KAJIAN PELAN INDUK SISTEM PENGANGKUTAN PINTAR

Development of ITS System Architecture for Malaysia

REVISED

TECHNICAL NOTE NO. 6
Adoption of Critical ITS Standards

June 2007

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1 INTRODUCTION

1.1 Purpose and Scope

The ITS System Architecture for Malaysia is an important step in a larger process that is intended to promote country-wide compatibility and interoperability across Intelligent Transportation System (ITS) deployments. Ultimately, to achieve national compatibility, standards consistent with the architecture framework must be identified or developed and adopted by the implementers of ITS. To support this crucial translation between architecture and standards, this document identifies and assesses the potential standards areas associated with the ITS System Architecture.

The development of ITS standards is critical to the interoperability of ITS applications. However, it should be noted that these standards address the technical requirements for how ITS components interconnect and communicate, but not on the selection of products to deliver such connection and communication.

1.2 What are ITS Standards

There are hundreds of standards used across all different types of transportation, such as vehicle safety standards, road and pavement standards, and rail standards. ITS standards define how ITS systems, products, and components can interconnect, exchange information and interact to deliver services within a transportation network. ITS standards are open-interface standards that establish communication rules for how ITS devices can perform, how they can connect and how they can exchange data in order to interoperate. It is important to note that ITS standards are not *design standards*: They do not specify products or designs to use. Instead, the use of standards gives transportation agencies confidence that components from different manufacturers will work together, without removing the incentive for designers and manufacturers to compete to provide products that are more efficient.

Although stand-alone ITS applications create benefits, the integration of ITS devices and center-based systems results in the greatest efficiencies and improves mobility and safety. ITS standards are an important element in the integration of advanced technologies and systems. ITS standards allow both like and different ITS devices and equipment to exchange and interpret data directly through a common communications interface. This exchange and recognition of data can take place between devices located within a single system or between devices operating in different systems. By using standard-based ITS, agencies can join forces to extend the reach and capabilities of their ITS infrastructure investment. An example of this integration is a road weather data collection system using pavement sensors that can communicate with the nearby dynamic message signs so that the appropriate warning message can be automatically displayed based on pavement condition data sent by the pavement sensors.

ITS standards cover different “communications layers” in their descriptions of how data is communicated between the relevant transportation systems. These layers start with the description of how bits of data are transmitted and extend to the meaning of the entire messages sent over the communications path. ITS standards specify consistency and compatibility of the interconnections and interfaces within an advanced transportation systems.

1.3 ITS Standards Benefits and Risks

1.3.1 Potential Benefits

Well chosen, well timed, and broadly accepted standards can provide the following frequently referenced benefits:

- *Interoperability between diverse systems* – This benefit facilitates cost-effective area-wide implementations that ultimately provide enhanced service to the consumers.

- *Preservation of investment* – Timely standards can reduce investments in multiple incomplete approaches, some of which will become casualties of natural selection from the market place.

- *Technology insertion* – Systems can be incrementally improved to take advantage of new technologies.

- *Creation of broader market* – Interoperability standards set the stage for national and/or international markets. The lack of standards may ultimately limit the size of the market.

- *Interchangeability* – Interchangeable equipment reduces capital cost through increased competition and reduces maintenance costs through smaller spares inventories of less expensive replacement parts.

- *Multiple suppliers* – Interoperable standards provide a common platform allowing data sharing between devices manufactured by different ITS vendors at different times.

1.3.2 Potential Risks

Unfortunately, standardization is no panacea. In particular, accelerating standards ahead of tangible markets, promulgating standards for interfaces independent of need, or heavy handed standards adoption policies which undermine market forces will inevitably have negative repercussions. In additional, standards can have the following undesirable affects:

- *Hinder development of new and innovative technology* – Once a standard is developed and deployed; superior incompatible may not be vigorously pursued or marketable once it has been developed. This problem is accentuated of conditional funding or regulation is tied to adoption of the standard. An order of magnitude improvement may be required to overcome the inertia surrounding the standard.

- *Jeopardize investments by early adopter's of incompatible approaches* – Advanced ITS implementations are several years ahead of the supporting standards. Incompatible equipment may be rendered obsolete by emerging standards and require costly retrofit or replacement.

- *Inhibit market competition* – The market is an extremely efficient selective force. Standards that are accelerated ahead of the market will not benefit from lesson's learned during initial, competitive efforts to satisfy the market and may miss the market that finally does materialize, or result in sub-optimal solutions.

1.4 Standards Development Organizations

Standards Development Organizations (SDO) are independent organizations that develop standards. Each organization is typically responsible for some specific technical areas. Because ITS spans such as large number of agencies, producers, and technologies; there are a number of SDOs that of interest. This section describes the roles and responsibilities of the following SDOs: ISO, NTCIP Joint Standards Committee - NEMA / AASHTO / ITE, IEEE, ASTM, SAE, and APTA.

1.4.1 ISO

The International Organization for Standardization (ISO) was founded in 1946 by 25 national standards organizations to bring together producers and users in the development of voluntary international standards. The objective of the ISO is to promote international standardization of industrial products in order to encourage international exchange of goods and services.

ISO is made up of three different groups of members known as Member Bodies, Correspondent Members and Subscriber Members. Member bodies are entitled to participate and exercise full voting rights on any technical committee of ISO. Correspondent members do not take an active part in the technical and policy development work, but are entitled to be kept fully informed about the work. Subscriber membership is established for countries with very small economies. Malaysia is participating as a member body in the ISO through the Department of Standards Malaysia (DSM).

