ITS Standards for Developing Countries

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Introduction

The purpose of this ITS Technical Note 4 is to introduce the subject of ITS standards to decision makers in developing countries who are planning to introduce ITS as part of their transportation system. ITS standards, like other standards, help to make the introduction of technology more systematic and economic. In some respects, ITS standards present a greater challenge than many other kinds of standards because they, like ITS, tend to be interdisciplinary. They include aspects of transportation engineering, civil engineering, electrical engineering, computer science, and communications technology. This is one reason why a good understanding of ITS standards is particularly helpful as part of the process of introducing ITS.

This Note will point out that, on the whole, developing countries will find it most convenient and economical to adopt standards developed and proven elsewhere. However, even countries with relatively limited resources can participate in the development of ITS standards if they want, usually in cooperation with representatives of other countries, either directly or in international standards forums.

Section 1 of this Note describes the need for standards, both in general and more specifically to aid the introduction of ITS in developing countries.

Section 2 describes the three basic types of standards: de facto, consensus, and regulatory, and briefly discusses how each type is created. The section provides additional detail on the process of creating consensus standards both in industry consortia and in organizations specifically oriented to standards development.

Section 3 provides a brief overview of important ITS standards that are already in place, especially those that may be of interest to developing countries.

Section 4 discusses approaches that developing countries can pursue, both for identifying and adopting standards that were created by others and for participating directly in the process of creating standards of particular interest to the country.

The Note concludes with an Appendix that provides a list of prominent standards development organizations, the areas in which they create standards, and where they can be found via the Internet.

1 The Need for Standards

In many respects, the need for ITS standards is the same as the need for other standards, and this general case will be examined first. After the general discussion of why standards are important and beneficial, this section will turn more specifically to ITS standards.

Standards are agreements, within industries, and between governments and industries, to build products and conduct practices in particular well-defined ways. The result of good standardization is to open markets, encourage competition, and ensure quality. Good standards do not limit technical creativity or progress. Instead, they focus on ways to help to stimulate continuing development, but without causing premature obsolescence. This will be discussed further below.

More specifically, good standards will:
• Help to make product behavior consistent and expectable
• Improve the interfaces between parts of complex systems
• Enable users to expect at least minimum product performance
• Help public agencies and other organizations to cooperate and interact successfully
• Offer buyers a greater choice of suppliers, at lower risk and lower cost, and the prospect of faster and more reliable system development
• Offer manufacturers and vendors easier entry to markets, economies of scale, and lower product liability risks
• Offer governments a better ability to achieve social goals uniformly and fairly.

Product Behavior

Standards can help prescribe consistent ways that products should behave under a variety of circumstances, so that users understand how to make them work and also easily understand product responses. Consistency in standards can be as simple as agreeing on what a stop sign or no-left-turn sign should look like, or on the order that various gear choices appear in an automatic transmission. Standards help assure that discs and tapes from many sources all work consistently in audio systems from many manufacturers, that controls in all makes and models of automobiles operate consistently, and that everyone understands that a red traffic signal light means “stop” and a green light means “go.”

Interfaces

One of the most valuable things that standards do is to facilitate connecting components into complex systems by standardizing the interfaces between parts of the system. In the Information Technology (IT) world, “Plug and Play” has become an important selling point and an enabler of the widespread deployment of IT. Plug and Play means that devices can be connected to a computer using standard cables and plugs and, once connected, the device will work properly with minimal need for intervention from the user. For example, many different kinds of printers can be attached to a computer using the same interface, and be automatically recognized and used by the computer. In traffic control
systems, a current trend is to work for plug and play in traffic control devices. This would allow, for example, traffic signals from different manufacturers to be easily and interchangeably connected to the same traffic controller and to behave as expected.

Performance

Many standards prescribe how well a product or system must perform, insuring that users get at least a minimum level of quality when they acquire a product or system. In automobiles, for example, there are standards for how rapidly the brakes must be able to stop the vehicle, and how far ahead headlamps must illuminate the road. One of the attractive aspects of performance standards is that they generally do not specify how the performance is to be achieved. Drum brakes or disc brakes (or some new braking technology) are all acceptable, provided they stop the car in the prescribed time and distance. Lights can be incandescent or fluorescent or halogen (or some new lighting technology), as long as they provide enough illumination. Performance standards encourage manufacturers to find better and less expensive ways to accomplish the stated goal.

Cooperation and Interaction

In this information age, there is a great need for different agencies and other organizations to cooperate, by sharing information and working together. Doing so successfully often requires the development of standards for data models and communications. This facilitates information sharing and helps to ensure that information has the same meaning to all participants.

A very important area of ITS standardization deals with data dictionaries and message sets. These standards assign agreed-upon meanings to items of data and consistently define the format and content of messages used to convey the data. Other standards may be organizational. For example, agencies that want to work with one another may have to agree on a common type of radio communication and rules that facilitate cooperation and prevent interference with one another.

