

10 GLOSSARY AND DEFINITIONS

10.1 Abbreviations and Acronyms

Table 10.1 Glossary	
Abbreviation and Acronym	Full Name
AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standards Institute
APTS	Advanced Public Transportation Systems
ASC	Actuated Signal Controller
ASN.1	Abstract Syntax Notation One
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
AVI	Automated Vehicle Identification
AVL	Automated Vehicle Location
CASE	Computer-Aided Software Engineering
CCTV	Closed-Circuit Television
COTS	Commercial Off-The-Shelf
CS	Conceptual Schema
CVISN	Commercial Vehicle Information Systems And Networks
CVO	Commercial Vehicle Operations
DBMS	Database Management System
DC	Data concept
DE	Data element
DEC	Data element concept
DMS	Dynamic Message Sign
DSRC	Dedicated Short Range Communications
E911	Enhanced 911
EDI	Electronic Data Interchange
EMMS	Emissions Management System
EMS	Emergency Management System or Emergency Medical Services
EPA	Environmental Protection Agency
ES	external schema
ESS	Environmental Sensor Station

Table 10.1 Glossary	
Abbreviation and Acronym	Full Name
ET	entity type
ETTM	Electronic Toll And Traffic Management
FGDC	Federal Geographic Data Committee
FMS	Fleet Management System
HAR	Highway Advisory Radio
GIS	Geographic Information System
GPD	Generic Property Domain
ID	Identification
IEEE	Institute of Electrical and Electronics Engineers
IRDS	Information Resource Dictionary System
IS	Internal Schema
ISO	International Organization for Standardization
ISP	Information Service Provider
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System(s)
MS/ETMCC	Message Set for External Traffic Management Center Communication
NTCIP	National Transportation Communications for ITS Protocols
PR	Property
SAE	Society of Automotive Engineers
TCIP	Transit Communications Interface Profiles
TMC	Traffic Management Center
TMDD	(Advanced) Traffic Management (System) Data Dictionary
TMS	Traffic Management System
TrMC	Transit Management Center
TrMS	Transit Management System
TRSP	Traffic-Responsive
VD	value domain
VIN	Vehicle Identification Number

10.2 Definitions

The following table gives the terms and definitions that are used in the TMDD and/or MS/ETMCC Standards. The definitions from the TMDD Standard were based upon IEEE 1489-1999 Version 0.1.1. The user is referred to the IEEE Standard for more details as well as examples of some of the terms.

Table 10.2 Definitions		
Term, Abbreviation or Acronym		Definition
7.2.1	Altitude	Elevation above or below a reference datum, the z-value in a spatial address. See also elevation.
7.2.2	Application-specific data dictionary	A data dictionary specific to a particular implementation of an ITS application, including all internal and external schema definitions used by that application.
7.2.3	Application-specific message set	A message set specific to a particular implementation of an ITS application, including all data dictionary definitions used by that application.
7.2.4	Area	A generic term for a bounded, continuous, two-dimensional object that may or may not include its boundary.
7.2.5	Artery	A heavily traveled signalized surface street. Generally includes multiple lanes, with complex intersection geometrics and traffic patterns. Major traffic flows generally found along artery. Minor flows at cross streets.
7.2.6	ATIS	Advanced Traveler Information Systems/Subsystem. An ITS functional area.
7.2.7	ATMS	Advanced Transportation Management Systems/Subsystem. An ITS functional area.
7.2.8	Attribute	Any describing characteristic of an entity.
7.2.9	Cartesian coordinates	A two-dimensional x,y location of a point on a plane in relation to two intersection straight lines (axes). If the axes are perpendicular to each other, the coordinates are rectangular; if not, they are oblique. By convention, the x-axis measures the horizontal distance and the y-axis measures the vertical distance from the origin point of intersection. An x,y coordinate defines every point on the plane. Relative measures of distance, area and direction are constant throughout the Cartesian coordinate plane.
7.2.10	Classification scheme	A scheme for the arrangement or division of entities into groups based on properties that the entities have in common.
7.2.11	CCTV	Closed-Circuit television camera field device.
7.2.12	Concept	A unit of thought constituted through abstraction on the basis of characteristics common to a group of entities.
7.2.13	Controller	An electromechanical traffic device that can be used to control traffic signals and other field devices.
7.2.14	Coordinates	Pairs of numbers expressing horizontal distances along orthogonal axes; alternatively, triplets of numbers measuring horizontal and vertical distances.
7.2.15	Coordinate system	A reference system for the unique definition of a location of a point in n-dimensional space.