The standards are developed by technical committees (TC) and they are subdivided into Sub-committees for specific area of standards if necessary. ISO/TC204 is the technical committee that responsible for the standardization of information, communication, and control systems in the field of urban and rural surface transportation. This includes intermodal and multimodal aspects, traveller information, traffic management, public transport, commercial transport, emergency services and commercial services in the ITS field.

The TC204 is composed of representatives from United States, Canada, Europe, Japan, and other countries with ITS interests. It is responsible for the overall system and infrastructure aspects of the ITS as well as the co-ordination of the overall work program in this field including the schedule for standards development. The TC204 is supported by 12 active working groups (WG) and each is responsible for a specific field as shown in **Table 1**. There are 52 published ISO standards under the responsibility of TC204 and they are listed in **Appendix A.**

Table 1 – List of Working Groups under ISO/TC204

WG No.	Responsibility	Convenor Country
1	Architecture	United Kingdom
3	TICS Database Technology	U.S.
4	Automatic Vehicle and Equipment Identification	Norway
5	Fee and Toll Collection	Sweden
7	Commercial / Freight	Canada
8	Public Transport / Emergency	U.S.
9	Integrated Transport Information, Management and Control	United Kingdom
10	Traveller Information Systems	United Kingdom
11	Route Guidance and Navigation Systems	Germany
14	Vehicle / Roadway Warning and Control Systems	Japan
15	Dedicated Short Range Communications for TICS Applications	Germany
16	Wide Area Communications / Protocol and Interface	U.S.

The Department of Standards Malaysia (DSM) adopts the ITS standards developed by ISO as the national standards for ITS. A list of ISO Standards that have been approved to be adopted as Malaysian Standards is summarized in **Appendix B**. These standards are currently pending the formal endorsement from the DSM.

1.4.2 NTCIP Joint Standards Committee - NEMA / AASHTO / ITE

The National Electrical Manufacturers Association (NEMA) was created by joint resolution of the directors of the Associated Manufacturers of Electrical Supplies and the Electric Power Club in 1926. It is responsible for the standardization of electrical equipment which enabling consumers to select from a range of safe, effective, and compatible electrical products.

The American Association of State Highway and Transportation Officials (AASHTO) is the organization which represents transportation departments in 50 states to advocate transportation related policies and provides technical services to support the states to efficiently and safely move people and goods. The goal of the AASHTO is to foster the development, operation and maintenance of a nationwide integrated transportation system and to cooperate with other appropriate agencies in considering matters of mutual interest in the fields of transportation.

The Institute of Transportation Engineers (ITE) is an international educational and scientific association of transportation and traffic engineers, transportation planners and other professionals who are responsible for meeting mobility and safety needs. The Institute facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy and standard development for any mode of transportation. There are 11 ITE Councils which are responsible for the development of standards in different areas of interest.

In 1992, the NEMA began discussions on the development of a common communications protocol for traffic signal systems in response to frequent requests for standardization from the users of traffic signal controllers. In order to encourage the process, the U.S. Federal Highway Administration (FHWA) sponsored a symposium to develop the standards for all types of traffic and ITS devices. The steering committee for the National Transportation Communications for ITS Protocol (NTCIP) was established in 1995 which includes representatives of users, designers, and developers of all types of ITS devices. In 1996, the NEMA was joined by AASHTO and ITE to form a consortium and the NTCIP steering committee was renamed as the NTCIP Joint Standards Committee to further develop the standards for the field of ITS.

1.4.3 IEEE

The Institute of Electrical and Electronics Engineers (IEEE) formed in 1963 with the merger of the American Institute of Electrical Engineers (AIEE) and the Institute of Radio Engineers (IRE). It is responsible for the development of international standards in the areas of telecommunications, information technology and power generation products.

IEEE-SA Standard Board is responsible for coordinating the IEEE standard development activities. Due to the diversification of technical activities, various Societies have been setup within the IEEE structure. Each IEEE Society operates in a distinct technical area and carries out its own publications for standards within the specified technical area. When the scope of a technical area is too broad to be encompassed in a single IEEE Society, or if an IEEE Society finds itself not in a position to carry out the necessary work, the IEEE-SA Standards Board will establish Standards Developing Committee (SCC) to perform this function when necessary.

1.4.4 ASTM

The American Society for Testing and Materials (ASTM) International formed in 1898 is one of the largest voluntary standards development organizations in technical standards for materials, products, systems, and services. The ATMS Technical Committees are responsible for developing standards under the scope of ASTM International. Each technical committee is made up of three levels: main committee, subcommittees, and task groups. Each main committee is a semiautonomous group approved by the ASTM Board of Directors and is responsible for developing standards in a given subject area. Each main committee is divided into multiple subcommittees that address specific areas within the scope of the main committee. Task groups are organized to complete a single specific project such as the development of a new standard or the revision of an existing standard.

1.4.5 SAE

The Society of Automotive Engineers (SAE) formed in 1905 is an educational and scientific organization dedicated to advancing the mobility technologies in the field of aerospace and ground vehicle. There are over 700 technical committees within the organization and they are responsible for the preparation, development and maintenance of the standards within their scope. SAE published various standards in the field of ITS and intelligent vehicle technologies such as Advanced Traveller Information Systems (ATIS), In-vehicle systems interface, ITS data bus, and map database.