Benefits for Buyers

When products are standardized, they will generally be available from more than one supplier. This has a number of benefits for the people and organizations that acquire these products. First, having multiple suppliers to choose from lowers the risk of a product becoming unavailable or impossible to maintainable if a single supplier goes out of business. This is especially important for critical products or products which are relatively expensive. Second, multiple suppliers will be in competition with one another, which frequently results in better products at lower prices. Finally, since the basic specifications of standardized products are known in advance, the use of these products can lead to more rapid system specification and implementation.

Benefits for Vendors

Standards also provide benefits to the manufacturers and suppliers of the products to which the standards apply. This is not surprising, since most standards are developed by these companies to advance their collective interests. Standards make it easier to enter a market by predefining important features of products. In addition, standards will generally be developed only for products for which there is already a demonstrated demand, lowering the risk of market entry. By reducing some amount of product variation, standards also help manufacturers realize economies of scale. Finally, because standardized products are built to specifications which an industry has carefully considered and agreed upon, they are less likely to fail or perform incorrectly. Even if such a product does fail, adherence to standards is a good demonstration by a company that it has not been negligent in its design and manufacturing practices.

Benefits for Governments

Governments and public agencies share in the benefits that are available to all buyers of standardized products. In addition, however, governments can use standards to help achieve social goals in a fair and equitable manner. For example, everyone may agree that reducing automobile exhaust emissions is a good idea. However, reducing emissions is generally not cost free, and few consumers will voluntarily buy a lower-emissions automobile if it costs more than unmodified automobiles. If consumer won’t buy a feature, automobile manufacturers will probably not offer it. No one wants to be first. To achieve lower emissions and the better air quality that will result, governments have imposed emissions standards that all new automobiles have to adhere to. Although the cost of the automobile may be somewhat greater, this increase is moderated by economies of scale, since all new automobiles must meet the standard. In addition, since everyone is treated equally, it is easier for consumers to accept the change, and overall social benefits result.
Case Study: ETC and DSRC Standards Around the World

Standards for electronic toll collection (ETC) and dedicated short-range communications (DSRC, used to communicate between vehicles and ETC systems) provide interesting examples of success and failure in the creation and use of standards in the developed world. Electronic toll collection, in general, has been one of the most widely adopted and economically successful applications of ITS in both developed and developing countries. One reason for its attractiveness and success, of course, is that it helps to generate revenue by eliminating delays at toll barriers and by generally reducing congestion on toll roads and bridges. It can also help reduce labor costs (more important in developed countries) and make collection more reliable (important in all countries).

However, if a country or region has many different toll systems, it may be inconvenient or expensive for drivers (both of private automobiles and of commercial vehicles) to sign up for each system, acquire multiple transponders, and maintain several accounts. Therefore, these users, particularly commercial users, have pushed for standardization across toll systems. In addition, some toll authorities have recognized the potential efficiencies of joining with other toll authorities for the joint operation of processing centers and other administrative operations. This has tended to work best in compact countries like Japan and in well-defined regions of larger countries (e.g., the northeastern U.S. which is densely populated and heavily traveled). There has been very little success in standardizing the technology for ETC and DSRC in larger areas.

The U.S. tried unsuccessfully for over 10 years to standardize DSRC transponder and communication protocol technology at 915 MHz. Eventually, several years ago, the U.S. Department of Transportation mandated a transponder technology standard, but aimed at helping trucks electronically present their credentials and safety information at state and national borders, not at standardizing toll collection. To date, no company has been willing to manufacture transponders to this standard. A new effort is underway to standardize DSRC at 5.9 GHz, with a primary focus on vehicle safety applications, not toll collection. This effort has already taken far longer than expected, but its participants continue to express optimism that a standard will result.

Europe has been similarly unsuccessful in standardizing ETC technology, despite long and arduous efforts at the European Standards Committee (CEN). An EU Directive requiring this standardization intensified efforts, but did not result in a pan-European standard.

The lesson, for developing countries who aim for nationally standardized ETC, is to focus first on the institutional and administrative aspects of ETC, and the systems needed for a collective operation. Once these can be harmonized, selecting a common technology for ETC communications is relatively easy.

The same story appears at ISO/TC204, where efforts to standardize DSRC for ETC were ultimately unsuccessful, due not only to differences between world regions, but also to the lack of agreement within world regions on the content of these standards. The focus at ISO/TC204 has now shifted to general approaches for vehicle-infrastructure communications with a focus on promoting vehicle safety applications. DSRC in the 5.8-5.9 GHz band is making significant progress, in conjunction with IEEE 802.11 (Wireless LANs), as one of the communications technologies covered by the effort to develop Communications Air interface for Long and Medium range (CALM). Other CALM technologies include infrared, 2.5G and 3G cellular, and millimeter wave (~63 GHz).

