterial Incident management Center -Construct and Update DB of Linkage info.
		Info. linkage with Regional Traffic Info. Center		-Info. linkage I/F with Info. linkage with Regional Traffic Info. Center -Construct and Update DB of Linkage info.
	Urban arterial traffic signal control Center	Info. linkage with Urban arterial Traffic Info. Providing Center		-Info. linkage I/F with Urban arterial Traffic Info. Providing Center -Construct and Update DB of Linkage info.
	Urban arterial incident management Center	Collect/Provide Incident Info.	Urban arterial incident management Subsystem	-Detect Incident -Reporting -Verify Incident -Provide Incident Info.
		Verification/Surveillance action for Incident		-Action Verification -Monitoring -Mayday Service
		Info. linkage with Urban arterial Traffic Info. Providing Center		-Info. linkage I/F with Urban arterial Traffic Info. Providing Center -Construct and Update DB of Linkage info.
		Info. linkage with Urban arterial traffic signal control Center		-Info. linkage I/F with Urban arterial traffic signal control Center -Construct and Update DB of Linkage info.
		Info. linkage with Automated Highway System		-Info. linkage I/F with Automated Highway System -Construct and Update DB of Linkage info.
	Urban arterial traffic signal control Center	Info. linkage with Urban arterial incident management Center		-Info. linkage I/F with Urban arterial incident management Center -Construct and Update DB of Linkage info.

Urban Traffic Management System : UTMS				
Component Type	Component	Equipment Package (EP)	Relative Subsystem	Functional Specification
Urban Traffic Management System' Center Type at ATMS	Urban Expressway Traffic Management Center	Control_able Traffic Info. Process	Urban Expressway Traffic Management Subsystem	-Traffic info. process · saving · forecasting
		Control_able Traffic Info. Providing		-Alternative guidance -Incident information providing -Providing Info.. highway control -Providing Info. Lane closure
		Facility for Traffic Info. Providing		-Detect and handle automatically Indication Malfunction -Detect and handle automatically Malfunction of WIS & other device
		Down stream Traffic situation Control		-Highway control -Lane closure
	Urban Expressway Traffic Management Center	Ramp control	Urban Expressway Traffic-flow control/Coord. Subsystem	-Fixed time Ramp control -Actuated Ramp control
		Lane Control		-Main-lane Metering -Vehicle moving Limit -Reversible Lane Operation
		HOV Control		-Exclusive Lane for Bus -High Occupancy Vehicle
		Collect/Manage Traffic Info.		-Collect point/spatial Traffic Info. -Process Traffic Info.
		Facility Management for Urban expressway		--Detect and handle automatically working status of signal device --Detect and handle automatically working status of detector device
		Coord. control with Rural Traffic Signal Management Center		-Coord. control I/F with Rural Traffic Signal Management Center -Construct & update DB for Coord. control
		Coord. control with Freeway Traffic Management Center		-Coord. control I/F with Freeway Traffic Management Center -Construct & update DB for Coord. control
		Coord. Control with Urban arterial Traffic signal management Center		-Coord. Control I/F with Urban arterial Traffic signal management Center -Construct and Update DB of Control info.
		Info. linkage with Electronic Toll Acquisition Center		-Info. linkage I/F with Electronic Toll Acquisition Center -Construct & update DB for Info. linkage
	Info. linkage with Regional Traffic Info. Center	-Info. linkage I/F with Info. linkage with Regional Traffic Info. Center -Construct and Update DB of Linkage info.		
	Urban Expressway Incident Management Center	Collect/Provide Incident Info.	Urban Expressway Incident Management Subsystem	-Detect Incident -Reporting -Verify Incident -Provide Incident Info.
		Verification/Surveillance action for Incident		-Action Verification -Monitoring -Mayday Service
		Info. linkage with Urban Expressway Traffic Management Center		-Info. linkage I/F with Urban Expressway Traffic Management Center -Construct and Update DB of Linkage info.
		Info. linkage with Automated Highway System		-Info. linkage I/F with Automated Highway System -Construct and Update DB of Linkage info.
	Urban Expressway Traffic-flow control/Coord. Center	Info.. linkage with Urban Expressway Incident Management Center		-Info. linkage I/F with Urban Expressway Incident Management Center -Construct and Update DB of Linkage info.