1.4.6 APTA

The America Public Transportation Association (APTA) was found in 1882. APTA is an international association of over 1,500 public and private member organizations including transit systems and commuter rail operators; planning, design, construction and finance firms; product and service providers; academic institutions, transit associations and government agencies. APTA, through its policy and planning committees, has played a major role in creating active working structures within the organization focused on the development of standards. APTA focuses on developing standards for the public transportation industry to provide a safe, efficient and economical public transportation services to better serve the public. APTA currently has eight separate active standards development programs in the following areas:

- Passenger Rail Equipment Safety Standards (PRESS)
- Rail Transit Standards
- Bus Transit Standards
- Universal Transit System Fare Collection Standards
- Transit Communications Interface Profile (TCIP) Standards
- Accessibility Standards
- Procurement Standards
- Security Standards

Under the scope of the standards recommendation for the ITS System Architecture for Malaysia, the area of interest is on the TCIP standards.

TCIP is an APTA Standard that provides a library of information exchange building blocks, to allow transit agencies and transit suppliers to create standardized tailored interfaces. APTA TCIP is based on the earlier TCIP work performed by ITE, AASHTO, and NEMA and published as the NTCIP 1400-series standards. APTA TCIP extended the NTCIP Standards to include a Concept of Operations, Model Architecture, Dialog Definitions, and a rigorous, modular approach to conformance.

2 TELECOMMUNICATIONS IN MALAYSIA

2.1 Background

Communication protocols are essential for all the technology used in the delivery of major ITS products and services. In this approach, the communication requirements as identified during the development of the physical architecture will initially be used to narrow the choice for adopted communication standards. To reflect the nature of the communication infrastructure, the communication requirements will be split in two segments – wireless and wireline communication.

2.2 Wireless Communications Systems

Differentiated by the intended range for information exchange, the wireless systems to be considered fall into two different classes: wide-area and short-range communication systems.

2.2.1 Wide Area Communications Systems

In ISO/TC 204, Wide area communications consist of Communications Air-Interface, Long and Medium Range

(CALM) Areas and Probe Areas. Both CALM and Probe are under the WG16 work item list that has been approved by ISO/TC 204 committee. CALM refers to long and medium range, high speed, air interface parameters and protocols for broadcast, point-point, vehicle-vehicle and vehicle-point communications in the ITS sector. It supports the ITS services and internet services, supports continuous communication during handover from one medium to another, covers differences between communication media and/or providers and realizes various communication modes.

The CALM SWG 16.1 defined the media at the lower layer such as Wireless broad-band and cellular phones. SWG 16.2 (CD21210) provides a function to realize a seamless communication environment, particularly the handover among the same medium and medium switching. SWG 16.3 (CD22837) provides the standardization of probe data. SWG 16.4 (NP24101) regularized the application management, which is a scheme to download application software from outside sources and realize new application services for equipment with ITS radio communication functions. Lastly, SWG16.5 established the eCall to deal with the standardization efforts on emergency call using cellular network (CD24977) and automatic crash notification using any available wireless media (CD24978).

At the general structure of CALM, it has an access interface Service Access Point (SAP), making access to the Network layer possible from various media. Multiple media are capable of using CALM, and new media will be added, depending on the future progress in technology or changes in demand. Under the CALM architecture, media other than those not regulated at the moment are also capable of access to network layer. Under the wide area context, the media to be analyzed include: Cellular Network, Wireless Internet Connection, Satellite Communication, 2-way and 1-way radio.

2.2.1.1 Cellular Network

A cellular network is a radio network that made up of a number of radio cells, each served by a fixed transmitter, known as a cell site or transmission tower. The entire cell cites are connected to cellular telephone exchanges “switches”, which in turn connect to the public telephone network or another switch of the cellular company. The cellular phone is a portable telephone that receives or makes calls through a cell site or transmission tower. Radio waves are used to transfer signals to and from the cell phone.

Cellular communication is a common telecommunication infrastructure available in Malaysia. Malaysia uses the second generation (2G) system or Global System for Mobile Communication (GSM) service. Currently, there are three telecommunication operators in Malaysia that uses different GSM bands: Maxis (GSM 900/1800), Celcom (GSM 900) and Digi (GSM 1800). GSM not only support voice communication in digital quality, but also offers data communication capability through SMS, WAP or GPRS and EDGE under the 2.5G framework.

The data communication was built into the system from the 3rd Generation Partnership Project (3GPP). Besides that, the growing interest and attention towards 3G services will also sustain the development of 3G applications and infrastructures. In July 2002, the government's issuance of three Third Generation (3G) licenses to Maxis, Celcom and Time has marked the emergence of 3G technology. Currently, Maxis and Celcom are offering 3G services while Digi still attaching to the EDGE standard.

The key advantages of GSM system are higher digital voice quality and the open standard that allows easy interoperability such as roaming services. In terms of the mobile technology offered, besides the GSM digital voice communication capability, Short Messaging Service (SMS) is the most commonly services being used in Malaysia. The Multimedia Messaging Service (MMS), Wireless Application Protocol (WAP), General Packet Radio Service (GPRS) and Enhanced Data Rates for Global Evolution (EDGE) are the alternative 2.5G standards for data packet communications.

GPRS was added by 3GPP in the Release '97, and EDGE in the Released '99 version of the standard. EDGE increases the data rates three times faster (384kbps) than GPRS (115kbs). The official 3G mobile network is based on the ITU family of standards under the International Mobile Telecommunications Program 'IMT-2000'. It consists of 6 radio interfaces: WCDMA, CDMA2000, CDMA2001, TD-CDMA / TD-SCDMA, UWC-136 and DECT. In Malaysia, the operators use WCDMA technology with the support of around 100 terminals designed to operate 3G mobile networks. The radio spectrum in bands that is provided by the ITU for Third Generation IMT-2000 mobile services is subsequently licensed to operator. 3G uses 5MHz channel carrier width to deliver significantly higher data rates.

