DEVELOPMENT OF ITS STANDARDIZATION IN KOREA
- Focus on APTS –

Kyung Soo CHON
Professor
Department of Civil Engineering
Seoul National University
Sinlim-Dong, Kwanak-Gu, Seoul,
151-742, Korea
Fax: +82-2-872-8845
Email:chonks@snu.ac.kr

Chang Ho PARK
Professor
Department of Civil Engineering
Seoul National University
Sinlim-Dong, Kwanak-Gu, Seoul,
151-742, Korea
Fax: +82-2-889-0032
Email: parkch@gong.snu.ac.kr

Hyeon Hong LEE
Researcher
Transport Planning & Traffic Eng.
Seoul National University
Sinlim-Dong, Kwanak-Gu, Seoul,
151-742, Korea
Fax: +82-2-889-0032
Email: traffici@chollian.net

Abstract: Intelligent Transport Systems (ITS) is a strategy used world-wide in order to deal with worsening traffic problems in urban and rural areas, increasing traffic accidents, and degradation of the environment. Korea has adopted ITS since 1990 and has made efforts on building ITS to fit the needs of Korea. Thus, in 1997, the Master Plan for National ITS Development was established, and a great deal of effort has been provided towards the actual implementation of the program.
Therefore, the purpose of this paper is twofold. One is to review the standardization activities in countries, where ITS has already been put to use, such as the United States, Europe, and Japan. The other is to develop and prioritize the standardization work items, which will be implemented in Korea within the area of APTS.

1. INTRODUCTION

Intelligent Transport Systems (ITS) is a strategy used world-wide in order to deal with worsening traffic problems in urban and rural areas, increasing traffic accidents, and degradation of the environment. Korea has adopted ITS since 1990 and has made efforts on building ITS to fit the needs of Korea. Thus, in 1997, the Master Plan for National ITS Development was established, and a great deal of effort has been provided towards the actual implementation of the program.

ITS program will be implemented step by step based on the Master Plan for National ITS Development. And it will be carried out individually or aggregately according to its functions, the scope of services, the components of system, and the geographical range. Thus, it is essential to develop ITS standards in order to prevent non-compatibility and non-interoperability among systems or services, to prohibit duplicate investments, and to participate in the international ITS market.

Therefore, the purpose of this paper is twofold. One is to review the standardization activities in countries, where ITS has already been put to use, such as the United States, Europe, and Japan. The other is to develop and to prioritize the standardization work items, which will be implemented in Korea within the area of APTS.

2. ITS STANDRADS

2.1 Standards Needs for ITS

ITS standards provide the basis for coordination in the process of deploying various ITS projects nation-wide, and for area-wide interoperability and compatibility among ITS user

services and systems.

ITS standards expedite the development of domestic ITS technology, and enhance international competitions of related industries by understanding the world's sophisticated technologies. They also help to cope with the trend of ITS related international standard organizations such as ISO and ITU, and enable us to reflect our domestic situations when the international standards are established.

2.2 Advantages and Disadvantages of ITS Standardization

1) Advantages
- Guarantee interoperability between various systems
- Prevent double investment
- Rapid dissemination of new standard technology
- Create a wider market
- Interchangeability
- Enhance safety

2) Disadvantages
- Obstructs the development of new technology
- Incapable of using incompatible equipment
- Suppress market competition

2.3 Architecture and Standardization of ITS

Architecture, which is developed to deploy coordinated ITS, is ultimately achieved by physical interfaces and communication protocol, message set, and standardization of contents. For example, in Figure 1, information is exchanged between Traffic Management Center and Public Transportation Center in order to provide signal priority service of public transport (ex: bus) is defined using architecture. And standardization work items which is necessary to deploy actually is presented.

Therefore, in this paper, standardization work items are selected using architecture, which is proposed in the National ITS Architecture Development Project. The latter was coordinated by KRIHS (Korea Research Institute for Human Settlements) in 1998.