Japan is really the only major developed country which has successfully standardized DSRC for ETC. As mentioned above, it has the advantage of a relatively small and densely populated geography, and a government resolve not to go forward with ETC except in a uniform national manner.

Successes in standardizing toll collection then, have mainly resulted from regulatory standards (as in Japan) and from toll authority-driven de facto standards (as in the U.S.). One reason that the toll authority perspective is so important is that ETC does not become interoperable simply by having technical compatibility. Two toll systems which use identical technology will only be interoperable if they can arrive at administrative agreements, to recognize the toll tags issued by the other system and to appropriately distribute revenues collected on the other’s behalf. This is obviously simpler in countries like Japan in which there are relatively few toll operating authorities. (This contrasts, for example, with the 13 different toll operating authorities in the metropolitan New York City area, which nonetheless joined together to form the EZ-Pass coalition, which has now attracted other authorities to join from as far away as the central U.S.).

The lesson, for developing countries who aim for nationally standardized ETC, is to focus first on the institutional and administrative aspects of ETC, and the systems needed for a collective operation. Once these can be harmonized, selecting a common technology for ETC communications is relatively easy.
2 Types of Standards

This section introduces four different kinds of standards – de facto standards, voluntary consensus standards, industry consortia standards, and regulatory standards – each of which is developed differently and each of which has somewhat different effects.

2.1 De Facto Standards

De facto standards are standards that are imposed on an industry by a small number of market leaders (typically one or two).

A classic instance of a de facto standard is the personal computer. In the early days of personal computers, a large number of manufacturers each developed their own designs and technologies. The ways they worked were often quite different from one another and it was difficult to transfer programs or peripheral devices (like printers) from one computer to another. As a result, many businesses and consumers were reluctant to invest in this technology. This changed drastically when IBM announced a “standard” personal computer using Intel microchips and a Microsoft disk operating system (DOS). In addition, IBM made this standard PC architecture available to the marketplace and encouraged other companies to manufacture PCs according to this standard. The result was a highly active and competitive market for these PCs. Even though IBM is itself no longer the largest manufacturer of PCs, it probably sells more units than if it had never created the standard.

At this point in history, Microsoft is the dominant market leader in PC software. It has been able to impose standards for software and peripheral devices, particularly their interfaces to users and to the PC itself, generally making interacting with PCs more uniform.

Another de facto standard is the audio compact disc (CD), which was developed by Philips and Sony. This standard includes the physical form of the disc and the format of the information encoded onto it.

The advantage of de facto standards is that they can be produced and imposed fairly quickly. They encourage some kinds of competition (e.g., among manufacturers of printers or video monitors for computers, among manufacturers of CD players for sound systems) and discourage other kinds (e.g., among word processing and spreadsheet software vendors).

2.2 Voluntary Consensus Standards

By far the largest number of technology standards are those developed using a voluntary collaborative process, typically through a recognized standards development organization (SDO). SDOs are often part of professional societies, like the Institute of Electrical and Electronics Engineers (IEEE) and the Society of Automotive Engineers (SAE).

Other kinds of associations can also have a standards development component. For example, in the U.S., the American Association of State Highway and Transportation Officials (AASHTO) is a major developer of standards related to the construction of roads, tunnels, bridges, and traffic control systems. AASHTO’s members are state departments of transportation, and AASHTO does many things besides standards development, including the support of transportation research and the development of transportation policy.

Some SDOs were created purely for the purpose of developing standards. These include the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and their European counterparts (see Table 1).

<table>
<thead>
<tr>
<th>Standardization Area</th>
<th>International Organization</th>
<th>European Regional Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectrum and Broadcast Rules</td>
<td>International Telecommunications Union (ITU)</td>
<td>European Telecommunications Standards Institute (ETSI)</td>
</tr>
<tr>
<td>Electronics</td>
<td>International Electrotechnical Commission (IEC)</td>
<td>Comité Européen de Normalisation Electrotechnique (European Committee for Electrotechnical Standardization Committee – CENELEC)</td>
</tr>
<tr>
<td>All other</td>
<td>International Organization for Standardization (ISO)</td>
<td>Comité Européen de Normalisation (European Committee for Standardization – CEN)</td>
</tr>
</tbody>
</table>

Table 1 International and Regional Standards Organizations
In addition, most countries, both developed or developing, have a national organization that oversees the development or adoption of standards.

The organizations are also the official members ("national member bodies") of ISO and IEC.