Table 10.2 Definitions		
Term, Abbreviation or Acronym		Definition
7.2.16	Data	Representations of static or dynamic entities in a formalized manner suitable for communication, interpretation, or processing by humans or by machines.
7.2.17	Database	Collection of information structured in an organized way, typically held and maintained in a computer system.
7.2.18	Data concept	Any one of a group of data dictionary structures defined in IEEE 1489-1999, Version 0.0.7 (e.g., data element, data element concept, entity type, property, value domain) referring to physical objects that can be identified with explicit boundaries and meaning and whose properties and behavior all follow the same rules.
7.2.19	Data dictionary	An information construct for documenting, storing and retrieving the syntactical form (i.e., representational form) and some semantics of data elements.
7.2.20	Data element	A data item that is the basic building block of a data dictionary. A syntactically formal representation of some single unit of information of interest (such as a fact, proposition, observation, etc.) with a singular instance value at any point in time, about some entity of interest (e.g., a person, place, process, property, object, concept, association, state, event). A data element is considered indivisible in a certain context. Defined by a set of data descriptors found in IEEE 1489-1999, Version 0.0.7, Draft Standard for Data Dictionaries for Intelligent Transportation Systems, 9 Oct., 1997.
7.2.21	Data element concept	An expression of the inherent concept embodied in a data element without regard to the value domain(s) by which it can be physically represented.
7.2.22	Data registry	An advanced data dictionary that contains not only information about data elements in terms of their names, representational forms and usage in applications, but also about the semantics or meaning associated with the data elements as concepts that describe or provide information about real or abstract entities. A data registry may contain abstract data concepts that do not get directly represented as data elements in any application system, but which help in information interchange and reuse both from the perspective of human users and for machine-interpretation.
7.2.23	Data structure	Any construct (including data elements and data concepts) used to represent the contents of a data dictionary
7.2.24	Data type	A classification of the collection of letters, digits, and/or symbols used to encode values of a data element based upon the operations that can be performed on the data element.
7.2.25	Datum	A set of parameters and control points used to accurately define the three-dimensional shape of the Earth (e.g., as an ellipsoid). The corresponding datum is the basis for a planar coordinate system.
7.2.26	Detector	A traffic field device that indicates the presence or passage of vehicles or pedestrians.
7.2.27	Device	General nomenclature for any type of electromechanical field equipment including controllers, signals, dynamic message signs, highway advisory radios, etc.
7.2.28	Digital data	Data represented in a computer-compatible format.
7.2.29	Directed links	Links bounded by start and end points.
7.2.30	DMS	Dynamic Message Sign field device.
7.2.31	Elevation	A vertical distance below or above a reference surface. Terrain elevation is expressed with reference to mean sea level (MSL).

Table 10.2 Definitions		
Term, Abbreviation or Acronym		Definition
7.2.32	EMMS	Emissions Management System/Subsystem. An ITS functional area.
7.2.33	EMS	Emergency Management System/Subsystem. An ITS functional area.
7.2.34	Entity	Anything of interest (such as a person, place, process, property, object, concept, association, state, event, etc.) within a given domain of discourse (in this case within the ITS domain of discourse).
7.2.35	Entity type	The construct used to represent an entity in ITS data dictionaries.
7.2.36	ESS	Environmental Sensor Station – provides sensor measurements for roadway air quality and weather conditions
7.2.37	Event	A traffic element that represents the singular occurrence of any abnormal condition that adversely effects traffic operations. Events maybe unplanned (i.e. a multi-vehicle roadway accident) or planned, (i.e. a maintenance lane closure).
7.2.38	Foreign data dictionary	A data dictionary developed by a non-ITS community.
7.2.39	Functional-area data dictionary	A data dictionary that is intended to standardize data element syntax, and semantics, within and among application areas within the same functional area. NOTE—Functional-area data dictionaries contain among their contents refined or synthesized composites of the contents of application-specific data dictionaries, primarily in the form of logical application data elements.
7.2.40	Geodetic datum	A mathematical model of the earth's shape. A geometric set of five quantities that serve as a location reference or base for other quantities. The five quantities are the latitude and longitude of an initial point, the azimuth of a line from this point and two constants necessary to define the terrestrial spheroid.
7.2.41	Geographic coordinates	The quantities of latitude and longitude that define the position on the Earth with respect to the reference spheroid or ellipsoid.
7.2.42	HAR	Highway Advisory Radio field device.
7.2.43	Identifier	A means of designating or referring to a specific entity instance.
7.2.44	Incident	An unplanned randomly occurring traffic event that adversely effects normal traffic operations. For example, a multi-vehicle roadway accident is an incident.
7.2.45	Information Service Provider (ISP)	A public or private entity responsible for gathering, fusing, analyzing and reporting transportation related information motorists and other transportation users.
7.2.46	Instance	An individual occurrence of an entity that belongs to a particular type of entity.
7.2.47	Intersection	Two or more crossing roadways in a surface street network. Generally, an intersection involves conflicting traffic movements and active control devices.
7.2.48	Intelligent Transportation Systems (ITS)	Systems that apply modern technology to transportation problems. Another appropriate meaning of the ITS acronym is integrated transportation systems, which stressed that ITS systems will often integrate components and users from many domains, both public and private.
7.2.49	Interoperability	The ability to share information between heterogeneous applications and systems.
7.2.50	ITS Databus	An electronic implementation of a device layer where electronics components related to advanced vehicle functions can interoperate.
7.2.51	Linear referencing	Process of identifying location(s) on a transportation network or specific link in a network by specifying a start position, direction and distance along a particular route.
7.2.52	Link	A network element that represents the one-way network connection between two nodes. A link carries traffic in a one direction. For example, a link can represent the traffic flow between two interchanges on the mainline of a freeway.

