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A Report to the ITS Standards Community
ITS Standards Testing Program

FINAL TEST REPORT

For Traffic Management Data Dictionary (TMDD)
and Related Standards as Deployed by the
Utah Department of Transportation

By

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Prepared for

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16. Abstract

This report presents the results of the ITS Standards Testing Program for the field testing, assessment, and evaluation of the three volumes comprising the Standards for Traffic Management Center to Center Communications (TMDD) version 2.1 and the NTCIP Application Profile for XML Message Encoding and Transport (NTCIP 2306) ; that apply in the domain of traffic management and Center-to-Center (C2C) communications. These two standards are identified and described in the following sections. This report fulfils the work product specified in Task 6.2 of Work Order BA34020.

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Table of Contents

Table of Contents (Continued)

Page

List of Appendices

Table of Contents (Continued)

Page

List of Appendices (Continued)

List of Tables

List of Figures

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EXECUTIVE SUMMARY

Introduction

This executive summary presents an outline of the assessment of two ITS standards involved with the dissemination of traffic management and Center-to-Center (C2C) communications as deployed by the Utah Department of Transportation (UDOT). The two standards evaluated by this report are:

Identification	Title	Date
Rev 2.1 Standard	Standards for Traffic Management Center to Center Communications – Volume I: Concept of Operations and Requirements	June 1, 2005
Rev 1.5 Provisional Standard	Standards for Traffic Management Center to Center Communications – Volume II: Message Tables & Sequence Diagrams	December 15, 2003
Rev 2.1 Standard	Standards for Traffic Management Center to Center Communications – Volume II: Companion Annexes	June 1, 2005
NTCIP 2306 v1.51	NTCIP Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications	March 2005

The ITS standards are deployed as part of UDOT's Advanced Traffic Management System (ATMS) and are used to communicate inventory and status information between ATMS and third-party data consumers such at Traffic.com/NAVTEQ. In this deployment, the ITS standards are embodied in the XML messages produced by the ATMS web service and exchanged between agency centers.

Test Methodology

Testing of the ITS standards was accomplished in three phases. The first phase involved the collection and assessment of the body of the standards and the vendor documentation, specifications, and data as it related to the UDOT deployment. This examination included a detailed review of the documentation, a search for consistency, completeness, and compatibility in the standards, and an analysis and evaluation of any issues or concerns discovered. This step was referred to as the static analysis.

The second phase involved generating and conducting a detailed questionnaire to investigate issues identified during the static analysis phase and to probe the experiences and issues encountered by the developer and assess any non-testable technical features. These interviews were conducted with UDOT, the system developer (TransCore), consumers of the ATMS data (Traffic.com/NAVTEQ), and representatives of the Standard Development Organization (SDO) working group. The texts of the interviews are attached in Appendix C of this report.

The third and final phase of the testing process involved the testing of the deployed system and capture of XML messages for analysis to determine how well the user needs are being satisfied

by the standard. The first part of testing was performed by conducting a set of test cases that exercised all of the implemented messages of the standards using a prescribed order and having known expected results. A description of each test case is available in Appendix D of this document. The second part of the testing phase involved monitoring live data from the deployed system and capturing actual messages over a period of five days.

Deployment and Coverage

The results of the static analysis indicated that some modest customization of the standard messages was done and that additional messages were developed and deployed to augment the standards. Despite these customizations, the UDOT deployment does include a significant number of messages that closely adheres to the ITS standards and shows a commitment to use of the features of the standards. The following tables summarize the accounting of user needs and schema components that were implemented at UDOT.

TMDD	Implemented by ATMS	Total	Coverage
User Needs	18	60	30%

TMDD	Implemented by TransSuite	(Entire TMDD)		(Implemented Message Groups)	
		Total	Coverage	Total	Coverage
Messages	15	87	17%	35	43%
Data Frames	23	63	37%	63	37%
Data Elements	55	233	23%	193	28%

Summary of Test Results

Testing was successfully conducted remotely in Columbus, OH on July 25, 2007 at the offices of Battelle. The live monitoring was conducted from June 22, 2007 through June 27, 2007. During this time, each of the 12 ATMS web services was polled once every hour.

The field-testing phase yielded a large body of XML messages that were captured and archived for analysis purposes. These messages are included in the companion CD accompanying this report. The test cases and live monitoring produces the following inventory of XML messages:

- A total of 24 XML messages were captured from the test cases.
- A total of 1,428 XML messages were captured from the live system monitoring.