Development of Voluntary Consensus Standards

While standards are developed at these SDOs, the standards are developed by volunteers with interests in the subject matter of the standard. In practice, these volunteers are typically sponsored by their employers to help advance their technology (or other vested interests). However, officially, each volunteer participates as an individual, or in the case of international standards development, as the representative of his or her country's position. The voluntary consensus standards development process is characterized by:

- Openness – Any interested party must be allowed to participate and express views.
- Due Process – Standards are developed according to clearly stated rules and through a series of well-defined stages from initial drafts through final publication. This typically includes multiple levels of review and approval.
- Consensus – Decisions of the development group are arrived at by consensus. This means that all views are listened to, that objections are addressed, and that general (although not unanimous) agreement is required to approve a standard.

In almost all cases, consensus standards, once approved and published, have a specific lifespan, typically on the order of five years. By the end of this lifespan, the standard must be re-approved, sometimes with modifications. If this does not occur, the SDO withdraws the standard at the end of its lifespan, and it has no further force.

By its nature, the voluntary consensus standards development process is a relatively slow one, since large numbers of potentially conflicting vested interests need to be harmonized. In addition, since the participants are usually volunteers, they often have other important responsibilities. Participating in standards development is a part-time (and therefore protracted) activity. SDOs are always looking for ways to speed up their processes, especially in areas like IT and ITS where the technology evolves rapidly. Even so, it often takes two years, often more, to develop a voluntary consensus standard. The other side of this issue, however, is that voluntary consensus standards, once approved, tend to be robust, well accepted, and of great value.

The Use and Force of Voluntary Standards

The quality of voluntary consensus standards is important, since these standards are also voluntary in the sense that companies and agencies not generally obliged to adopt them. They are free to adopt or ignore SDO-developed standards as they see fit, mainly on the basis of their own commercial or political interests. Good standards tend to be broadly adopted, since they help to open markets and promote commerce, and they provide some legal protections to the manufacturers that adopt them.

Some countries (mainly in Europe) have regulations that, in certain circumstances, mandate the use of otherwise voluntary standards (mainly from ISO and IEC) and require that an international standard on a subject must take precedence over national or regional standards on the same subject.

The World Trade Organization adopted an Agreement on Technical Barriers to Trade (TBT), which includes a code of good practice regarding national and international standards. The objective of this code is to minimize
impediments to trade that could arise from differences in regulations and technical standards from one country to another. Nearly 150 SDOs and government agencies from developed and developing countries around the world have subscribed to this code of good practice.

The code encourages SDOs to give equal treatment to products and technologies from other countries and not to develop standards which cause unnecessary barriers to international trade. The code encourages SDOs to base national standards on existing international standards wherever possible and to participate in the development of these international standards. The code encourages the development of performance-based standards and discourages the development of standards that are based on particular designs or specifications. Signatories to the code are expected to report to WTO every six months on the standards they have approved and are developing.

In practice, the code has been regarded more as advisory than compulsory, and it does permit exceptions to its provisions in a variety of special cases. Nonetheless, the TBT Agreement and the code have been very helpful in encouraging the harmonization of standards and in reducing the proliferation of unlike standards on similar subjects.

2.3 Industry Consortia

Consensus standards are also developed in a manner that mixes the traditional voluntary consensus process of SDOs with the de facto standards process. These standards are developed by industry consortia. These consortia are sometimes existing industry associations, but more often industry alliances that are formed for the purpose of advancing a particular technology.

Technology whose standardization is currently being addressed by industry consortia include: Bluetooth (for wireless interconnection of electronics and computer components), the ITS Databus (IDB, an in-vehicle network for channeling data to and from ITS devices in the automobile), and much of the Internet through the Internet Engineering Task Force (IETF).

The number of organizations involved in standards development by consortium is usually much larger than the number involved in setting de facto standards. However, the process is typically not open to all interested parties; often participation is limited to manufacturers of the subject technology. The primary advantage of consortium-developed standards is that the process is generally much faster than the voluntary consensus process, and a critical mass of manufacturers (the members of the consortium) are already in place to adopt and promote the standard. The disadvantage is that the standards are somewhat less likely to be automatically accepted by the marketplace and, in some cases, competing consortia develop competing standards on the same subject, setting back overall standardization. This kind of competition rarely occurs in the voluntary consensus process.

2.4 Regulatory Standards

Regulatory standards are standards imposed by government agencies with the force of law. Some regulatory standards simply mandate the use of standards that were developed by other processes (e.g., voluntary consensus standards). In other cases, government agencies create the standards as well as require them.

Generally, the appropriate role for regulatory standards is to help ensure health and safety and to achieve social goals. For example, government-imposed automotive standards address subjects like brake safety and performance, the availability and use of seatbelts and airbags, restrictions on emissions, required crashworthiness, etc.