Currently, the cellular network is studied under the ISO CALM-2G, 3G (CD21212, CD21213), in cooperation with ITU-R and ETSI with a view to standardization of the interface to utilize 2^{nd} and 3^{rd} generation cellular phones in ITS.

2.2.1.2 Wireless Internet Connection

Wi-Fi is a brand originally licensed by the Wi-Fi Alliance to describe the underlying technology of Wireless Local Area Networks (WLAN) based on the IEEE 802.11 specifications. It was originally developed to be used in LAN environment, but now increasingly used for internet and even VoIP phone access. As part of ITS, more standards are in development that will allow Wi-Fi to be used by cars in highway, and enable mobile commerce such as Electronic Toll Payment System.

The acceptance of wireless internet is prominent in Malaysia. Hotspot is a term coined for the location with wireless internet coverage that allows users to online using the Wi-Fi (IEEE 802.11) technology. Due to the natural characteristic of Wi-Fi that can only cover limited area, the interest has gradually shifted to the more favorable WiMAX. However, the adoption of WiMAX is still in preliminary stage in Malaysia as the issuance of its first license is pended at bidding stage.

IEEE 802.11 or the Wi-Fi standard is a protocol established to describe the underlying technology of WLAN based on the IEEE 802.11p task group under the 802.11 standard. Among the presently possible CALM media, CALM-M5 (CD21215) using WLAN technology is expected to play a central role. CALM-M5 (CD21215) has established the communication interface for ITS communication in compliance with the IEEE 802.11. It is commonly used by the consumer and commercial sectors for their mobile computing devices, such as laptops and Personal Digital Assistant (PDA).

The technologies convergence between the mobile data services and wireless broadband has marked the emergence of Mobile Wireless Broadband (MWB). Due to its ability to function well over large distances and at high travel speeds, MWB is useful for commercial and public-related applications of ITS. Because of that, ISO/TC 204 and ETSI TG37 are forming relationships with the developers of MWB standards and practices, including IEEE 802.16 and the WiMAX forum, IEEE 802.20, ATIS, IETF's Network Mobility (NEMO) working group and TIA initiating inclusion of CDMA2000.

2.2.1.3 Satellite Communication

A communication satellite is an artificial satellite stationed in space for the purposes of telecommunications. One of the applications for communication satellite is in international telephony. Fixed-point telephones relay calls to an earth station, where they are then transmitted to a geostationary satellite. A similar path is then followed on the downlink. In contrast, mobile telephones must be directly connected to equipment to uplink the signal to the satellite. It is renowned as the satellite telephone that communicates directly with orbiting communication satellites.

The satellite solutions in Malaysia started in 1996 when Boeing Satellite Systems and Binariang Sdn. Bhd. signed a contract for the construction of the Malaysia East Asia Satellite (MEASAT) system. MEASAT 1 and 2 were launched in 1996 and MEASAT 3 in 12th December, 2006. The system is operated by the only licensed commercial satellite operator in Malaysia to provide telecommunication, broadcasting and internet services for the region.

The satellites also enable the Global Positioning System (GPS) which can accurately determine the location in any weather and day or night. GPS receivers vary widely in accuracy based on the number of channels they can monitor simultaneously. GPS receivers may include an input for differential corrections using the RTCM SC-104 format. Many GPS receivers that can relay position data to a PC or other device uses the NMEA 0183 protocol.

GPS is an important technology that used on various ITS applications such as probe vehicle system, which consists of a group of vehicles that collect and transmit various types of data using medium and wide area communications, and center functions for statistical processing of the received data to acquire information concerning traffics, road and environment.

2.2.1.4 Radio

Radio is a medium for wireless communication using modulation of electromagnetic waves with frequencies below those of visible lights. A radio receiver is an electronic circuit that receives radio signal at a tuned frequency from an antenna and converts the signal into voice.

Radio is a very conventional telecommunication tool existed even before the independence of Malaysia. Radio Television Malaysia (RTM) is the pioneer in providing radio and television broadcasting services. At present, RTM runs 8 national, 16 state and 7 district radio stations through FM broadcast band that extends from 87.5MHz to 108MHz in Band II. Today, the convergence and compatibility of technology have enable public to listen radio not only through the normal radio set, but also television, handheld devices and through internet.

The two-way radio or walkie-talkie is a hand-held portable, bi-directional radio transceiver. Its major characteristics include a half-duplex channel and a push-to-talk switch that starts transmission. It uses Citizens Band (CB) with channels numbered from 1 to 40. The application of two-way radio can be found in the security company, taxi radio booking and construction site.

In the deployment of ITS, the one-way radio is normally used as a medium to disseminate traffic information to the public through different stations during peak hours. Two-way radio is always used for emergency response purpose and also for the traffic polices to communicate with each other white duty on the ground.

2.2.2 Short-Range Communications

The short range communication systems differ intrinsically from wide area wireless systems. The former benefit from being in a confined geographical area, and therefore are less susceptible to multi-user, multi-base station interference than systems that cover a whole metropolitan area. In this category, Dedicated Short Range Communications (DSRC) and Bluetooth are evaluated.

2.2.2.1 Dedicated Short Range Communications (DSRC)

DSRC is a short-to-medium range wireless protocol specifically designed for automotive use. It offers communication between the vehicle and roadside equipment and is a sub-set of the RFID technology.