Overall Findings

All the information collected by the static analysis, questionnaire interviews, and field-testing was compiled into the knowledge base. For each issue identified, a determination was made if it

represented a genuine finding against the standards or was an artifact of some other influence such as versioning, legacy concerns, local requirements, misinterpretations, etc. All issues that were deemed noteworthy are annotated here.

The findings are separated into two categories. The first category is the general findings that apply to the general use of the concepts presented in the standards but do not necessarily apply to any single data object. The second category is the specific findings, which are comments and issues directly related to one item such as a data object, document paragraph, diagram, etc.

The following list summarizes the general and specific findings resulting from the analysis and testing of the ITS standards. In all, there were 22 general findings and 74 specific findings. These findings are described in more detail in the body of this report.

1. The Requirements Traceability Matrix (RTM) provided in Volume II is incomplete and obsolete. The paragraph numbers it references do not coincide with the rest of the TMDD standard and it is missing any reference at all to the standard dialogs.
2. The use case realization diagrams in the standard do not add any apparent value or understanding of the standard and it is not obvious as to what information they are intended to convey. A legend for the diagrams and a usage description should be included in the standard or the diagrams should be removed.
3. The schemas for the TMDD messages are provided in two locations. Once in the companion annex and again the dialog sequences. This has created the opportunity for many discrepancies between these two schema definitions. For clarity, the message schemas should be removed from the dialog sequences.
4. Some terminology and inconsistent naming conventions used in the standard can be confusing. Though this type of issue is considered minor, it can have a significant effect on the clarity of the standard.
5. The industry is trending toward a combined date/time field expressed by the World Wide Web Consortium (W3C) rather than the TMDD date-time data objects. This is ineffective and it would be beneficial to migrate to this industry standard format.
6. The traffic detector requirements do not fit easily with the configuration models of a modern complex detector station that may use multiple technologies to monitor multiple roadways and directions. This area of the standard also does not provide for vehicle counts based on vehicle classifications or allow for information from an aggregated grouping of traffic lanes.
7. The standard uses a link-based model for traffic detector data. The station-based method is an alternative and possible better approach to model point-detection from the field. Forcing the point-based traffic detector data from a real-life system into a link-based form can render the data unusable by the end user. The standard should provide structures for both link and station based models.
8. There is some inefficiency in overhead built into the status messages, which include some data fields that contain static information. To streamline the data flow, it is suggested that static information about devices be limited to the device inventory messages while the device status and data messages be minimized to provide only dynamic data.

9. The standard is void of any significant informative examples to illustrate and clarify the intended use of the data objects. It is felt that addition of these can have a positive impact on the clarity of the standard and the interoperability of systems.
10. The need for traffic detector data lacks a functional requirement for the inventory and status of detector stations. This omission led the developer to implement a custom solution to supplement the standard. It is suggested that this feature be considered for inclusion in future version.
11. The user has a need to exchange travel time information along routes between detector stations. The standard does not provide user needs or functional requirements to describe routes; and travel time information is limited to links. This led the developer to implement a custom solution to provide this capability. It is suggested that this feature be considered for inclusion in future version.
12. There are many cases where the data objects described in the standard do not properly implement the functional requirements set forth in the standard as identified in the specific findings of this report. Since the functional requirements are derived from the user needs, it is likely that the message schemas are not meeting the user needs where these discrepancies occur.

Conclusion

The TMDD standard employed a systems engineering approach to the development of center-to-center communications and defines user needs, functional requirements, communication dialogs, and messages schemas. However the interrelation among these elements is not adequately defined due to the Requirements Traceability Matrix (RTM) being obsolete and incomplete. The RTM maps the relationship between the user needs, functional requirements and message schemas, but is missing references to the standard dialogs. Also, many of the paragraph number references do not coincide with the rest of the TMDD standard. As such, an assessment of the dialogs support for interoperability cannot be adequacy evaluated.

Deficiencies with the RTM also precludes the use of the systems engineering aspects of the TMDD standard. The UDOT deployment overcame these issues by implementing a customized web service design to exchange the TMDD messages. This deployment, though effective, and sufficient to meet the needs of UDOT and the consumers of the information provided by them, demonstrates that interoperability based on the merit and content of the TMDD standard has not been achieved.

The suitability of the TMDD standard to meet the operational user needs was assessed by mapping the messages implemented by the UDOT deployment to their intended user needs and evaluating if the actual needs of UDOT were adequacy met. The TMDD suitability was assessed to be marginal with the need to extend the message schema to accommodate additional needs not addressed by the standard. The TMDD standard is deficient in the areas of point-based detector stations, route inventory and status, and travel time information resulting in extensive custom solutions to fill these gaps. There are also many instances where the message schema does not coincide with the functional requirements set forth in the standard.