Table 10.2 Definitions		
Term, Abbreviation or Acronym		Definition
7.2.53	Link Id	An identifier assigned to a link. Link-Id may be arbitrary, or may be assigned by convention to assure that multiple occurrences of the same Id will not occur within one network or within the universe of similar networks or databases.
7.2.54	Link referencing	System that identifies a link in a network, and returns its Id value to an external application.
7.2.55	Location referencing system	System of determining the position of an entity relative to other entities or to some external frame of reference.
7.2.56	Map database	A collection of map data, possibly in digital form.
7.2.57	Message	A grouping of data elements and message attributes, used to convey information. For the purposes of this document, a message is an abstract description using a message set template; not a specific instance of transmission.
7.2.58	Message group	A collection of message sets referenced to a specific ITS functional area
7.2.59	Message set	A collection of messages referenced to a specific ITS function.
7.2.60	MS/ETMCC	Message Set for External Traffic Management Center Communication. This is a functional area message set.
7.2.61	Message set template	An abstract structure addressing the data and syntax used to specify the requirements and properties of ITS messages, as well as rules for producing message set standards.
7.2.62	Meta	A wording denoting a description that is one level of abstraction removed from the entity being described.
7.2.63	Meta attribute	In a data dictionary or data registry, a documenting characteristic of a data concept.
7.2.64	Meta data	Data that defines and describes other data.
7.2.65	Meta entity	In a data dictionary or data registry, a structure used to document a data concept.
7.2.66	Model Deployment Initiative	One of the joint public-private programs to implement and test integrated ITS systems and infrastructure in the U.S.
7.2.67	Name	An indexical term used by humans as a means of identifying data elements and other data concepts.
7.2.68	Network	A connected directed set of links and nodes that represent a physically connected set of roadways and intersections.
7.2.69	NTCIP	National Transportation Communications for ITS Protocols, A set of communication protocols, for data transfer, between an operation center and roadside devices.
7.2.70	Node	A network element that represents the starting and/or terminating location of any number of network links. For example, a node can represent a roadway intersection or the merge of two freeways.
7.2.71	Organization-contact	The traffic or transportation organization that has operational jurisdiction for a specific network of traffic highway and/or surface streets and/or combination.
7.2.72	Organization-resource	The public or private organization that has operational jurisdiction of transportation related equipment, facilities or vehicles.
7.2.73	Phase	The right-of-way, change and clearance intervals in a traffic signal cycle assigned to any independent movement of traffic.
7.2.74	Preempt	The transfer from a normal signal control mode to a special signal control mode at an intersection. Used for assigning a green phase to approaching priority vehicle.
7.2.75	Probe	A traffic field device that electronically reads the identification of a passing vehicle.

Table 10.2 Definitions		
Term, Abbreviation or Acronym		Definition
7.2.76	Property	A documenting characteristic of an entity type that is used to group and differentiate individual entities.
7.2.77	Ramp meter	A traffic field device that directs entrance ramp vehicles to stop and proceed in accordance with metering rates.
7.2.78	Restricted maneuver	A prohibition of movement from one roadway (link) to another roadway (link) due to a physical impediment, regional restriction, one-way flow of traffic, or a posted restriction. There may be multiple restrictions pertaining to any link and these restrictions may be limited to a specific time of day and/or day of the week.
7.2.79	Route	An aggregation of sequentially connected links and nodes in a network typically denoting an intended or scheduled path of a transport vehicle. A single transversal of a route by a vehicle constitutes a trip.
7.2.80	Routing	The problem of calculating least-time, least-cost, or other optimized path (route) through a road network.
7.2.81	Schema	An abstract description of the structure of data.
7.2.82	Section	A surface street traffic sub-network of signalized intersections that are interconnected and have a timing relationship between them.
7.2.83	Semantics	The meaning, including concept and use, associated with a given data element or message.
7.2.84	Spatial data	Information about the location, shape, relationships, and attributes of geographic features.
7.2.85	Street address location	Translating a user-oriented place specification (e.g., street address, intersection, vanity address, named place) to a specific object (node or link) in a database.
7.2.86	Street address range	The range of street numbers associated with a street or a particular name, usually within a given area.
7.2.87	Syntax	The structure of expressions in a language, and the rules governing the structure of a language. ITS message syntax is ASN.1 language.
7.2.88	Three-schema architecture	A structured way of organizing the contents of a data dictionary that allows for the separation of the meaning of data concepts from their internal physical implementations in storage media and their external presentation to users or application programs.
7.2.89	Timing plan	A set of cycle lengths, splits and offsets within a section of signals.
7.2.90	TMS	Traffic Management System/Subsystem. An ITS functional area.
7.2.91	TrMS	Transit Management System/Subsystem. An ITS functional area.
7.2.92	TRSP	Traffic-Responsive, A system in which a master controller either selects or computes signal timing based on the real-time demands of traffic as sensed by vehicle detectors.
7.2.93	Value domain	An expression of a specific and explicit representation of a data element within the ITS domain.