3. ITS STANDARDIZATION ACTIVITIES IN OTHER NATIONS

3.1 Europe

Europe began constructing standards before the U.S. and Asian countries. In 1988, the technical committee 278 under CEN, which is a standard development organization in Europe, was established. It is currently working vigorously on the development of ITS interface standards.

The fields, which are given priority by CEN/TC278 are as follows: Electronic Toll Collection System (ETC), Traffic and Travel Information System, Road Geographic

Information database, Dedicated Short Range Communication (DSRC), and Automatic Vehicle Identification, etc.

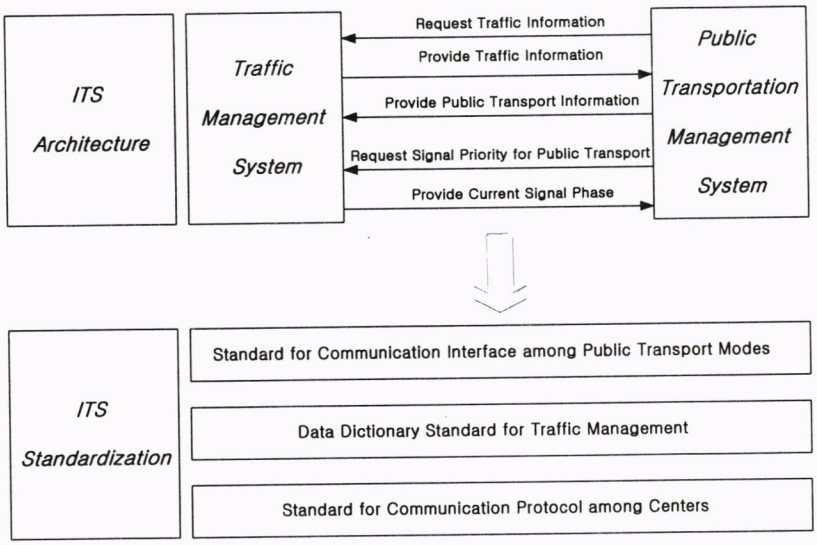

Figure 1. The Relationship between ITS Architecture and Standardization

3.2 The United States

The Standards and Protocol Committee was organized under ITS-America to implement efficiently the standardization work. It is currently developing strategies for mutual adjustment and cooperation of different standards.

The committee conducted a survey to determine the demand and priority of ITS standards, and established a five-year implementation plan for standards. The standardization is actually carried out by the standard development organization, such as SAE, ITE and IEEE. The Federal government is merely in charge of financial support.

A number of experts in related fields are strategically dispatched to international standard organization (ISO/TC204) in order to occupy the future ITS international market. The United States Technical Advisory Group (USTAG) was established to systematically cope with international standards.

3.3 Japan

Japan has developed its own standards based on an agreement with the Technical Barrier to Trade (TBT) in WTO, and is working hard to adapt to international standards. Fourteen domestic standard implementation agencies were selected as working groups in ISO/TC204, in order to set up strategies according to parts.

Japan is trying to become a main actor in ITS international standards with the cooperation of the U.S., Korea, Malaysia and other Asian-Pacific countries in an effort to catch up with

Europe, which have already made ITS standards.

3.4 APTS Area

Standardization work items of APTS are generally a message set, which is exchanged among diverse systems. ISO/TC204/WG8 is developing standardization based on the U.S. SAE standards' J1455, J1487, J1708 and NTCIP. The United States, Japan, Australia and Canada are actively participating in this project. In Europe, CEN/TC278 is developing standards, which are data exchange programs among devices inside the vehicle and message set to inform passengers.