For these reasons, the TMDD standard was assessed to be only marginally effective with significant deficiencies in the documentation and tractability between the user needs, standard dialogs and message schemas as discussed in the detailed findings in this report. Also, clarity of use appears to have been a recurring issue experienced by the developers. Providing an informative explanation with practical examples to augment the normative descriptions of each message would enhance the understandability and effectiveness of the standard.

Configuration control used in the standards development process needs to be more stringent to prevent deployments from being developed using incremental versions of the standards. The use of these non-released versions complicates the development, evaluation and acceptance of the ITS standards. Similarly, identification and distribution of the standards volumes need to be addressed. As it relates to the TMDD, version and date mismatches, coupled with ambiguous naming conventions and the lack of a simple identifier (e.g. NTCIP 2306 or SAE J2354) make identifying the proper volumes to be used difficult. This extends to their publication on the website, as the ISTT was not even aware of the Volume II "Message Tables …" relationship to the other V2.1 volumes until after a large portion of the evaluation had been conducted.

Two of the sub-profiles defined in the NTCIP 2306 standard were tested by means of capturing, framing and examining the network data packets to and from the ATMS web service. No discrepancies were found in the encoding and transportation of the TMDD messages over either protocol. Other than some minor omissions and typographical errors, there were no significant findings associated with the NTCIP 2306 standard.

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1.0 INTRODUCTION

This report presents the results of the ITS Standards Testing Program for the field testing, assessment, and evaluation of two ITS standards that apply in the domain of traffic management and Center-to-Center (C2C) communications. These two standards are identified and described in the following sections. This report fulfils the work product specified in Task 6.2 of Work Order BA34020.

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2.0 BACKGROUND

2.1 ITS Standards Testing Program

The U.S. Department of Transportation (USDOT) has created the Intelligent Transportation Systems (ITS) Standards Test Program, whose objective is to assess a standard's performance and evaluate the ability of the standard to accomplish interoperability and interchangeability in ITS deployments. The ITS Standards Test Team (ISTT) has been contracted by USDOT, in cooperation with the Standards Development Organizations (SDO) and USDOT, to evaluate the coverage and approach used by the site in deploying standards, and conduct both detailed static analysis and hands-on testing of the standard as used at the site.

2.2 ITS National Architecture

The TMDD standard is derived from the architecture flows identified in the National ITS Architecture version 4.0. The scope of this standard is to identify and describe the services that may be provided by a traffic management subsystem to other external center subsystems of the national ITS architecture. The flows of the ITS physical architecture that are subject to TMDD are shown in Figure 2.1.