11 BIBLIOGRAPHY

11.1 Selected Reading List and References

Table 8.1 Selected Reading List and References	
Subject	Reference
Normative References, for the TMDD Standard	IEEE 1489-1999 Version 0.1.0 Draft Standard for Data Dictionaries for Intelligent Transportation Systems. (Note – at the time of the TMDD balloting and formal standards approval by ITE and AASHTO, the IEEE 1489-1999 was still in ballot and revision to comments. The version used for the TMDD was the latest update available; but, it may vary slightly from the final version when formally approved by the IEEE).
Normative References for the MS/ETMCC Standard	IEEE P1488 Version 0.0.6 Draft Standard for Message Set Template for Intelligent Transportation Systems, 17 Oct. 1997.
Informative References, for the TMDD Standard	Strategic Plan for the Development of an ATMS Data Dictionary, Version 1.0, March 8, 1996, Institute of Transportation Engineers, 525 School Street SW, Suite 410, Washington, DC, 20024.
	ISO/IEC 11179 Information technology – Specification and standardization of data elements Part 1: Framework for the generation and standardization of data elements Part 2: Classification of concepts for the identification of domains Part 3: Basic attributes of data elements Part 4: Rules and guidelines for the formulation of data definitions Part 5: Naming and identification principles for data elements Part 6: Registration of data elements ISO/IEC Copyright Office, Case postale 56, CH-1211, Geneva 20, Switzerland
Informative References for the MS/ETMCC Standard	IEEE 1489-1999 Version 0.0.7 Draft Standard for Data Dictionaries for Intelligent Transportation Systems, 9 Oct. 1997.
	SAE-J2353, Revision 1.0.0, Data Dictionary for Advanced Traveler Information Systems (ATIS), 26 Feb. 1998.
	SAE-J2354 Revision 1.0.0, Message Sets for Advanced Traveler Information Systems (ATIS), 15 Dec. 1998.
	IEEE P1512 Version 0.0.2, Draft Standard for Incident Management Message Sets for Intelligent Transportation Systems, 18 May, 1998.
	ST-ITS-TCIP-SP, Transit Communications Interface Profiles Standard on Spatial Representation Objects, Version 1.0, 20 Feb. 1998.
	USDOT/FHWA, ITS National Architecture - Logical Architecture: Volume 1–Description, June 1996.
	Joint AASHTO/ITE/NEMA TS3. DATEX-199X, NTCIP Application Profile-Data Exchange-ASN.1, Drafter Ver. 98-01.02, 17 Feb. 1998, Part 3 – The DATEX-ASN Data Exchange Format.
	NEMA Standards Publications TS3.1-3.14; National Transportation Communication for ITS Protocol, Communication Standards and Device Object Definitions.
	Location Reference Message Specification (LRMS): Spatial Data Interoperability Protocol for ITS Rev. B. 5 May 1997.
	ISO/IEC 8824-1:1994, Abstract Syntax Notation One (ASN.1)

Table 8.1 Selected Reading List and References	
Subject	Reference
	ASN.1 Tool Set: Reference Manual for UNIX, VMS, OS/2 and MS-DOS, Open Systems Solutions Inc. June 1992.
	ASN.1 Tool Set: User's Guide for UNIX, VMS, OS/2, Windows/NT and MS-DOS, Open Systems Solutions Inc., June 1994.

12 PROCESS FOR REQUESTING UPDATES AND REVISIONS

12.1 Purpose and Options

There will be a continuing need to answer questions, provide interpretations and clarifications, and revise or enhance the TMDD and MS/ETMCC. The steering committee needs a clearly defined process and timeline for these activities. In short, we need:

- A mechanism to make decisions on how to interpret the application of a standard,
- An arbitration process, and
- A mechanism to quickly exchange information and dynamically make changes to the standard.

We anticipate questions, comments, or requests in at least the following categories:

1. What was the rationale for selecting a particular approach in the TMDD or MS/ETMCC?
2. I have run into a particular problem implementing the TMDD or MS/ETMCC. Do you have any suggestions on how to approach this problem? Do you know anyone who has run into this situation and resolved it?
3. I don't understand how to implement a particular data element or message set. Can you provide clarification?
4. I have found a problem with implementing the standard and suggest the following revision.
5. I have found a gap in the standard and suggest the following revision or addition.

The Steering Committee discussed three primary options for an approach to changing the TMDD or MS/ETMCC.

1. Filter questions, comments, and suggestions first by an ITE representative, an AASHTO representative, and a consultant expert. The process would include a mechanism to feed back the questions to the e-mail reflector.
2. Provide a reflector for submitting questions or suggested modifications, via a standard form, and have experts assigned to answer specific types of questions. The answers would go back out via the reflector so others could address answer.
3. A third approach would be to have a moderator that would pass the question to the expert(s) and the answer would be reflected.

The working group discussed these options, selected the third option and refined it.

12.2 Recommended Approach

The recommended approach is centered on a TMDD and MS/ETMCC website that includes:

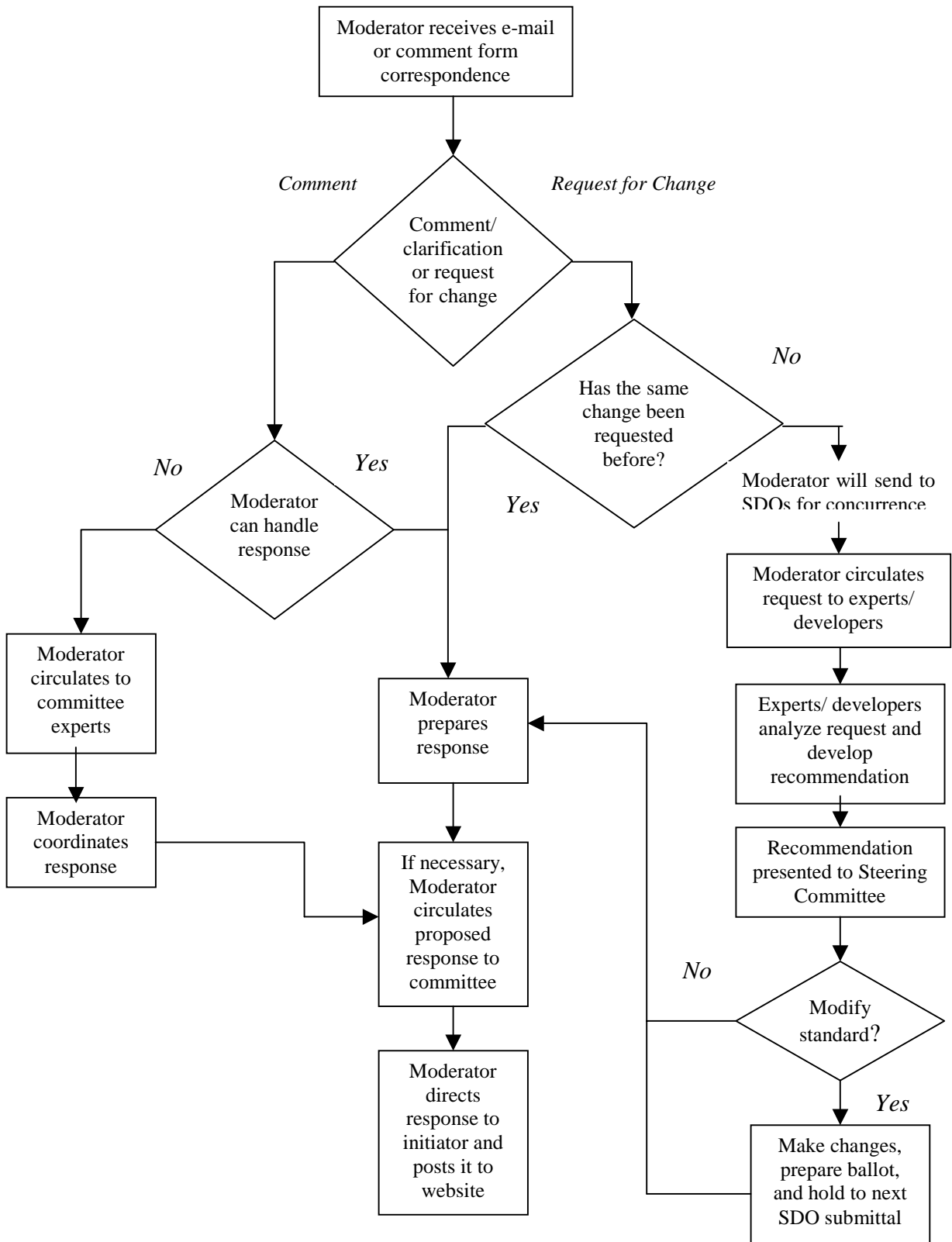
- Data dictionary and message set resources. Information that describes the effort and where to go to get the standards.
- Bulletin board function to post related information.
- Comment form to submit comments, questions, and suggested modifications.