In the U.S., some states and cities have created regulations that limit the use of cellular telephones while driving an automobile. This illustrates one of the problems with regulatory standards, namely that they may be adopted in various forms by different jurisdictions. Some automotive regulations differ from one state to another (sometimes one city to another) in the U.S., and often from one country to another (for example in Europe). As a result, regulations relating to driving can change during the course of a single automobile trip, as the vehicle moves into different jurisdictions. Japan has been able to maintain consistency in automobile regulations by insisting that most regulations be on a national level and by virtue of being an island nation.

The process for creating regulatory standards varies widely from one country to another. The processes may include opportunities for comments and suggestions from industry and the public before taking effect. In some countries, a clear scientific or social basis for the regulation must be stated before a regulation can be put into effect, making it more difficult for regulations to be purely political.

Regulatory standards that specify performance requirements (e.g., braking distances, acceptable emissions levels) can be controversial, since they frequently increase costs for particular stakeholders (e.g., vehicle manufacturers and purchasers). In these cases, careful political strategizing must be done to balance the social benefits against the commercial costs. However, performance standards are far less controversial than regulatory standards that prescribe the use of particular technology or technological approaches. Regulatory standards of this kind may provide advantages to some manufacturers at the expense of others and may result in protracted legal battles before being resolved.

Once adopted, regulatory standards are mandatory and have the force of law. The sanctions for failing to follow a regulation are generally specified as part of the regulation. These can vary, depending on the situation and who is affected by the regulation. Manufacturers may be subject to fines. Lower level jurisdictions (e.g., states in the U.S.) may be denied funds. In the extreme (for example, for ignoring safety regulations and thereby causing deaths and injuries), criminal sanctions may be imposed.
3 An Overview of Important ITS Standards

This section introduces a number of ITS standards of various kinds that have been important to the development and introduction of ITS around the world. This introduction is not intended to be a comprehensive catalog of ITS standards. Rather it serves to highlight standards of particular interest.

3.1 De Facto ITS Standards

At this time, there are really no de facto ITS standards in broad use. This reflects the fact that ITS is a relatively new industry, and industry participants are not yet particularly powerful. Microsoft is now trying to enter into partnerships with selected vehicle manufacturers to build its influence in a more measured way.

There have been some attempts to create de facto ITS standards. For example, Microsoft attempted to make its Windows-CE operating system a de facto standard as the platform for user-oriented electronics in vehicles. However, Microsoft does not have the influence in the automotive world that it has in the PC world, and this attempt was unsuccessful, partly because of strong resistance from the vehicle manufacturers.

General Motors has had some success in getting other vehicle manufacturers to adopt its OnStar telematics system in the U.S. and Europe, but this is not really a standard as much as a relatively successful product/service combination.

NAVTEQ and Tele Atlas, the two principal developers of digital roadmap databases outside of Japan have each attempted to create a de facto standard for the CD-ROM and DVD-ROM format of the map databases that are used in in-vehicle navigation systems. However, so far the industry has not broadly adopted either format, and vehicle manufacturer-specific proprietary formats continue to predominate. These two companies are now working together on a common approach for integrating real-time traffic information with the map data used in in-vehicle navigation products. This effort may produce de facto standards in this area in the fairly near future.

3.2 Consensus ITS Standards

North America

The U.S. has produced a number of important ITS standards, often with collaboration from Canada. These include:

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<thead>
<tr>
<th>Advanced Traveler Information System (ATIS) Data Dictionary</th>
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<tr>
<td>Advanced Traveler Information System (ATIS) Message Set</td>
</tr>
<tr>
<td>Advanced Traffic Management Systems (ATMS) Data Dictionary (TMDD)</td>
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<tr>
<td>Commercial Vehicle Electronic Credentials</td>
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<tr>
<td>Commercial Vehicle Safety and Credentials Information Exchange</td>
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<tr>
<td>Commercial Vehicle Electronic Safety Reporting</td>
</tr>
<tr>
<td>High Speed FM Subcarrier Waveform Standard</td>
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<tr>
<td>Information Service Provider - Vehicle Location Referencing Standard</td>
</tr>
<tr>
<td>Message Sets for Dedicated Short Range Communications (DSRC), Electronic Toll and Traffic Management (ETTM) and Commercial Vehicle Operations (CVO)</td>
</tr>
<tr>
<td>On-Board Land Vehicle Mayday Reporting Interface</td>
</tr>
<tr>
<td>Standard for Common Incident Management Message Sets for Use by Emergency Management Centers</td>
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<tr>
<td>Standard for Data Dictionaries for Intelligent Transportation Systems</td>
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<td>Standard Message Set Template for ITS</td>
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<tr>
<td>Standard Specification on DSRC – Data Link Layer</td>
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<tr>
<td>Standard Specification on DSRC – Physical Layer</td>
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<tr>
<td>Standard Specification on DSRC at 5.89 GHz</td>
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<tr>
<td>Standards for ATIS Message Sets Delivered Over Bandwidth Restricted Media</td>
</tr>
</tbody>
</table>

Table 3 ITS Critical Standards in the U.S.
• Data dictionaries and message sets for communicating traveler information (SAE J2353 and J2354), traffic management (ITE/AASHTO), dedicated short range communications (IEEE 1455), and incident management information (IEEE 1512). In addition, standards were developed to help prescribe the form and content of standards for data dictionaries (IEEE 1489) and message sets (IEEE 1488) aimed at particular applications. The objective of these “meta-standard” is to promote consistency and interoperability of the separate application-oriented standards.