The DSRC wireless technology can apply to various ITS areas such as Electronic Toll Collection (ETC), commercial vehicle clearance and safety inspections, traffic data collection, car park management system and etc. Examples of applications in Malaysia include Touch ‘n Go card that communicated with the reader through RFID induction technology, and Smart Tag that incorporated infra-red that communicates with infra-red transceiver mounted at the ceiling of toll plazas to allow drivers to pay toll without stopping. The DSRC technology for ITS applications in

Malaysia is working in the 5.8 GHz passive-system and is compatible with EN 12253:2004 and EN ISO 14906:2004.

2.2.2.2 Bluetooth

Bluetooth, also known as IEEE 802.15.1, is an industrial specification for wireless Personal Area Networks (PANs). Bluetooth provides a way of communication through globally unlicensed short-range radio frequency. With the evolution from Bluetooth 1.0, 1.0B, 1.1, and 1.2, the latest version is Bluetooth 2.0, which offers 3 times faster transmission speed than version 1.x, lower power consumption and wider 100 meter range.

Bluetooth is well-known to Malaysians as an important communication standard for technology products such as cellular phone, personal computer, printer and etc. However, Bluetooth is still not recognized as a common ITS communication protocol in Malaysia.

2.3 Wireline Communications Systems

After many years of development, wireline technologies have become generally accepted by public. Wireline communication technology in Malaysia can be generally divided into two: fixed line telephone and internet.

2.3.1 Fixed Line Telephone

The telephone is a telecommunications device that is used to transmit and receive voice across distance. Most telephones operate through transmission of electric signals over a complex telephone network that allows almost any phone user to communicate with almost any other.

Fixed line telephone is operated using the Public Switched Telephone Network (PSTN) facility that interconnects the dialers and the receivers by dedicated physical wire connections. It was widely accepted by the public and served as one of the most convenient way for communications.

Voice over IP (VoIP) is an emerging technology that is able to offer similar communication capabilities at a much lower rate. VoIP, or IP telephony, broadband telephone is the routing of voice conversations over the internet or through any other IP-based network. In Malaysia, the two major competing standards for VoIP are the IETF standard SIP and the ITU standard H.323.

Due to its low cost and steady connection, fixed line telephone is suitable for long air time communication such as Call Center in Transport Management Center to disseminate the traffic information, while VoIP appears to be a cost-effective solution with the compromise on the voice quality.

2.3.2 Internet

Internet is the worldwide, publicly accessible network of interconnected computer networks that transmit data by packet switching using the standard Internet Protocol (IP). It consists of millions of smaller domestic, academic, business and government networks, which together carry various information and services that include electronic mail, file transfer, World Wide Web, instant messenger and etc.

Previously, many traffic operations use "twisted pair" wiring to control field services such as traffic signals or ramp meters. However, as technology evolved, the existing infrastructure can be used to provide better bandwidth that can even support full motion video. This technology is called Digital Subscriber Lines (DSL). DSL technologies are widely used to implement high-speed data services on twisted pair wire. It becomes one of the favorite candidates for deploying ITS services. Internet can be used to disseminate pre-trip information and real-time traffic information. With the development of broadband facility, one can distribute the image and video information in a seamless process.

In terms of Internet Protocol, it includes Internet Protocol (IP) such as IPv4, Transmission Control Protocol (TCP), User Datagram Protocol (UDP) and Application Protocol, each has their own preferences and specific usage. Internet is another telecommunication mean that has become more important in Malaysia.

3 RECOMMENDATIONS ON ITS STANDARDS

3.1 Adoption of NTCIP

3.1.1 Background

The National Transportation Communications for ITS Protocol (NTCIP) consists of a set of communications protocols and data definition standards that have been designed to accommodate the diverse needs of various subsystems and user services. It differs from the past practice of transportation management protocols in that it is not a single communications protocol designed for a specific purpose. Rather, the NTCIP consists of a whole family of protocols covering the spectrum from simple point-to-point command to sophisticated object oriented communications techniques. Moreover, the NTCIP standards are widely adopted by the ITS industry and therefore are recommended for the Malaysian ITS System Architecture in order for Malaysia to synchronize with the international ITS communities.

NTCIP is a family of communications standards for transmitting data and messages between microcomputer control devices used in ITS. NTCIP provides a non-proprietary ITS language that can be used by all venders, developers and agencies to help achieve interoperability and inter-changeability of traffic control and ITS devices. NTCIP standards define the communications protocols via the definition of the following three elements:

- Data Dictionary Standards – describe the data needed to provide the functionality of transportation services.

- Message Set Standards – define the arrangement of the data being transferred so that the data can form standardized messages (similar to sentences).

- Protocol Standards – define the specific rules for transferring the information (messages) between centers and field devices.

The development and maintenance work for the NTCIP standards is done by the Working Groups (WG). There are fourteen WGs and each is responsible for the development of standards on a particular technical domain. The fourteen WGs include:

- Actuated Signal Control (ASC)
- Base Standards and Profiles 2 (BSP2)
- Center-to-Center (C2C)
- Closed Circuit Television (CCTV)
- Data Collection and Monitoring (DCM)
- Dynamic Message Signs (DMS)
- Electrical and Lighting (ELMS)
- Environmental Sensor Station (ESS)
- Field Management Stations (FMS)
- Global Objects (GO)
- Ramp Metering (RMC)
- Signal Control and Priority (SCP)
- Testing and Conformity Assessment (TCA)
- Transportation Sensor Systems (TSS)

3.1.2 Approach

NTCIP uses a layered or modular approach to segregate communications standards, similar to the Open Systems Interconnect (OSI) layering approach adopted by the ISO. The NTCIP standards are grouped into five different levels to indicate the standard type in different communication levels.