Table 1. Standardization Work Items in the Area of APTS

ORGANIZATION	CLASSIFICATION	STANDARDIZATION WORK ITEMS	STATUS
ISO	Message Set	Transit Vehicle Area Network	Developing
		Transit Communication Interface Profiles	Developing
CEN	Data Dictionary	Public Transport – Reference data model	Developed
		Public Transport – Requirement for on-board data transmission	Developed
		Public Transport Road Vehicles' Scheduling and Control Systems – On-board data transmission between equipment inside a vehicle – Part1: Definition of the transmission bus and general application rules	Developed
		Public Transport Road Vehicles' Scheduling and Control Systems – On-board data transmission between equipment inside a vehicle – Part2: Cabling specifications	Developed
		Public Transport Road Vehicles' Scheduling and Control Systems – On-board data transmission between equipment inside a vehicle – Part3: Message content specifications	Developed
		Public Transport – Road Vehicles – Visible variable passenger information devices inside the vehicle	Developing
		Public Transport – Passenger information systems at stops	Developing
	Other (Testing)	Public Transport – Road Vehicles – AVMS – Test methods for the measurement of the result of the system	Developing
	Other (Physical)	Public Transport – Road Vehicles – Dimensional requirements for variable electronic external signs	Developed
		Public Transport – Road Vehicles – Driver's Console Mechanical Interface Requirements – Minimum Display and keypad parameters	Developed
	Other (TBD)	Public Transport – Road Vehicles – Validators	Developed
The United States (TCIP)	Message Set	Standard on Passenger Information (PI) Objects	Developing
		Standard on Scheduling/Run-cutting (SCH) Objects	Developing
		Standard on Incident Management (IM) Objects	Developing
		Standard on Spatial Representation (SR) Objects	Developing
		Standard on Common Public Transportation (CPT) Objects	Developing
		Standard on Fare Collection (FC) Objects	Developing
		Standard on On-Board (OB) Objects	Developing
		Standard on Control Center (CC) Objects	Developing

4. DEVELOPMENT AND PRIORITIZATION OF ITS STANDARDIZATION WORK ITEMS

4.1 Procedure for Developing Standardization Work Items

The major standardization work items discussed in this paper are message sets, which are exchanged among APTS related centers, road-side devices, and vehicles as proposed in the fourth level of National ITS architecture. This paper derives standardization work items based on the four stages of analysis.

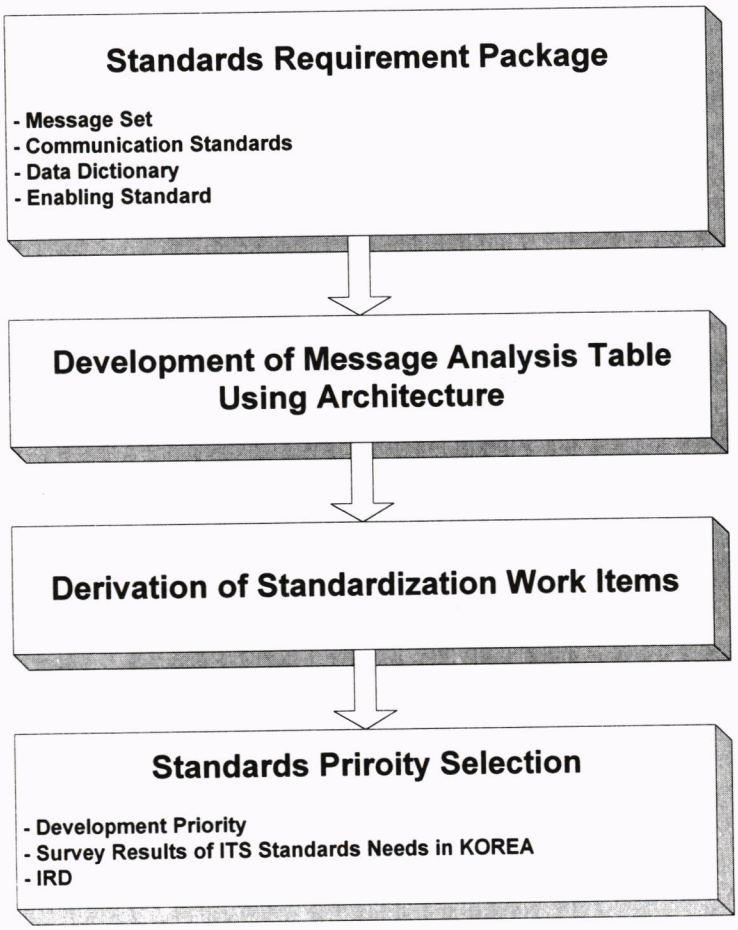

Figure 2. Flowchart for derivation and priority of standardization work items

▶ Step 1: Standards Requirement Package

As shown in Table 2, standardization work items are proposed in three areas, which are enabling standards, message set, and communication standards. And, these are derived by analyzing the architecture.