In-vehicle networks for ITS, notably the ITS Databus, IDB (SAE J2366)

• A family of standards called NTCIP (National Transportation Communications for ITS Protocols) for the control of traffic control devices (traffic signals, VMS, etc.) and to allow traffic management centers to communicate with one another and with other kinds of centers (e.g., emergency management centers).

These standards are being developed cooperatively by AASHTO, the Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA) with support from U.S. DOT.

U.S. DOT has helped to support the development of ITS standards where they were important to introducing ITS into the infrastructure and to promote public safety. In 1999, ITS America prepared a study that identified 17 particularly critical ITS standards, most of which have now been developed or are under development in various SDOs and industrial consortia. See Table 3.

Europe

The principal source of ITS standards in Europe is CEN’S technical committee on Road Transport and Traffic Telematics (TC204), which frequently works cooperatively and directly with ISO’s technical committee on Intelligent Transport Systems (TC204).

The highest profile CEN standards that are not being pursued jointly with ISO address dedicated short-range communications (DSRC), covering the physical, media access control, and application layers of the Open Systems Interconnection stack. These standards have only recently been approved after many years of work and controversy. There was a strong attempt to pursue these standards in ISO, but regional differences and vested interests prevented this from being successful.

Equally important are a series of CEN TC278 standards for electronic fee collection (EFC) that make use of DSRC. Of particular current interest are standards for adapting EFC Standards for road use charging via GPS and cellular.

CEN TC278 DATEX standards to support communications among traffic management centers and other centers are in the approval process, including a data dictionary (prENV 13106) and data model. These standards have been accepted in other parts of the world including the U.S. There is also considerable interest in current CEN TC278 work on electronic vehicle registration as part of automatic vehicle identification, and in after-theft systems for the tracking and recovery of stolen vehicles.

Europe also regards as important a series of CEN TC278 standards for traveler and traffic information (TTI) messages and standards for automatic vehicle and equipment identification for which CEN has the lead in joint work at ISO (see discussion on International below).

CEN TC278 includes an active working group on public transport, including development of a reference data model (prEN 12896) and standard message sets related to the WORLDIFIP and CAN in-vehicle networks (prENV 13149), with emphasis on vehicle scheduling and control.

Japan

Japan is an active participant in international standards groups like ISO, but does not have a large-scale domestic voluntary consensus standards program. The standards that are developed tend to be developed by industry agreement or through industry-government cooperation, primary for use within Japan.

Japan has been very successful in establishing a nationally uniform ETC system and has established the Organization for Road System Enhancement (ORSE) to promote ETC throughout Japan. Another success is providing widespread and widely-used traffic information through the Vehicle Information and Communications Systems (VICS) program. Similarly, there is a map database format (Kiwi) widely used in Japan for in-vehicle navigation, but which has not proven to be applicable in North America and Europe, where street addressing conventions are different.

International

ISO/TC204 is the principal focus of ITS standards in the international standards community. Notable standards published by TC204 include:

• Reference model architecture (ISO 14813)
• Automatic vehicle and equipment identification for intermodal goods transport (ISO 14815/14816, ISO 17262/17263)
• Requirements for a central ITS Data Registry and Data Dictionaries (ISO 14817)
• Traveler and Traffic Information (TTI) Messages via Traffic Message Coding (ISO 14819)
• Geographic Data File (GDF) specification (ISO 14825) for the exchange of spatial information
• Electronic Fee Collection (EFC) (ISO 14904, ISO 17573)
• In-vehicle navigation systems communications message set requirements (ISO 15075)
• Performance requirements for adaptive cruise control systems (ISO 15622), forward collision warning systems (ISO 15623), and traffic impediment (obstacle) warning systems (ISO 15624)
• Protocol information management for wide area communications (ISO 15662)
A large number of other standards are being pursued at present, with particular activity in the areas of updating the ITS reference architecture, map database technology, electronic fee collection, intermodal freight management, public transport, traffic management, and wide area communications.