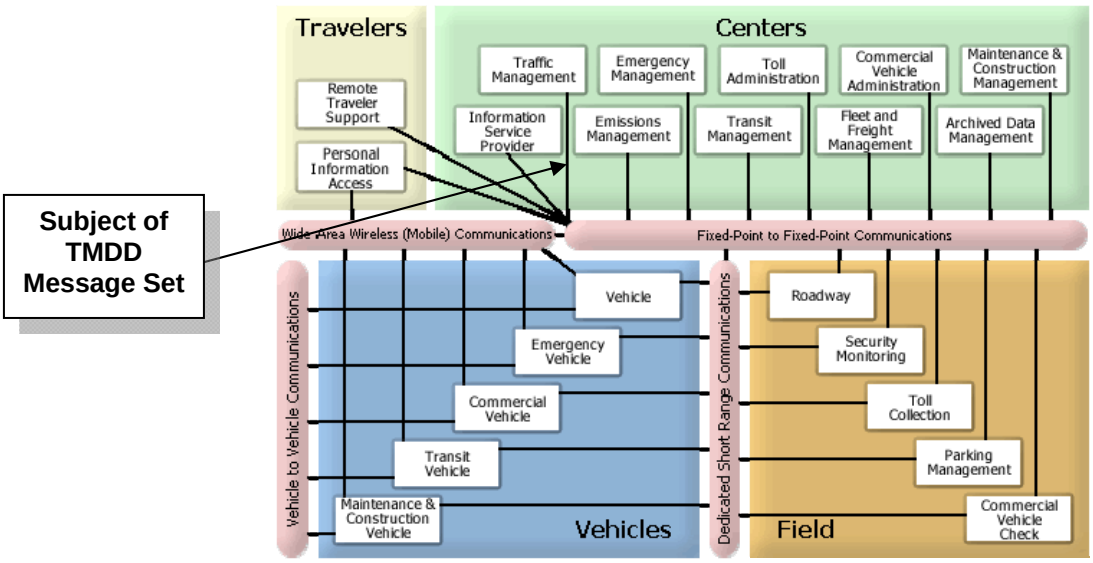

Figure 2.1. ITS Physical Architecture

2.3 Standards Baseline

This report contains the results from the field testing of a specific subset of ITS standards applicable to the center-to-center exchange of information relating to advance traffic management. The primary standards of interest for ITS standards testing at UDOT are the Traffic Management Data Dictionary (TMDD) standard and the National Transportation

Communications for ITS Protocol (NTCIP) 2306 standard. These standards are enumerated in detail in Table 2.1.

Table 2.1. Standards of Interest

Identification	Title	Date
Rev 2.1 Standard	Standards for Traffic Management Center to Center Communications – Volume I: Concept of Operations and Requirements	June 1, 2005
Rev 1.5 Provisional Standard	Standards for Traffic Management Center to Center Communications – Volume II: Message Tables & Sequence Diagrams	December 15, 2003
Rev 2.1 Standard	Standards for Traffic Management Center to Center Communications – Volume II: Companion Annexes	June 1, 2005
NTCIP 2306 v1.51	NTCIP Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications	March 2005

The standards of interest listed in Table 2.1 reference other standards and protocols. These standards were not directly evaluated but are included here for reference.

- **ISO/IEC 8824-1**, (ASN.1): Specification of basic notation
- **ISO/IEC 8824-2**, (ASN.1): Information object specification
- **ISO/IEC 8824-3**, (ASN.1): Constraint specification
- **ISO/IEC 8824-4**, (ASN.1): Parameterization of ASN.1 specifications
- **WS-I BPV-1.0a**, Basic Profile Version 1.0a – Final Specification, August 08, 2003
- **W3C WSDL 1.1**, Web Services Description Language, March 15, 2001
- **W3C XML 1.0**, Extensible Markup Language, February 04, 2004
- **W3C SOAP 1.1**, Simple Object Access Protocol, May 08, 2000
- **RFC 2616 1.1**, Hypertext Transfer Protocol (HTTP), June 1999
- **RFC 959**, File Transfer Protocol (FTP), October 1985
- **ITE TCIP**, Standard on Incident Management Objects
- **SAE J2354**, Messages for Advance Traveler Information Systems (ATIS), October 2000
- **IEEE 1512**, Standard for Traffic Incident management Messages Sets for Use by Emergency Management Centers

2.4 The UDOT Deployment

The State of Utah Department of Transportation (UDOT) has deployed an Advanced Traffic Management System (ATMS) to provide data to verified third-parties using the Center-to-Center (C2C) protocol for TMDD message sets and NTCIP schemas via an XML web service. The standards are deployed in the communication protocol between the web server and the third-party consumers. A system diagram of the TransSuite system is shown in Figure 2.2.