- *Information Level* – This level contains standards for the data elements, objects and messages to be transmitted, for example TCIP, MS/ETMCC. It defines the meaning of data and message and generally deals with ITS information. This is similar to defining a dictionary and phrase list within a language.

- *Application Level* – This level contains standards for the data packet structure and session management, for example, SNMP, STMP, DATEXASN, CORBA, FTP. It may include the definitions of proper grammar and syntax of a single statement, as well as the sequence of allowed statements.

- *Transport Level* – This level contains standards for data packet subdivision, packet reassembly and routing when needed, for example, TCP, UDP, IP. It applies to the exchanges of Application data between point A and point X on a network, including any necessary routing, message disassembly/reassembly and network management functions.

- *Subnetwork Level* – This level contains standards for data exchange between physical interfaces, such as modem, network interface card, CSU/DSU, and the data packet transmission method, for example HDLC, PPP, Ethernet, ATM.

- *Plant Level* – This level consists of the physical transmission media used for communications such as copper wire, coaxial cable, fiber optic cable, wireless connection. The plant level selection will have direct impact on the subnetwork level selection to which it must interface.

The NTCIP communications levels can be illustrated in a "framework" as shown Figure 1 below.

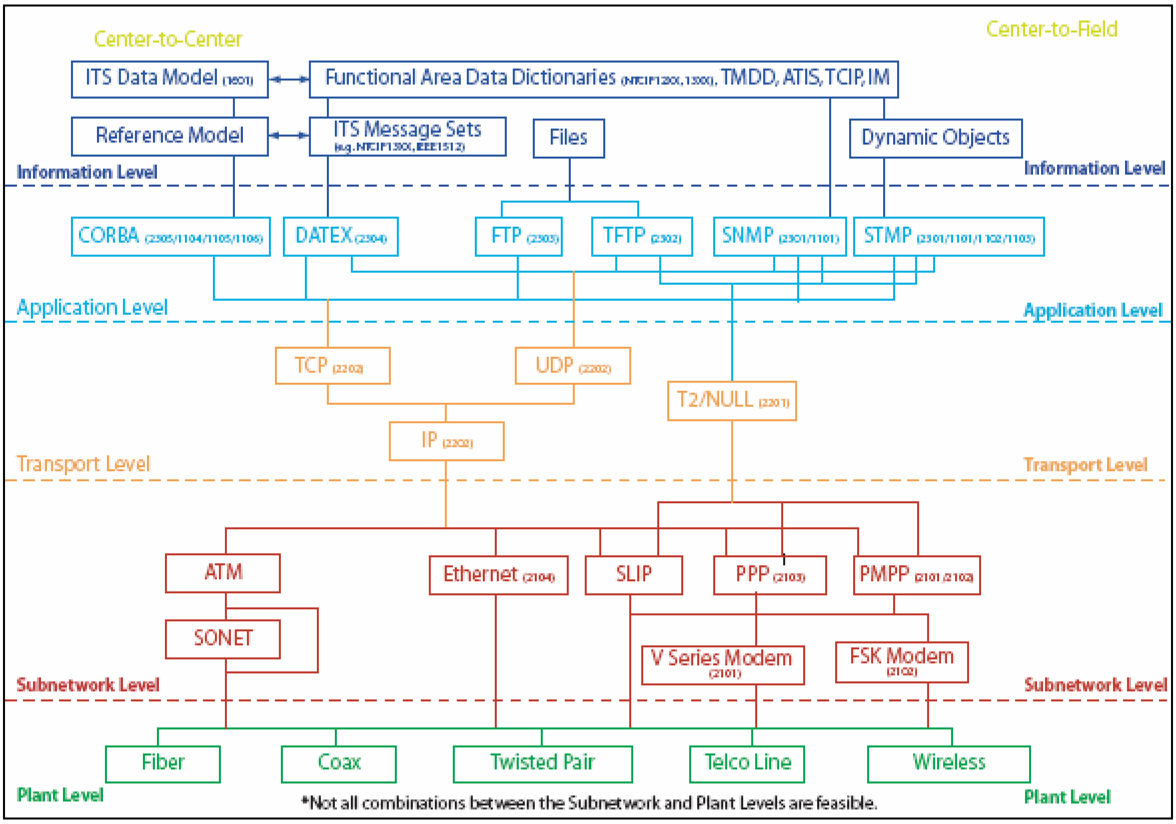

Figure 1 – NTCIP Standards Framework
(NTCIP 9001 - The NTCIP Guide version 3)

The diagram shows the different protocols that can be chosen at each level (boxes) and which ones are compatible (lines connecting the boxes). A particular message transmission can use at least one protocol from each level of the NTCIP framework. A series of protocols used in the message transmission is called a "protocol stack". If there is a line connecting different protocol boxes, then the connecting protocols are compatible and can be used together as part of a protocol stack.

Figure 2 illustrates an example of the deployment of a NTCIP-based system. The highlighted route provides an example of a C2F protocol stack choice that can be defined using NTCIP.