Table 2. ITS Standards Areas

CATEGORY	CONTENTS	SYMBOL
Enabling Standards	ITS Glossary, Architecture, Digital Road Map, Data Dictionary	ES
Message Set	Contents and formats exchanged among ITS user services and systems	MS
Communication Standards	Communication Protocol for switching message among physical components	CS

▶ Step 2: Development of Message Analysis Table using National ITS Architecture.

1) Determination of interoperability and architecture interconnect diagram

① To define services and detailed functions of each subsystem based on the third level architecture.
② To analyze messages exchanged among subsystems and other terminators.
③ To define interfaces among physical components based on the fourth level of National ITS physical architecture
④ To determine interoperability degree of these interfaces.
⑤ To determine architecture interconnection in order to achieve interoperability considering the present communication technology, deployment speed and usefulness.
⑥ Table 3 & 4 present interoperability types and interconnection types.

Table 3. Interoperability Types

INTEROPERABILITY	DESCRIPTION
National (N)	Interfaces of the mobile subsystems in the architecture support national interoperability since the same mobile subsystem should be able to roam the nation and use the local infrastructure to support ITS Services. National Interoperability is specified for all interfaces to mobile subsystems except where both the mobile subsystem and interfacing infrastructure are owned and operated by the same user. Examples include the Information Service Provider to Personal Information Access Subsystem, and the Toll Collection Subsystem to Vehicle Subsystem.
Regional (R)	Interfaces connecting subsystems that may be operated by different agencies (interfaces that can span jurisdictional and/or regional boundaries) can be standardized to facilitate the sharing of information between agencies. Regional interoperability is specified where the underlying coordination issues are regional, rather than national, in scope.
Product (P)	Interfaces between subsystems are operated and maintained by a single stakeholder (e.g. company or agency).
None (NS)	The sheer range of application-specific interfaces precludes efficient national standardization, and no standard is suggested.

Source: ITS America. Standard Development Plan, 1997, P87

Table 4. Interconnect Types

INTERCONNECT	INTERCONNECT NAME	DESCRIPTION
H	Human Interface	Can be a user interface to the system, an operator interface, or a driver
L	Position Location	Interface between position location equipment and the source for indicating position location. This could be either information from a terrestrial source, GPS, FM sub-carrier, or Dead Reckoning, etc.
P	Physical Interface	This is an interface, which senses some physical characteristic, or causes action that is not represented using standard communications technology (e.g. observing an obstacle)
S	Payment Instrument	This interface is between the card, which is carried by the traveler, containing the account number of stored value and the object, which accepts this information. The non-card interface could be a reader at a kiosk or in a vehicle.
U1t	Wide Area Wireless	Wide area 2-way communication capable of communication between a mobile traveler or vehicle and the infrastructure from any location.
U1b	Wide Area Broadcast	Wide area broadcast information, for which the mobile traveler or vehicle can receive information from any location.
U2	Vehicle-to-Roadside	Short-range vehicle to roadside (e.g. beacon).
U3	Vehicle-to-Vehicle	Primarily AHS type communications yet to be defined
W	Wireline	Wireline system interconnection which includes fixed communication capabilities.

Source: ITS America, Standard Development Plan, 1997, P86

2) Development of Message Analysis Table

To build message analysis table, this paper analyzes the content and origin/destination of exchanging message, interoperability degree and architecture interconnect. An example is shown below (see Table 5).

▶ Step 3: Derivation of Standardization Work Items

This paper examines comprehensively the message analysis table, and classifies according to the standards areas described in the first step. The standardization work items are derived based on exchanged information among systems or communication methods (or technology).