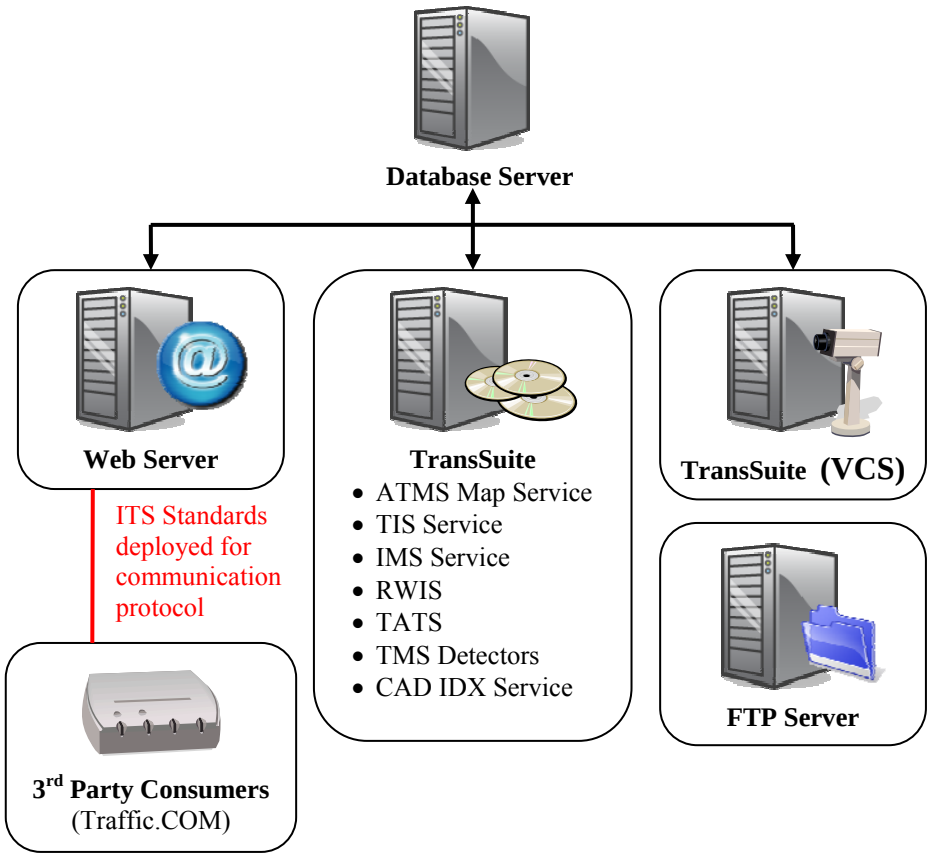

Figure 2.2. ATMS System Diagram

The TransCore data sharing scheme consists of a series of standard web services, which provide access to the TMS data within UDOT. The TransSuite web service is deployed using the Microsoft® IIS and .NET technologies and consists of a total of 12 Remote Procedure Calls (RPC) that return inventory and status information about the following highway system categories.

- Closed-Circuit Television (CCTV) Devices
- Environmental Sensor Station (ESS) Devices
- Dynamic Message Sign (DMS) Devices
- Traffic Detector Devices
- Traffic Network Entities
- Active Events

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3.0 TESTING PROCESS METHODOLOGY

3.1 Scope of Test

These tests address the specific observable and testable features of the two ITS standards as they are embodied in the communication protocols of the ATMS system. The test is not a system acceptance test or stress test, which seeks to compare behavior of the test items to functional or contractual requirements. Rather, this test seeks to compare the usage of the test items to their intended usage described in the standard and identify the reasons for any variations.

> Note: The term *Testing* is used in two distinct contexts in this final report. In general, all work performed with respect to the static analysis, evaluation and interviews and on-site controlled experiments and data gathering of the standards are grouped under the general term *Testing*. Specifically, the process of performing a set of pre-defined, controlled experiments to acquire data from the deployed system and compare this data to known expected values is also referred to as the onsite *Testing* phase. Attempts have been made to ensure this distinction is clear in the context of the usage of the term.

3.2 Testing Goals

The overall goal of the ITS Standards Testing Program is to assess and evaluate the suitability, effectiveness, interoperability and interchangeability of ITS standards. To best focus on the process to assess and evaluate ITS standards, the test team has identified these three key elements as essential in understanding whether or not a particular standard is ready for field use. These three high-level categorical elements for assessment and evaluation are defined and expanded in the following discussion.

3.2.1 Suitability

The dimension of suitability addresses those aspects of a standard that make it appropriate for a given purpose, easy to understand and use, or the contrary. This also includes issues and measurements relating to a standard's completeness and coverage when defining all aspects of the problem domain and providing access to, and control of, the appropriate technologies. The impact of an unsuitable standard tends to happen early in the system development life-cycle by needlessly complicating or subverting the choice from suitable alternative standards. The evaluation of suitability will be based on quantitative and qualitative analysis of the standards, structured questionnaire responses, and product capabilities, requirements, and design tradeoffs.

3.2.2 Effectiveness

The dimension of effectiveness addresses those aspects of a standard that make its use an appropriate means to achieve the intended or desired effect. This also includes issues relating to how well the features of the standard enable a reasonable and effective implementation in terms of performance requirements and other such operational and maintenance criteria. The impact of an ineffective standard will tend to happen during design and implementation of the system in

terms of excessive resource requirements, negative effects on schedule, product performance, etc. The evaluation of effectiveness will be based on quantitative and qualitative analysis of the standards, structured questionnaire responses, operational use, and results from test trials.