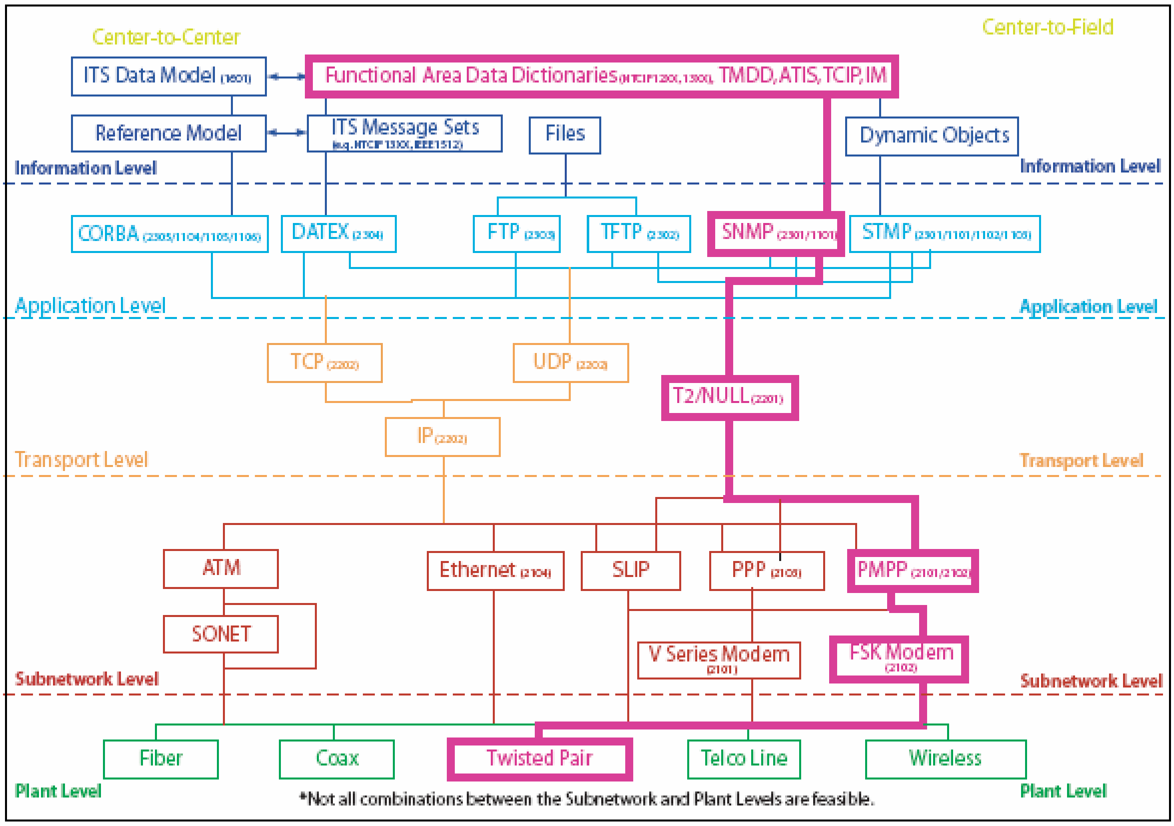

Figure 2 – Example of Center-to-Field Protocol Stack (NTCIP 9001 - The NTCIP Guide version 3)

Most of the standards in the lower levels are existing commercially available standards used in the telecommunications industry and were not developed uniquely by NTCIP, although NTCIP often specifies which sub-options within those standards are to be used. The majority of standards unique to ITS are found in the first two levels (Information Level and Application Level).

3.1.3 Areas of Application

NTCIP defines a family of communications protocols that support most types of computer systems and field devices used in transportation management. Applications for NTCIP are generally divided into two categories: C2F and C2C.

C2F normally involves devices at the roadside, communicating with management software on a central computer. C2C applications usually involve computer-to-computer communications. For both C2F and C2C applications, NTCIP supports systems and devices used in traffic, public transport, emergency management, traveller information and data archiving systems. The NTCIP supports the following systems and devices:

Center-to-Field (C2F)

- Dynamic message signs
- Traffic signals
- Field masters (closed loop systems)
- Data collection and monitoring devices such as traffic counter, traffic classifiers and weigh-in-motion stations
- On-board sensors and controllers

- Environmental sensors
- Ramp meters
- Vehicle detectors
- Closed circuit television cameras (camera control only)
- Video switches
- Highway lighting control

Center-to-Center (C2C)

- Traffic management (freeway/surface street, urban/rural)
- Public transport management (bus/rail/other)
- Incident management
- Emergency management
- Parking management
- Traveler information (all modes)
- Commercial vehicle operations regulation

3.2 Applications of XML

3.2.1 Background

XML stands for the eXtensible Markup Language, is a standard of the World Wide Web Consortium (W3C). XML is a means by which one computer can encode some information (data) so that another computer receiving that encoded information will be able to understand its contents and act on that content (e.g., process the information, display the information to a human, store the information in a database, issue a command to a field device, etc.). It is a useful communications technology for C2C data exchange which allows transportation agencies and center managers to specify communications interfaces for transmitting information between centers.

3.2.2 C2C Communications Environments

There are two XML-based communications mechanisms in ITS C2C Communications. The first mechanism is called a Web Service, enabled by the use of XML-SOAP (Simple Object Access Protocol) and WSDL (Web Services Description Language). Web Services support consumer-initiated requests to a center and the corresponding responses to the consumer. Web Services also support subscription services, where a center can make a one-time request to another center that results in supplier-initiated messages being sent automatically at periodic intervals or whenever data changes.

The second mechanism is called XML Direct; it allows a center to offer information to other centers by simply making it available as an XML file at a known web address. The center providing the information updates this file when any data change. Other centers retrieve the file using plain HTTP or FTP whenever they need such information, or retrieve it regularly in order to monitor it for changes. Using XML Direct, a data provider center can make information available and other centers can retrieve it without having either party to implement the more complex software needed to support XML SOAP. This represents a significant cost saving for centers that do not need to support complex messaging.

3.2.3 Benefits of using XML for C2C Communications

In traditional database, data records require syntax set up by the database administrator. XML however provides the facility to define the syntax which allows developers to create their own customized syntax in order to define, share, and validate the information between systems. This enables easy data exchange between systems with the same syntax setup.