There would also be a reflector established to facilitate discussion about TMDD and MS/ETMCC. The TMDD steering committee's consultant would moderate the reflector. The consultant would also receive the comment forms from the website. The moderator would be responsible to:

- Know who can address specific issues, distribute the comments and e-mail questions appropriately, and coordinate responses.
- Know what activity has been undertaken, what things have been proposed, and what things have been rejected and why. This will short-circuit some of the e-mail inquiries so that moderator can answer them directly.
- Post proposed changes to the website.

Finally, the work group proposes that the committee aims to officially pass changes on to the SDOs (ITE and AASHTO) for balloting once a year. (If the committee feels that an issue is time critical, there could be a ballot on a shorter time frame.) The work group recommends that the steering committee acts on individual changes as they arise and are resolved and hold the changes to be bundled into a ballot annually.

Exhibit 12.1: Recommended Process for Comments and Changes



13 EXAMPLE TMDD AND MS/ETMCC IMPLEMENTATIONS

This Section presents somewhat of a dilemma in that the TMDD & MS/ETMCC Standards are relatively still very new and it takes time to plan, specify, design, implement, and then operate for or with the new Standards. As of this time, the Steering Committee is aware of only a small number of initial efforts that are beginning to deploy the TMDD Standard and fewer still of the MS/ETMCC Standard. As a result there is a very limited amount of information to call upon now from which lessons learned can be drawn and included here. However, as best as can be done at this time guidance based upon those initial limited lessons learned is discussed, including when possible some pitfalls and how to avoid them.

The intent of the TMDD Steering Committee is that this Section will become more complete and thorough over time in subsequent updates of the Guide as more experience with using the TMDD & MS/ETMCC Standards are obtained.

Four of these initial examples are reported on here, where each is response to a different set of functional needs and requirements. As a result each is tending to emphasis use of different combinations of Sections of the TMDD & MS/ETMCC Standards, as shown in Exhibit 13.1.

Exhibit 13.1: Examples by Section of TMDD & MS/ETMCC Standards being Emphasized as of October, 2000		
Application Examples	TMDD Standard Sections and Selected Partitions	MS/ETMCC Standard Groups and Selected Message Sets
New York Metropolitan <i>TRANSCOM</i> Regional Architecture Database (RAD)	Section 1: Links and Nodes Section 2: Events, Incidents, Notification Alarms	Group 1. Roadway-Network Group 2. Network-State Group 3. Network-Events
Seattle, Washington North Seattle Advanced Transportation Management System	Section 3: Traffic Network, Traffic Signal Control, Traffic Detectors, Ramp Meter	
Maryland CHART Dynamic Message Signs	Section 4: Dynamic Message Signs	
Dallas-Fort Worth Center to Center Communications Project	Section 1: Links and Nodes Section 2: Events, Incidents, Notification Alarms Section 3: Traffic Network, Traffic Signal Control, Traffic Detectors, Ramp Meter	Group 1. Roadway-Network Group 3. Network-Events Group 6. Traffic –Control

The following briefly describes the particular applications and discusses any lessons learned to date. The discussion is organized by each application.

13.1 Transcom Regional Architecture Database

TRANSCOM is a coalition of sixteen transportation and public service agencies in the New York-New Jersey-Connecticut metropolitan area. It was created in 1986 to provide a cooperative, coordinated approach to regional transportation management. *TRANSCOM* was selected as one of the four Metropolitan Model Deployment Initiatives (MMDI) by the ITS Joint Program Office of the U.S. DOT. As a MMDI it is implementing a traveler information center and to make consolidated, multi-modal, multi-agency transportation information available to individual travelers. The application of the TMDD and MS/ETMCC Standards reported on here also relates to the effort to deploy the TRANSMIT system for managing incidents and traffic and the TRANSCOM Regional Architecture (RA). The TRANSMIT system will be using Automatic Vehicle Identification (AVI) from toll tags to monitor traffic, detect incidents and estimate travel times and speeds. This system will cover approximately 225 miles of freeways and parkways throughout the tri-state region.