3.2.3 Interoperability and Interchangeability

The dimension of interoperability addresses those aspects of a standard that support the ability of systems to provide services to and accept services from other systems and to use the services so exchanged to enable them to operate effectively together. This necessitates that interoperability goes beyond the mere exchange of data and requires that the data exchanged must be usable by the other system. Further, interoperability is extended to interchangeability when characterized by standardized interfaces. The impact of standards that do not support interoperability and interchangeability will tend to occur during the integration with other systems. The evaluation of interoperability and interchangeability will be based on quantitative and qualitative analysis of the standards, logical characteristics of any external interfaces, and detailed examination of the syntactic and semantic content exchanged across those interfaces.

3.3 Testing Process Outline

This section presents an outline of the steps followed in the conduct of the ITS standards testing of the TMDD and NTCIP 2306 standards. The test process steps outlined in Table 3.1 describe the effort for determining what data and information would be identified and collected and where and how that collection would be accomplished.

Table 3.1. Test Process Steps

Step	Description	Expected Outcome
Baseline Standards Content	• Examine implementation and project documentation. • Research and examine standards schemas and compile a list of specific versions and identify standard and custom implementations.	• Identify the features of the standard used by the deployment. • Identify any exceptions to the standard that has been implemented by the system. • Determine if additional detailed testing is warranted.
Interview Users, Vendors, and System Integrators	• Conduct structured, guided interviews using a prepared questionnaire developed from examination of the baseline standards content.	• Identify additional findings not apparent from the static analysis of the system documentation. • Collect expert engineering and operational opinions on the suitability and effectiveness of the standards.
Evaluate the Purity and Integrity of the External Interfaces	• Examine dialogs across external interfaces to identify any exceptions in terms of syntax or semantics.	• Ensure testing approach yields valid samples / outputs.

Table 3.1. Test Process Steps (Continued)

Step	Description	Expected Outcome
Conduct Testing	• Conduct a controlled experiment using well-defined and documented test conditions. • Test all standard functions and features accessible through the implementation and all exception conditions.	• Complete the knowledge base of the deployment with observations of real-world examples. • Further investigate findings developed thru the analysis of the system and interview questionnaires.

3.3.1 Establish and Verify Standards Baseline

This step in the process supplements the baseline knowledge of the standards content. It is an essential step to ensure a sufficient and rich standards content baseline that contributes to the decision to proceed with full test planning and conduct. The test team qualitatively and quantitatively verified the degree of the use and conformance with the standards of interest. This process included static examination of standards, compilation, and examination of any XML schema (XSD) files and other technical documentation obtained from vendor/developers. This static analysis is the basis for the development of the detailed site interview questionnaire.

UDOT provided a robust package of documentation, specifications, and data as they related to the implementation of the TMDD standard by ATMS. This documentation was examined and compared with the standards to determine percentage of coverage and to identify any exceptions or customizations to the standards. The results of this analysis indicated that some modest customization of the standard messages was done and that additional messages were developed and deployed to augment the standards. Despite these customizations, the UDOT deployment does include a significant number of messages that closely adheres to the ITS standards and shows a commitment to use of the features of the standards. This drove the decision to move forward in the test process.

It should be noted that the vendor developed the ATMS system using a version of the schema, which when compared to that documented in the TMDD standard being evaluated herein, was determined to be inconsistent. The XSD file providing the schema for the standards messages, data frames, and data elements was generated on 27-Feburary, 2004; however the revision date of the TMDD standard is June 1, 2005. This fact, which is documented in the findings, required some additional analysis in order to facilitate testing to the standard. The differences between the standard and the implemented schema are identified in Table 3.2. This comparison is limited to the messages and data frames deployed by ATMS.

Table 3.2. Discrepancies in Implemented Schema

Discrepancy Description	Implemented by ATMS	Impact on Testing
In the implemented schema, many data structures that contain element arrays define an upper limit for the number of elements that can exist in the array as unbounded. In the standard, upper limits have been established for element arrays.	Yes	None
The implemented schema defines a `[GeoLocation]` data frame, which provides latitude and longitude data elements to a number of other data frames. The standard does not define the `[GeoLocation]` data frame; rather it uses the LRMS data frame of the same name.	Yes	None
The implemented schema uses a different object namespace to define the `[DMSBeaconType]` data element than that used by the TMDD standard. In the schema, the `[dms-beacon-type]` item is defined as a `[Device-beacon]` data element, however the TMDD standard uses the `[ntcip:DmsBeaconType]` namespace for this data element.	Yes	None
In the implemented schema, the `[DmsInventory]` message defines several data elements whose names have been changed from those in the standard. These data elements provide the sign technology and its height and width in pixels.	Yes	The XML tag for the sign technology data element will not match the TMDD schema.
The `[DmsInventory]` message includes a `[device-url]` data element in the standard that is not defined in the implemented schema.	No	None
In the implemented schema, the `[NodeStatus]` message misspells the name of the elements in the node status array as `[node-statu]` rather than `[node-status]`.	Yes	The XML tag for the node status array elements will not match the TMDD schema.
The name of the data element for the organization location data is `[Organization-location]` in the implemented schema; however it is called `[Organization-location-FIPS]` in the standard.	Yes	None
The implemented schema uses a different object namespace to define the `[DateTimeZone]` data frame than that used by the TMDD standard. In the schema, `[DateTimeZone]` is defined using a local object structure; however the TMDD standard uses the `[ATIS.DateTimePair]` namespace for this frame.	Yes	None
The implemented schema provides a `[station-id]` data element in the `[DetectorDetails]` data frame that is missing from the standard XML notation. However, this element is provided in the ASN.1 notation.	Yes	None