▶ Step 4: Standards Priority Selection

1) Criteria
- Development Priority (from the supplier's perspective)

- Survey Results of ITS Standards Needs on KOREA (from the demander's perspective)
- IRD (Interoperability Level)

Table 5. Message Analysis Table for City Bus Information Subsystem

SYSTEM	SUBSYSTEM	MESSAGE FLOW		CONTENTS	AID	IRD
		Origin	Destination			
City Bus Information System	City Bus Information Subsystem	CBIC	RTIC	Operation Schedule Information Operation Status Information Incident Aid Information	W	R
		RTIC	CBIC	Transportation Information Incident Information Road Information	W	R
		CBIC	Display Device	Expected Arrival Time Information	W	P
		Display Device	User	Expected Arrival Time Information	H	NS
		CBIC	RTS	Operation Schedule Information Static Travel Guidance Dynamic Travel Guidance	W	P
		RTS	User	Operation Schedule Information Static Travel Guidance Dynamic Travel Guidance	H	NS
		CBIC	PIS	Operation Schedule Information Static Travel Guidance	W|U1t	P
		PIS	User	Operation Schedule Information Static Travel Guidance	H	NS
		CBIC	RCD	Operation Status Information Expected Arrival Time Information	W	P
		RCD	CBIC	Bus Location Information	W	P
		RCD	TVS	Operation Status Information Expected Arrival Time Information	U2	P
		TVS	RCD	Bus Location Information	U2	P
		TVS	Bus Driver	Operation Status Information Expected Arrival Time Information	H	NS
		TVS	Bus Passenger	Expected Arrival Time Information	H	NS
		GPS	TVS	Bus Location Information	L	N

Note) CBIC (City Bus Information Center), RTIC (Regional Traffic Information Center), RCD (Roadside Communication Device), RTS (Remote Traveler Support Subsystem), PIS (Personal Information Subsystem), TVS (Transit Vehicle Subsystem)

2) Procedure

① The development priorities for APTS subsystem proposed in National ITS Architecture Development Project are classified into four levels (A, B, C and D). The four levels are developed based on the eighth criteria in the National ITS Architecture Development Project and the Master Plan for National ITS (see Table 6).

② The Survey Results of ITS Standards Needs in Korea are classified into four levels (see Table 7).

③ The levels of interoperability are also classified into four (N, R, P and NS).

④ The total score of each work items is gained by adding 40% of the development priorities, 40% of the survey results and 20% of the interoperability level. The perfect score is 40 points. According to this score, the final priorities of each standardization work items are determined.

Table 6. Development Priorities of APTS

SERVICE AREA	SYSTEM	SUBSYSTEM	EVALUATION CRITERIA								PRIORITY RATING
			Possibility of connection with other systems	Relationship with existing system	Service urgency	Easy accessibility of technology	Relatively low institutional issue	Effect proved	Easy funding opportunities	Low initial deployment cost	
APTS	CBIS	CBIS.BIS	○	△	△	○	△	△	△	△	B
		CBIS.BOMS	×	×	△	△	△	×	△	△	C
		CBIS.BLMS	×	×	△	○	△	×	△	△	C
		CBIS.IFCS	×	×	△	△	○	△	○	△	C
	EBIS	EBIS.BIS	○		△	○	△	△	△	×	B
		EBIS.BOMS	×	×	△	△	△	×	△	△	C
		EBIS.SRS	×	×	×	○	○	×	△	○	C

Note) CBIS (City Bus Information System), EBIS (Express Bus Information System), CBIS.BIS (Bus Information Subsystem), CBIS.BOMS (Bus Operation Management Subsystem), CBIS.IFCS (Integrated Fare Collection Subsystem), EBIS.BIS (Bus Information Subsystem), EBIS.BOMS (Bus Operation Management Subsystem), EBIS.SRS (Seat Reservation Subsystem)
Note 2) ○ : high, △: med, ×: low

Table 7. Survey Results of ITS Standards Needs[1]

WORK ITEM	SCORE	PRIORITY RATING
Location Reference Specification	3.37	1
Message Set for Public Transit Information Services	3.32	2
Message Set for Public Transportation Information Services	3.15	2
Message Set for Public Transit Emergency Services	3.13	2
Message Set for Public Transit Operations Management	3.08	3
Data Dictionary for APTS	3.06	3

Note) Priority Rating is classified by the length of time necessary to develop standards. 1: completed in 1 year; 2: completed in 3 years; 3: completed in 5 years; and 4: others.