To carry out its responsibilities to its constituent agencies *TRANSCOM* is providing center-to-center communications among 47 Traffic Operations Centers (TOCs) with 52 workstations. That includes a number of state and county DOTs, bridge and tunnel authorities, police agencies, airports, and 6 major transit agencies. The intent of the Regional Architecture is to communicate messages about the tracking of incidents, construction closures, special events, and real-time traffic and transit conditions on the freeways, parkways and transit facilities among all of the workstations. The workstations are more than display terminals each having their own relational databases. There are also 8 servers that operate in a fully meshed fashion with all of the workstations. As of the fall of 2000 the servers were being deployed and a second round of agency testing was taking place. The workstation installation is expected to begin by the end of 2000.

The RA effort focuses on the tracking of incidents, etc. and not on the management of responses to them or on traffic control. The carrying out of such functions are a responsibility of the individual constituent agencies and are dealt with as necessary as part of each of their local architectures and systems.

This example is the most complex of the four implementations presented here and is probably among the most complex in the nation. The project managers and system developers chose to bring in the TMDD and MS/ETMCC Standards as soon as practical in order to effectively deal with the complexity resulting from needing to work with many agencies. The TMDD Section 1 on Links and Nodes and Section 2 on Events, Incident Notification, and Alarms were the ones most relied upon. The Message Set Groups most frequently used included Group1 on Roadway-Network, Group 2 on Network-State, and Group 3 on Network-Events, which emphasize incident and event tracking rather than the management of them

The RA project was begun subsequent to the initial efforts to integrate systems and data from the TRANSCOM member agencies. The RA project defines the data elements and message sets to use in the needed center-to-center communication. The RA project also defines the particular communication flows that would be needed as well as the common databases and relational

database links that enable effective communication and the sharing of data and information to occur among the many centers.

Without the availability of the Standards it is felt that the process would have taken much longer than it has. The desire of the TRANSCOM member agencies to have a standards-based system made arriving at a design consensus easier and faster than would otherwise have been possible. The member agency buy-in process was greatly aided by the existence of the standards. Also, the use of the Standards facilitated the main system developer in obtaining the cooperation of the other system development consultants working in the region.

The implementation needed to develop supplemental sets of application-specific data elements and message sets, which included the following examples:

- In particular, the incident types needed to be expanded and a separate set was specified that better accounted for types of highway and transit incidents. The *TRANSCOM* group had already logged over fourteen years of incident history prior to beginning to implement the Standards. They intend to suggest to the TMDD Steering Committee that consideration be given to having the Standards modified to recognize this expanded list of incident types.
- A supplemental set of generic messages were also developed that provided “Center-to-Center status” to enable the system to explicitly know that connections are not working.
- For some of the advanced traveler information system related information, it was necessary to add some message sets that conform to the Standards in order to stay consistent with messages that are typically used by the local operators.
- Other application-specific message sets dealt with generic alarms, static elements when adding in a new device, and geographic referencing for adding in links. The later in many systems is treated as a very static element, but their experience has been that needing to add in new links has been a very dynamic process.

These application-specific data elements and message sets were handled as supplemental, additional data elements or message sets above and beyond those included in the Standards. The intent was to stay true to the Standards yet have the benefit of more locally applicable data elements and message sets.

As noted above, to date two rounds of constituent operating agency reviews have taken place. The *TRANSCOM* project manager and system developer have found the review comments and suggestions to be very good ones that when addressed have improved the overall implementation. These changes are in the process of being incorporated into a major system release for December of 2000.

There were several lessons learned by this implementation, which included the following:

- The RA should have proceeded earlier than it did prior to efforts to physically connect-up many agencies and some of their vendors and attempting to distribute information.
- Adequate and sufficient time is needed, particularly in a complex multi-agency situation, to review and address comments and concerns expressed by specific agencies. Because agency buy-in is a multi-year commitment to a specific set of operations tools, issues such as what information is needed, what screen layout to use, the content of GIS maps, and the specific site configurations can take a while to resolve.
- *TRANSCOM* specified that only one software should be used in the center-to-center communications, which they commissioned to be developed. That has facilitated reducing the number of interfaces that need to be written to access the software. The software is owned by *TRANSCOM* and they make it available to the constituent members free of charge.

The above information was gathered by personal interviews. For more information on the technical aspects of this implementation of the Standards, contact Sanjay Patel or Tom Batz of *TRANSCOM* in Jersey City, New Jersey at 201-963-4033 or John C. Wintermute of PB Farradyne Inc. in Rockville, Maryland at 301-816-1837.

13.2 North Seattle Advanced Transportation Management System

The North Seattle Advanced Transportation Management System is a project being done for the Washington Department of Transportation. One of the main intents of the project was to develop a standardized approach that the Department could use in interrelating an arterial traffic control system with their Freeway Management System. The North Seattle area was a convenient test case of for developing such an approach. It was also seen as a test of using DATEX.ASN as the communication protocol standard.