XML is broadly adopted and supported in the general computing and information technology industry. Many industry leading firms like IBM, Sun, Microsoft, SAP, and many others have already announced support for XML. Experienced personnel, off-the-shelf software, and support tools are readily available and relatively inexpensive. Moreover, since XML is structured in a tagged text format, it is possible to directly read and understand the message content. This allows an easy system development and debugging process.

3.2.4 C2C Communications Standards

Successful C2C data exchange requires the involved centers to agree on several key items such as the following:

- *Message Patterns* – define how the message is being requested or triggered.
  (e.g. The Incident Message is sent only when a new incident is first created and thereafter when a change in status occurs, and only to those centers that previously sent a subscription message requesting incident data).

- *Message st*ructures – define the format of the message.
  (e.g. Message 1 contains three elements – Incident ID, Incident Type, and Incident Status)

- *Data elements* – defines the meaning of the data elements that made up the message.
  (e.g. Incident Type 3 means an accident involving at least one fatality)

- *Encode rules* – define the rules used to encode the data into computer readable format.
  (e.g. Incident Type is encoded as an enumerated short integer, with valid values between 0 and 8)

- *Transmission protocols* – define how the message is being transmitted between two computers.
  (e.g., The Incident Message is transmitted using the Transmission Control Protocol (TCP) and the Internet Protocol (IP).

The XML communications for C2C communications in the transportation domain is being developed by the NTCIP C2C Working Group under the document NTCIP 2306. The standard was accepted as a Recommended Standard in December 2005 and the final draft was submitted in December 2006 and awaiting for the final approval.

4 RECOMMENDED ITS STANDARDS FOR COMMUNICATIONS INTERFACE CLASS

One of the main goals for the creation of the ITS System Architecture is to define the major interfaces for standardization. Interoperability is the key to achieving the full potential of the ITS deployments. Interoperability means to have the ability to exchange data using different ITS devices and components via a common interface. Seamless data exchange between different control centers, service vehicles, field equipment and personnel enables an integrated ITS network. A standards-based approach to integration helps to facilitate the exchange of transportation data as well as more easily accommodate future equipment replacements, system upgrades, and system expansions. A set of desirable standards and protocols is therefore essential in achieving nation-wide interoperability and compatibility.

The ITS System Architecture is divided into different communications interface classes which are defined by the type of system / entity at each end of the communications path. The communications interfaces defined in the Architecture can be grouped into six classes and each one is supported and guided by a set of ITS standards. The communications interface classes are defined as follows:

Center-to-Center (C2C)

This class of application areas includes interfaces between transportation management centers.

Center-to-Field (C2F)

This class of application areas includes interfaces between transportation management centers and field equipment (e.g., traffic monitoring, traffic control, environmental monitoring, driver information, and security monitoring devices).

Center-to-Vehicle/Traveller (C2Veh)

This class of application areas includes interfaces between transportation management centers and the devices used by drivers or travellers. It includes interfaces with motorists and travellers for exchange of traveller and emergency information as well as interfaces between transportation management centers and fleet vehicles to support vehicle fleet management.

Field-to-Vehicle (F2Veh)

This class of application areas includes wireless communication interfaces between field equipment and vehicles on the road.

Driver-to-Vehicle (D2Veh)

This class of application areas includes operator interfaces between drivers and in-vehicle ITS equipment (e.g., adaptive cruise control, collision warning system, and navigation and route guidance).

In-Vehicle ITS Communications (In-Veh)

This class of application areas includes data bus protocols for the on-board ITS equipment.

Each SDO covers different areas in the ITS System Architecture and **Table 2** summaries the application areas for each SDO. Refer to **Appendix C** for the recommended standards from each SDO and **Appendix D** for the supporting standards for each communications interface class.

Table 2 – Application Areas for each SDO

SDO	Malaysian ITS System Architecture Communications Interface Class					
	C2C	C2F	C2Veh	F2Veh	D2Veh	In-Veh
NTCIP Joint Committee	✓	✓		✓		
IEEE	✓			✓		
ITE	✓	✓				
ASTM				✓		
SAE	✓		✓		✓	✓
APTP	✓	✓	✓			

5 CONCLUSION

The ITS development in Malaysia is prominent. As the country becomes more developed, the integration of the transportation and information system to enhance the performance becomes more critical. As a pioneer, Kuala Lumpur has implemented the Intelligent Transportation Information Systems (ITIS) to further escalate their traffic monitoring, transportation management and information dissemination capabilities. More second-tier city municipal councils as well as state governments have started to look for intelligent solutions for their deteriorated urban transportation quality.

Defining the appropriate standards is crucial to the establishment of nationally interoperable ITS deployments. However, it should be emphasized that in order to achieve national interoperability, both technical and institutional requirements must be satisfied. Standards only address the technical requirements but not the institutional requirements such as agreements between different government entities for exchanging and sharing information. ITS standards alone will not ensure complete interoperability; institutional issues must also be addressed.

References

1. NTCIP 2306 – Application Profile for XML Message Encoding and Transport in ITS Center to Center Communications (v01.66), NTCIP Joint Committee, 2005

2. NTCIP 9001 – The NTCIP Guide v03.02b, NTCIP Joint Committee, 2002

3. TCIP 9010 – XML in ITS Center-to-Center Communications (v01.07), NTCIP Joint Committee, 2003

4. http://www.astm.org/

5. http://www.ieee.org

6. http://www.iso.org/

7. http://www.ite.org/

8. http://www.nema.org/

9. http://www.ntcip.org/

10. http://www.sae.org/

11. http://www.apta.com/