4.2 Derivation of APTS Standardization Work Items

1) Enabling Standards
Enabling standards, which are 'the standards to standardize,' are divided into architecture, data dictionary, digital road map, and etc. Since this area has a high priority and is making progress actively, it should be standardized before the other items. And the standards include not only the items in APTS area, but also those in the entire area of ITS (see Table 8).

2) Message Set

▶ Development of Standardization Work Items
According to the message analysis table made on the basis of the formats and the contents

[1]) ITS Standardization Demand Survey (ISDS) was conducted by the Korea Research Institute of Human Settlements (KRIHS) from June 8 to June 20, 1998. The focus of ISDS was on the standardization priorities and willingness to participate in the development for each standard. For this study, KRIHS referred to the National ITS Priority Standards Work Plan presented by Standards and Protocol Committee in ITS-America. The Survey was distributed to 216 ITS-related industry participants and research institutes. The results were considered primarily for prioritizing ITS standardization work items, and organizing working groups for each standardization area. This table shows the items related to APTS from the survey results.

of information which is exchanged among physical components of each subsystem in the 4th-level architecture, standardization work items can be divided into 4 main items. These items are included public transportation operations management, public transportation information services, public transportation electronic fare collection and public transportation emergency services for incident management.

Table 8. Standards priorities of enabling area

CATEGORY	SUBCATEGORY	STANDARDIZATION WORK ITEMS	SCORE	NUMBER
Enabling Standards	Data Dictionary	Data Dictionary for APTS	32	ES-1
	Digital Road Map	Location Reference Specification	40	ES-2
	Other	Message Set Template	40	ES-3
		Standard for AVL/AVI	33	ES-4

❍ MS-1: Message Set for Public Transportation Operations Management
MS-1 is the standardization work items which is necessary to operators. The information is the vehicle identification which violates the Exclusive-Bus-Lane, the operation coordination guidance provided by the city bus operation management center and the emergency call to 119 rescue squad from the city or express bus operation management center when the unexpected incidents occur on the roads.

❍ MS-2: Message Set for Public Transportation Information Services
(Part1: Center-to-Center)
This work item specifies the formats and the contents of the information exchanged among the public transport operation centers. These information are provided to public transport users and include operation schedule, operation coordination, operation status, expected arrival time, traffic & road condition, travel time and reservation condition, etc.

❍ MS-3: Message Set for Public Transportation Information Services
(Part2: Center-to-Roadside)
This work item specifies the formats and the contents of the public transportation operation information exchanged between public transport operation center and roadside equipment such as detector and display devices. These information are exclusive-lane operation condition, operation schedule, expected arrival time and bus location, etc.

❍ MS-4: Message Set for Public Transportation Information Services
(Part3: Center-to-Travelers)
This work item specifies the formats and the contents of the information exchanged between public transportation operation center and travelers' terminal devices (RTS, PIS) which users can access easily. These information are reservation condition, operation schedule condition and travel guidance (static or dynamic), etc.

❍ MS-5: Message Set for Public Transportation Information Services
(Part4: Information exchange with TVS)
This work item specifies the formats and the contents of public transportation information exchanged among transit vehicle, detector devices and the satellites. These information are operation condition, expected arrival time and bus location, etc.

❍ MS-6: Message Set for Public Transportation Electronic Fare Collection
This work item specifies the formats and the contents of the information exchanged among the traveler's fare card, automatic fare collection machine inside the public transit,

integrated fare collection center, bank and other public transport companies. These information are fare collection, fare charge condition and fare account, deposit & withdrawal and balance information, etc.