The project started prior to the Traffic Management Data Dictionary Standard being developed. The project began using proprietary data elements and protocols of a vendor. With the availability of the TMDD Standards, the focus of the project was shifted somewhat to develop a translation of data elements to those of the TMDD Standard, which was consistent with the intent of the project to develop a standardized approach that could be used in interrelating arterial traffic control systems with the Freeway Management System. By the summer of 2000, the actual development of the approach, Phase I, has been completed and a system build test has been done prior to live deployment. Phase II is the delivery and Phase III will focus on the role of DATEX.ASN.

Technically the project is designed to collect data from local traffic controllers various operating characteristics on synchronization, splits, and offsets as well as system detector data such as volumes and occupancy. In developing the approach, the consultant took the existing definitions of the desired data elements and found the closest matching one from the TMDD Standard and that worked with the DATEX.ASN protocols. The “tool kit” to benchmark the DATEX.ASN protocol developed by the group that is now Iteris was used. There was also some expansion of

the data elements to include some application-specific ones. One example was the need to have a time stamp based upon Greenwich Mean Time, which is not a data element in the TMDD Standard.

In total, about 25 to 30 data elements from the TMDD were used for the project approach, while a handful of data elements needed to be application-specific. The latter included cycle lengths for the controllers, offsets, phase data on the splits, the system clock, as noted above, and alarms for the controllers, such as the door is open or the controller is in flash mode. To some extent the need to develop these application-specific data elements, as contrasted to already having them provided for in the TMDD Standard, was viewed as a short-coming of the TMDD Standard, rather than providing for local flexibility.

There were several lessons learned by this implementation, which include the following:

- There can be a long learning curve for the system developer to become sufficiently acquainted with the TMDD Standards with their first experience with it. The categorizations of the data elements were not always grouped as expected and it was hard to figure out where to look for a particular concept. The consultant team found it necessary to call in staff from another office, who had direct experience in developing the TMDD Standard, in order to significantly short-cut the learning curve.
- It would have been useful to have a “check-list” or “how-to-do” guide in trying to figure out using the TMDD Standard. For example, it was not clear to the consultants that the message set standard was also being developed and they project wound up developing their own message sets for communication purposes by piecing together raw TMDD data elements.
- There is some concern and uncertainty about the actual way to do the implementation of data element transfers with the protocol standards of DATEX.ASN or with CORBA. The DATEX.ASN “tool kit”, which was found to be very helpful may not continue to be supported and without it further development would be very difficult. While CORBA could be used, there are perceptions of problems with using that too.
- The data elements for latitude and longitude where not specific or flexible enough regarding which projection system to reference, such as NAD 83, or one of the many other numerous projection systems.

The above information was gathered using personal interviews. For more information on the technical aspects of this implementation of the Standards, contact Thomas Saul of PB Farradyne, Inc. in Seattle, Washington at 360-297-3821.

13.3 CHART’s Dynamic Message Signs

The State Highway Administration of the Maryland Department of Transportation has a Freeway Management System that is termed CHART, which stands for Coordinated Highways Action

Response Team. CHART has been undergoing a significant system upgrading. Among the purposes of the upgrading has been to migrate from a previous proprietary system to one with an open architecture, and to enable the more effective management of many detectors and an expanding set of Dynamic Message Signs (DMS). The timing was such that the use of the new TMDD Standard is being followed in the system upgrading.

The system design and software consultants are using the TMDD Standard. When one or more particular data elements are defined in the needs and requirements process that is being used, a check is made to see if there is a data element from the TMDD Standard that can meet the intended use. The work has progressed in a staged fashion, with an initial effort being given to the DMSs in Release 1, Build 1. The second build is focusing on incident events and Highway Advisory Radio (HAR) applications. The deployment of a system of improved detectors and the establishment of a data archiving functionality are among the features being worked on for subsequent releases.

The specifications called for the upgrading to follow the National ITS Architecture, with no explicit task reference to the TMDD Standard. It was however referenced in the proposal by the consultant. As of the summer of 2000 the work associated with the upgrading has deployed the initial build, with work for Build 2 for incident events and HAR in the design phase.

There were several lessons learned by this implementation, which include the following:

- It can be a challenge to interrelate the TMDD with the NTCIP protocols for device control. Careful effort is required to match data elements and concepts and to avoid redundancy and conflict.
- The documentation available with the TMDD Standard was not clear enough and required study and educated guesses in order to specify data elements in accordance with the TMDD Standard.
- The TMDD Standard appears to be written with flexibility in mind. In the initial work, only a few application-specific data elements seemed necessary, but more are being anticipated in the forthcoming phases of the work. An example of an application-specific data element relates to tracking the organizational ownership and deployment of arrow boards and portable DMSs dispatched to an incident or construction site. It was necessary to refine the status and notification data elements to address that.
- If the client is very set on what particular types of data they want to use, the resulting needed data elements may not necessarily map well to the TMDD Standard. It is anticipated that the data elements that will be used for events and incidents may need to be significantly different from those provided for in the TMDD Standard.
- Regarding the development of message sets and the use of the MS/ETMCC Standard the CHART implementation is using CORBA protocols.

In general, the availability of the TMDD Standard has been very helpful, describing data elements well. In addition the options that are available provides for needed flexibility.

The above information was gathered using personal interviews. For more information on the technical aspects of this implementation of the Standards, contact John Schumitz of PB Farradyne, Inc. in Rockville, Maryland at 301-816-1852.