Table 3.2. Discrepancies in Implemented Schema (Continued)

Discrepancy Description	Implemented by ATMS	Impact on Testing
The [phrase] data item in the [EventDescription] data frame has a data type of [EventType] in the implemented schema, but this item's data type is defined as [EventCategories] in the standard.	Yes	The XML tag for the event type will not match the TMDD schema.
The implemented schema uses a different object namespace to define the [EventType] data element than that used by the TMDD standard. In the schema, [EventType] is defined using a local object structure; however the TMDD standard uses the [ITISEventType] namespace for this frame.	Yes	None
The [LinkList] data frame in the standard defines numerous data elements that are not defined in the implemented schema.	No	None

3.3.1.1 TMDD Standard Coverage

When considering percentage of coverage, it should be noted that the TMDD standard addresses a diverse range of information exchanging for traffic management. As such, it is expected that any single deployment would implement only a portion of the TMDD. Therefore, for the purpose of determining the effective coverage provided by the ATMS implementation, it is reasonable to consider only the components associated with the implemented portions of the TMDD standard. This paragraph provides coverage percentages based on this reasoning as well as on the entire TMDD standard. The coverage of the TMDD standard provided by the UDOT implementation is described in detail in Appendix A of this report.

The features of ATMS system deployed by UDOT that use the TMDD standard were not based on a rigorous requirements specification process, but instead, were based on implementing the corresponding messages from TMDD that matched the features and data already embodied within the ATMS system and allowed for their dissemination. As such, the evaluation of the user-needs coverage being provided by the UDOT deployment must be done indirectly by mapping the implemented TMDD messages back to their intended user needs. This evaluation is further complicated as the Requirements Traceability Matrix (RTM) provided in Volume II is both inaccurate and outdated as described in the findings section of this report. Given these limitations, the estimated percentage of coverage for the user needs of the TMDD standard is provided in Table 3.3a.

Table 3.3a. TMDD User Needs Coverage

TMDD	Implemented by ATMS	Total	Coverage
User Needs	18	60	30%

The messages sets that make up the TMDD schema are organized in a series of message groups which embody the user needs. There are a total of seven message groups associated with the TMDD user needs that have been implemented by the ATMS system. The coverage percentages of the TMDD messages, data frames and data elements are provided in Table 3.3b.

Table 3.3b. TMDD Message Group Coverage

TMDD	Implemented by ATMS	All of the Messages, Data Frames and Elements in TMDD		Messages, Data Frames and Elements Associated with the 7 Message Groups used by ATMS.	
		Total	Coverage	Total	Coverage
Messages	15	87	17%	35	43%
Data Frames	23	63	37%	63	37%
Data Elements	55	233	23%	193	28%

3.3.1.2 NTCIP 2306 Standard Coverage

The NTCIP 2306 standard provides protocol profiles for the exchange of information for ITS center-to-center environments. The web services deployed by ATMS employ the Remote Procedure Call (RPC) model that provides support for both the SOAP and XML over HTTP request-response profiles defined by the standard. Table 3.4 describes which sections of the standard are applicable to each profile.