❍ MS-7: Message Set for Public Transportation Emergency Services
This work item specifies the formats and the contents of the unexpected incident information exchanged among public transportation management centers to move passengers safely and quickly when the unexpected incidents occur on the road due to the breakdown or the accidents of the city or express buses.

▶ Priority Selection
Based on the priority criteria and methods presented in the previous section, the priority is rated (see Table 9).

The message set for public transportation information services that enhances the user's convenience has the highest priority score, which agrees with the main objective of APTS in that the consumers' benefit is considered first. The priorities in the public transportation information services are shown in the order of information exchange with public vehicles, center-to-center, center-to-roadside, center-to-traveler devices. Particularly, MS-5 has the top priority because it has rapid deployment priority and requires a national interoperability between transit vehicles and GPS satellites.

Table 9. Standards priorities of Message Set

Category	Subcategory	Standardization Work Items	Score	Number
Message Set	Operation Management	Message Set for Public Transportation Operations Management	21	MS-1
	Information Services	Message Set for Public Transportation Information Services : Part1 (Center-to-Center)	30	MS-2
		Message Set for Public Transportation Information Services : Part2 (Center-to-Roadside)	29	MS-3
		Message Set for Public Transportation Information Services : Part3 (Center–to-Traveler Devices)	28	MS-4
		Message Set for Public Transportation Information Services : Part4 (Information exchange with TVS)	31	MS-5
	Fare Collection	Message Set for Public Transportation Electronic Fare Collection	23	MS-6
	Emergency Service	Message Set for Public Transportation Emergency Services	29	MS-7

MS-4 has the lowest priority score in the public transportation information services since it does not require the connection with other systems due to the low interoperability between center and traveler device and deployment priority is also slow.

MS-7 for unexpected incident occurrence has a moderate priority in APTS as it requires regional interoperability (since information exchange is carried out mainly through center-to-center) and deployment priority is slow

MS-1 has the lowest priority because low score in standards demand survey and slow deployment priority. It results from recognition of both consumers and suppliers that MS-1 is not necessary to provide prior service to other systems.

The table shows that the standards priorities in APTS are not very high as 21～31 since it is not very urgent to construct system compared to ATIS and ATMS.

3) Communication Standards
The communication types used in APTS are center-to-center wireline communication (W), center-to-roadside wireline communication (W) or wide-area wireless communication (U1t) and vehicle-to-roadside dedicated short range communication (U2). However, as they are commonly used in all other parts of areas, not just in APTS of ITS, the standardization work items presented in this study are not just confined to APTS.

Existing international and domestic standards are adopted untouched if possible. And if it is necessary to standardize within ITS, they are developed as the standardization work items.

Table 10. Standards priorities of Communication

Category	Subcategory	Standardization Work Items	Score	Number
Communication Standards	Common	Communication Standard Profile for ITS	40	CS-1
	Wireless	DSRC Protocol for ITS	36	CS-2
		Wide-area Wireless Broadcasting Protocol for ITS Information Services	34	CS-3
	Wireline	National Transportation Communications ITS Protocol for Center-to-Center	30	CS-4
		National Transportation Communications ITS Protocol for Center-to-Roadside	28	CS-5

5. SUMMARY

Though ITS is considered as an efficient method to reduce traffic accidents, congestion, energy consumption and environmental pollution, it requires compatibility and interoperability among ITS user services and systems provided by various agencies.

Therefore, first, the fundamental ITS standards and the international standardization trend were examined. Second, standardization work items and priorities were determined based on the results of APTS architecture analysis and standardization demand survey.

As a result, total 16 standardization work items were developed; 4 in the enabling standards (data dictionary for APTS), 7 in the message sets among physical components of the each subsystem of APTS, 5 in communication standards (DSRC). Of the standardization work items proposed in this paper, the enabling standards except data dictionary for APTS and the communication standards are progressed not in APTS field but in ITS level.

In order to carry out the standardization work smoothly, domestic ITS related companies and academies need to work closely to develop the ITS related standards. Also National Standards Development Organization should make an effort to cope with the international standards trend to assist future domestic ITS industries.

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