13.4 Dallas/Fort Worth Area Deployment Using the National ITS Architecture

The State of Texas has a number of Traffic Management Centers (TMCs) either deployed or in final stages of development. These include ones in Dallas/Fort Worth (DalTrans and TransVISION). Collectively, the TMCs in Texas have been developed utilizing variants of at least four distinctly different system architectures. In 1999, the Texas Department of Transportation (TxDOT), along with the United States Federal Highway Administration (FHWA) initiated a program to develop a Center-to-Center Communications Project that would utilize ITS National Standards to allow traffic conditions information to be gathered and displayed. Additionally, the project implemented the infrastructure necessary, again using standards, to provide the capability to perform device command and control from dissimilar TMCs. The goals of the project include:

- The transfer, storage, and display of traffic conditions data
- Development of a web site to display traffic conditions on a regional basis having the data being drawn from dissimilar TMCs.
- The exchange of device status, command, and control requests: Devices supported include: Dynamic Message Signs (DMS), Lane Control Signals (LCS), and Closed Circuit Television (CCTV) cameras.

The project is being implemented using the evolving Traffic Management Data Dictionary (TMDD) Standard as well as the MS/ETMCC Standard. The use of ITS standards is expected to create a system that is reusable in other ITS application areas and provide the Dallas/Ft. Worth Metroplex with a baseline system that can be cost effectively extended in the future. The project executes in a Microsoft Windows NT environment. The software utilizes TCP/IP and DATEX/ASN to communicate data between computers. The software is designed to operate in a distributed fashion that will support a variety of hardware configurations. The implementation approach is being performed in a phased manner.

- **Phase 1:** An Internet based Traffic map containing speed and incident information was developed and a Graphical User Interface based application was provided so that organizations with no TMC could inject incident information.
- **Phase 2:** Includes exchange of device status information and device control capability between TMCs. Devices include DMS, LCS, and CCTV. Video snapshots were also included.
- **Phase 3:** Includes interface to the ATMSs in other major Texas cities (e.g. San Antonio, Houston, and Austin) so that a "Texas View" of traffic conditions can be displayed.

Regarding the specific technical approach, the project must interconnect several dissimilar traffic management systems. In order to create the center-to-center environment, interfaces to the existing systems will be created. The data from these interfaces will communicate with the existing system in a "system specific" format. The data being deposited into the center-to-center environment will be converted to a standard format that is based on the TMDD Standard. The project is being created using a series of building blocks. These building blocks allow the software to be utilized in a number of configurations by simply altering the configuration parameters of the software. The building blocks being developed include:

- **Data Provider:** receives data from an ITS system in a system specific format and converts the data to TMDD format and then transmits the data to other blocks.
- **ATIS Data Server:** receives traveler information data (e.g., speed, incident, lane closure, screen snaps) from multiple sources in TMDD format and stores the data. Data Extractor blocks subscribe to this block to receive the stored data in TMDD format.
- **Data Extractor:** receives data from the ATIS Data Server block in TMDD format and converts it to a system specific format.
- **Command/Control Sender:** interfaces to an ITS system to transmit command/control requests for ITS equipment.
- **Command/Control Receiver:** interfaces to an ITS system to receive command/control requests for ITS equipment.

This implementation also required the development of a number of custom applications in order to enable the interconnection of these building blocks given above to interface with specific proprietary infrastructure of a TMC or other center. In that customization, the data is converted in format to the standard ones of the TMDD Standard and MS/ETMCC Standard to enable

transmission to other TMCs. In Phases 1 of the project several custom applications were developed related to the Standards, including the following:

- **Fort Worth TransVISION Interface:** An application which extracts data from Fort Worth's database centric TMC and converts the data to TMDD based format for transmission to a data provider.
- **Dallas DalTrans Interface:** An application that extracts data from the Dallas TMC and converts the data to TMDD based format for transmission to a data provider.
- **Incident GUI:** An application that allows the manual entry of incident information. The information is then transmitted to a Data Provider building block.
- **Web Server Application:** An application which receives data from a Data Extractor block and interfaces with ESRI's Internet Map Server (IMS) to display graphical maps featuring travel speeds and incident information to users through Internet Web browsers.

Phase 2 of the project added the ability to provide remote command/control of ITS devices (which includes DMS, LCS, and CCTV). This command/control takes the form of one TMC sending a request message set (specifying a control command) to another TMC. The receiving TMC then must decide if the command can be implemented. The custom applications developed to support this include the following:

- **Fort Worth TransVISION Interface:** An application that allows command/control requests to be transmitted/received by the TransVISION system.
- **Dallas DalTrans Interface:** An application that that allows command/control requests to be transmitted/received by the DalTrans system.
- **Remote ATMS GUI:** An application that allows device command/control commands to be issued and submitted to an ATMS for execution. This GUI is a standalone application that can be executed without having the need to have an ATMS system to issue command/control requests.

This work involved developing some application-specific message sets related to the MS/ETMCC Standard. In several of the major metropolitan areas in Texas extensive use is made of overhead lane control signals. The MS/ETMCC Standard does not have a message set that relates to such devices and communicating to other TMCs or centers the status of the lane configuration at a given time. As such, this project needed to develop one or more application-specific message sets in order to send messages out on the status of the overhead lane control signals.

Regarding lessons learned, the ITS National Architecture is still a work in progress. Projects such as this one demonstrate that components of the architecture are mature and ready for deployment to operational TMCs. The center-to-center building blocks described in this paper provide a basic set of functionality that could be used in a number of environments where center-to-center communications needs to occur. While the initial cost of using standards is not trivial, a well-designed implementation should foster the reuse of source code and in the long run make center-to-center communications a reality for TMCs.

The above information was gathered from a paper presented at ITE 2000 and by using personal interviews. For more information on the technical aspects of this implementation of the Standards, contact Steven W. Dellenback, of the Southwest Research Institute in San Antonio, Texas at 210-522-3914.