Urban Traffic Management System : UTMS				
Component Type	Component	Equipment Package (EP)	Relative Subsystem	Functional Specification
Urban Traffic Management System' Roadside Type at ATMS	Detection Device	Detect Vehicle	Urban arterial Basic Signal Control Subsystem	-Collect basic traffic info.(Volume, Occupancy, speed, etc.) -I/F with Controller
		Detect Vehicle		-Collect basic traffic info.(Volume, Occupancy, speed, etc.) -I/F with Controller/Center -Detect automatically malfunction of detector
		Detect Probe Vehicle	Urban arterial Real-time Traffic Signal Control Subsystem	-Collect in-vehicle Tag data to Determine Link Travel Time -Collect in-vehicle Tag data to Determine Link Travel Speed --I/F with Controller/Center -Detect automatically malfunction of vehicle -I/F with Controller/Center -Detect automatically malfunction of detector
		Detect Vehicle for priority	Urban arterial Priority Treatment Control Subsystem	-Collect detect data of priority -I/F with Controller/Center -Detect automatically malfunction of detector
		Detect main-lane Vehicle	Urban Expressway Traffic Management Subsystem	-Detect Volume, Speed and Occupancy, etc. -I/F with Controller/Center -Detect automatically malfunction of detector
		Detect Ramp entry Vehicle		-Collect Ramp entry vehicle detection info. -I/F with Controller/Center -Detect automatically malfunction of detector
		Detect HOV	Urban Expressway Traffic flow Control/Coord. Subsystem	-Detect info. of HOV -I/F with Controller/Center -Detect automatically malfunction of detector
		Detect Lane Usage		-Detect main-lane info. by vehicle classification -I/F with Controller/Center -Detect automatically malfunction of detector
	Signal Device	Traffic signal	Urban arterial Basic Signal Control Subsystem	-Signal data I/F with Controller/Center -Detect automatically Signal Status or malfunction of detector
		Traffic signal	Urban arterial Real-time Traffic Signal Control Subsystem	-Signal data I/F with Controller/Center -Detect automatically Signal Status or malfunction of detector
		Variable Lane Signal	Urban arterial Reversible Lane Control Subsystem	-Signal data I/F with Controller/Center -Detect automatically Signal Status or malfunction of detector
		Ramp entry signal	Urban Expressway Traffic flow Control/Coord. Subsystem	-Signal data I/F with Controller/Center -Detect automatically Signal Status or malfunction of detector
		Lane Control Signal		-Signal data I/F with Controller/Center -Detect automatically Signal Status or malfunction of detector

Urban Traffic Management System : UTMS				
Component Type	Component	Equipment Package (EP)	Relative Subsystem	Functional Specification
Urban Traffic Management System' Roadside Type at ATMS	Indication Device	Indicate Variable Info.	Urban arterial Traffic Info. Providing Subsystem	-Process indicate info. -I/F with Center -Detect automatically Signal Status or malfunction of device
		Indicate Variable Info.	Urban Expressway Traffic Management Subsystem	-Process indicate info. -I/F with Center -Detect automatically Signal Status or malfunction of device
	Surveillance Device	Collect Image Info.	Urban arterial Real-time Traffic Signal Control Subsystem	-Collect/process Image info. -I/F with Center -Detect automatically Signal Status or malfunction of device
		Collect Image Info.	Urban Expressway Traffic Management Subsystem	-Collect/process Image info. -I/F with Center -Detect automatically Signal Status or malfunction of device
	In-Vehicle Device	Collect Probe Info.	Urban arterial Real-time Traffic Signal Control Subsystem	-I/F with Detector -Collect/Save Probe info.

5. Conclusions

The current research provides the third-level architecture flow diagram; the fourth-level architecture flow diagram. which shows the information flow among the center, road and road side equipment, vehicle equipment, and the terminator; and the component, equipment package and functional specification for each center.

Thus, designing the ITS system in the future must take into account the above issues, and a national-level rational ITS architecture can provide the following benefits.

- Establishment of rational architecture will eliminate redundancies in agencies in the same area.
- Reducing the time necessary for research and establishment due to systematic development based on applicable service and function.
- Development of related technology will diversify the supply function, and the future system can expand due to the increasing demand for greater area application. Architecture, which includes future-oriented functions, must actively respond to such expansion.
- Service and functions defined and analyzed in this paper will help select the system which should receive priority in development based on the current traffic situation and level of technology. Thus the service and system will be established based on their actual applicability.

References

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- Ministry of Construction and Transportation, National Police Agency, A Study for Establishing of ITS Basic Planning, -A Summary Part, 2nd Last Report, vol 1, 1996. 7, Korea Society of Transportation, Korea Research Institute for Human Settlements, Korea Institute of Consturction Technology