ITU maintains a Working Party (WP8A) on the subject of ITS and periodically considers recommendations in the area. Attempts have been made, so far without success, to establish a global radio band for dedicated short-range communications in the 5.8-5.9GHz band. ITU also plans to recommend an update to cellular rules to allow automatic crash notification (ACN) messages to be sent from vehicles without requiring the cellular phone to register, and at very high power to help ensure that the message gets through.

4 Approaches for Developing Countries

The value of having relevant standards in place is unquestioned. However, it is probably not feasible or economic – probably not even desirable – for developing countries to establish their own independent program for developing voluntary consensus standards. The WTO’s Agreement on Technical Barriers to Technology provides strong encouragement to countries not to independently develop standards that have already (or are already being) developed elsewhere, unless such standards are unsuitable for domestic use. If a needed standard does not yet exist, the encouragement is to work with others to develop it. Many developed countries, particularly in Europe, are forgoing national programs of consensus standards development in favor of participation in regional (e.g., CEN) or international (e.g., ISO) development activities.

There are a number of avenues through which private industry and public agencies in developing countries can help to ensure that appropriate standards are available and in place in their countries, both for ITS and for many other areas of interest. These include:

- Adopting national and/or international standards developed by others
- Participating in international standards development
- Participating in relevant industry-oriented SDOs and consortia

All of these approaches (but especially the first one) will benefit from the existence of a national organization in a developing country that coordinates the adoption and use of standards. Usually, the logical candidate is the organization that serves as the country’s national member body at ISO. In addition, an ITS-oriented industry association or ITS promotion organization in a developing country can serve as a valuable advisor to the national standards organization in the area of ITS standards.

4.1 Adopting Standards from Elsewhere

Standards have been getting developed for ITS for nearly 15 years. In other areas of commerce and technology that relate to ITS, standards have been getting developed for far longer. As a result, for many parts of ITS, standards have already been developed, used, and refined. These standards are readily available for use by developing countries. Major SDOs publish catalogs of their standards, and copies of the standards are available for purchase in both hardcopy and electronic form. This includes industry-oriented SDOs like SAE and IEEE, and more broadly based SDOs like CEN and ISO. Like the standards, the catalogs are typically available both in print and online.

The biggest challenge is that there are often a great many standards on particular aspects of industry and technology. It is fairly rare for there to be multiple standards on exactly the same subject (although this happens occasionally), but it may be difficult to find exactly which standard or standards suit the particular need of a developing country, its industry,
and its people. This is an area in which the national standards organization and the industry advisory body can be extremely helpful, to:

- Clearly define the need that the developing country has for a standard.
- Explore the available existing standards and evaluate how well they meet this need.
- Select standards for adoption that are both a good fit to the domestic need and a good fit to other standards that are already in place in the country.
- Publicize to interested parties in the country that the standard has been adopted for national use.
- Provide assistance in including the standard both in procurement requirements and in product and system specifications to meet these requirements.

### 4.2 Participation in International Standards Development

Most developing countries are already members of international SDOs like ISO and IEC through their national member bodies. As a result, they are already well-positioned to participate in the development of international standards at any of a variety of levels. (Only European countries are eligible for membership and participation in CEN, CENELEC, and ETSI.)

Any member country can, if it wishes, become a full voting member (Participating Member or P-member) of an ISO or IEC technical committee (TC). Countries can also choose to be Observing Members (O-members). O-members can attend meetings, but cannot vote. O-members also receive the full collection of information about the TC’s activities so that they can stay informed on TC progress and activities.

If human and financial resources permit, developing countries can send delegates and subject matter experts to TC meetings and to meetings of their subcommittees and working groups.

In most cases, the plenary meetings of TCs focus on administrative and cooperation issues, information sharing about the general subject matter of the TC, and the approval of work items (new standards proposals) and drafts to be balloted. It is helpful to attend TC meetings, but not mandatory. On important issues, like the formal approval of draft international standards, votes are taken by correspondence, and all P-members can vote whether or not they attend plenary meetings.

Actual standards development is done by subcommittees and working groups, which typically meet more often than the TC as a whole. P-members can send experts to these meetings. However, countries are regarded as fully participating in the development of a standard even if they are only able to review and comment on drafts and eventually participate in the voting. This level of participation is a valuable contribution to the development of a standard, and it also helps to ensure that a country’s particular requirements are included in the standard as it is developed. A country can choose a level of participation or observation for each separate standards development initiative.

### 4.3 Participation in Industry Standards Development Initiatives

Developing countries have a similar opportunity to participate in the work of industry-oriented SDOs like SAE and IEEE and in industry consortia. The main impediment is that full participation requires attendance at meetings in various places around the world, which may be too costly for representatives of developing countries. In addition, industry consortia are not open to everyone; however, companies in the relevant industry are generally welcome to participate. Membership in these consortia is often available at a number of different levels of participation and cost. If a standard is important to the domestic industry (or even a particular company) in a developing country, membership and attendance may be a worthwhile expense.

In any case, most SDOs and industry consortia welcome input from any interested person or country. In addition, some SDOs (e.g., IEEE) establish balloting groups to comment and vote on new standards. These groups are separate from the committees that actually write the standards. The work of members of the balloting group is performed entirely by email.

### 4.4 Role of regulatory standards

The governments of developing countries, like all governments, are responsible for maintaining public health and safety and working to achieve agreed-on society objectives. In some cases, fulfilling this responsibility includes the development and imposition of regulatory standards. For ITS, there are some potential additional objectives for which regulatory standards may be helpful. These include promoting uniformity and interoperability of ITS systems so that, for example:

- ETC can be done consistently throughout the country
- Agencies can work together effectively both routinely and in times of emergency
- Nationally issued smart cards can be used in public transport systems in multiple cities

One way in which some countries have promoted uniformity and interoperability is through the use of an ITS system architecture. This is the topic of ITS Technical Note 5 in this series.

It is not a requirement that every person in a country agrees with a particular regulatory standard, but the politics of ITS are simpler and more satisfying if regulatory standards are well-accepted by most people. One way to achieve this is to give stakeholders an opportunity to provide their views as regulatory standards are considered and developed. Another is to conduct a program of outreach that clearly articulates the social or safety objectives of the regulatory standard and how the standard will help achieve these objectives. Regulatory standards that can be presented as carefully arrived at and generally fair will be better accepted and less politically sensitive.
Appendix Where to Find Further Information on SDOs and Standards

The best source of current information on standards, including ITS standards, is the web sites of the SDOs and of some government agencies. The table below provides the main link to these organizations. The use of each site’s "search" function is recommended to seek specific information, since the detailed web addresses are subject to significant change over time.

<table>
<thead>
<tr>
<th>SDO</th>
<th>Relevant Subject Area</th>
<th>Main Web Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Association of State Highway and Transportation Officials</td>
<td>Road design and traffic control standards</td>
<td><a href="http://www.transportation.org">www.transportation.org</a></td>
</tr>
<tr>
<td>(AASHTO) – U.S.</td>
<td></td>
<td></td>
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<tr>
<td>ASTM International</td>
<td>Road surfaces, weigh-in-motion, DSRC</td>
<td><a href="http://www.astm.org">www.astm.org</a></td>
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<tr>
<td>– U.S. and International</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automotive Multimedia Interface Collaboration (AMI-C)</td>
<td>In-vehicle interfaces to ITS equipment</td>
<td><a href="http://www.ami-c.org">www.ami-c.org</a></td>
</tr>
<tr>
<td>– International industry</td>
<td></td>
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<tr>
<td>Comité Européen de Normalisation (CEN) – European</td>
<td>All subjects except electronics and communications</td>
<td><a href="http://www.cenorm.org">www.cenorm.org</a></td>
</tr>
<tr>
<td>Comité Européen de Normalisation Electrotechnique (CENELEC) – European</td>
<td>Electronics</td>
<td><a href="http://www.cenelec.org">www.cenelec.org</a></td>
</tr>
<tr>
<td>European Telecommunications Standards Institute (ETSI) – European</td>
<td>Telecommunications</td>
<td><a href="http://www.etsi.org">www.etsi.org</a></td>
</tr>
<tr>
<td>Institute of and Electronics Engineers (IEEE) – U.S. and international</td>
<td>Electronics and communications</td>
<td><a href="http://www.ieee.org">www.ieee.org</a></td>
</tr>
<tr>
<td>Institute of Transportation Engineers (ITE) – U.S.</td>
<td>Traffic and road engineering</td>
<td><a href="http://www.ite.org">www.ite.org</a></td>
</tr>
<tr>
<td>International Organization for Standardizations (ISO) – International</td>
<td>All subjects except electronics and communications</td>
<td><a href="http://www.iso.ch">www.iso.ch</a></td>
</tr>
<tr>
<td>International Telecommunications Union (ITU) – International</td>
<td>Spectrum and communications</td>
<td><a href="http://www.itu.int">www.itu.int</a></td>
</tr>
<tr>
<td>National Electrical Manufacturers Association (NEMA) – U.S.</td>
<td>Electrical equipment, notably traffic control devices</td>
<td><a href="http://www.nema.org">www.nema.org</a></td>
</tr>
<tr>
<td>Society of Automotive Engineers (SAE) – U.S. and international</td>
<td>Road Vehicles (and aerospace)</td>
<td><a href="http://www.sae.org">www.sae.org</a></td>
</tr>
<tr>
<td>Society of Automotive Engineers of Japan (JSAE) – Japan</td>
<td>Road vehicle</td>
<td><a href="http://www.jsae.or.jp">www.jsae.or.jp</a></td>
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