Table 3.4. NTCIP 2306 Profiles

Profile Requirement	SOAP over HTTP	XML over HTTP
WSDL General	6.1	6.1
Definitions	6.2	6.2
Types / Schema	6.3	6.3
Message	6.4	6.4
Port Type	7.1.1	8.2.1
Binding	7.1.2	8.2.2
Service	7.1.3	8.3
Message Encoding	4.2	4.1.1
Message Transport	5.1.2 5.1.4	5.1.1 5.1.4

3.3.2 Interview Product Vendor/Developers

This step includes structured technical interviews conducted at the vendor/contractor facilities and follow-up by phone. Interview questionnaires are prepared in advance and are derived from the static examination of the standards and ATMS system documentation. Although the questionnaires primarily consisted of questions related to the vendor's implementation of the standards, it also included questions directed to programmatic issues, Standards Development Organizations (SDO), and consumers of the ATMS information. These interviews aid in the understanding of the vendor's implementation and address three categories of issues:

1) Issues related to exceptional conditions discovered by the developer.
2) Subjective and qualitative coverage and data collection for assessment of non-testable technical features.
3) Verification of standards content baseline prior to the commitment of resources to the more specific and extensive field testing.

The initial interview questionnaire for the TMDD and NTCIP 2306 standards testing was conducted in Salt Lake City, UT at the UDOT offices in May of 2007. Follow-up telephone conversations were later conducted to complete the questionnaire with Traffic.com/NAVTEQ representatives. The text of the questionnaire, along with the responses from the various participants, is included in Appendix C of this document.

Upon completion of these interviews, the results were reviewed and a document of preliminary findings was generated. These findings have been further clarified over time via additional question and answer discussions with UDOT and through on-site testing. These findings, both general and specific, are described in the findings section of this report.

3.3.3 Evaluate the Purity and Integrity of the External Interfaces

This step in the testing process was designed to examine the external interfaces employed in the system to determine that all communications and protocols used were consistent in terms of syntax and semantic content, and that there is no unexplained communications activity on the web service interface.

The test team used the Web Service Definition Language (WSDL) document provided by the developer to create test software to connect to and receive the TMDD messages from the ATMS system. The test team then examined the XML documents returned from ATMS and made the following determinations:

- The ATMS messages were well-formed XML documents.
- The ATMS messages conformed to the TMDD schemas except with the exception of the version-related inconsistencies described in Table 3.2.

The test team also used network testing software to capture and evaluate the data packets that were transferred between the test software and the ATMS web services. This information was examined by separating and framing the Ethernet, IP, TCP, and HTTP portions of the binary stream and the payload data. This allowed the profiles of both SOAP and XML transfers over HTTP to be observed.

It was noted that the transfer using the HTTP post protocol wrapped the web service response message inside an XML `[string]` tag as shown in the following XML excerpt. This is an implementation particularity and not part of the TMDD message.

```
<?xml version="1.0" encoding="utf-8"?>
<string xmlns="http://transcore.com/webservices/">
...
</string>
```

This step proved to be an important confidence builder in that it was a successful test of the ability to communicate with the ATMS system and to capture the network traffic. This served to reduce risk and eliminate distractions prior to conducting site testing.

3.3.4 Test Approach

The testing techniques utilized the live ATMS system deployed for UDOT. Each of the ATMS web services was invoked using both the SOAP and HTTP Post protocol profiles while network-monitoring software captured the packet data. Testing was performed remotely from the Battelle offices in Columbus, Ohio. The testing configuration is shown in Figure 3.1.

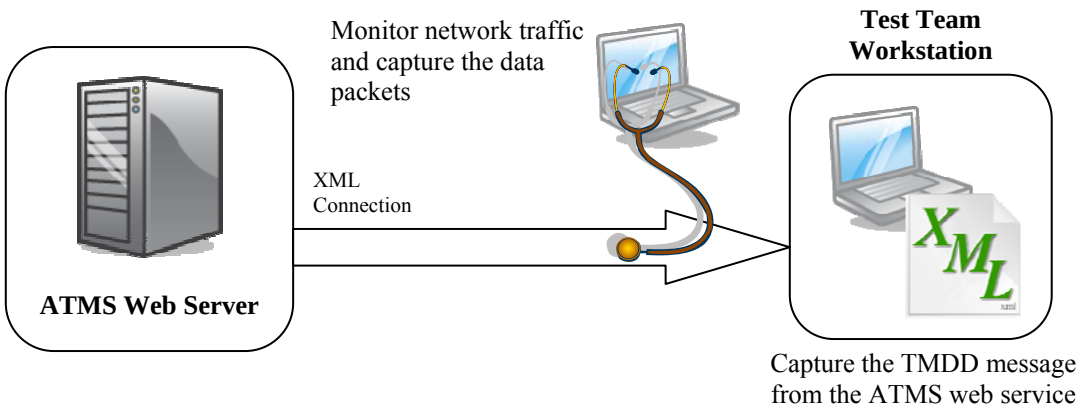

Figure 3.1. Test Configuration

For each test case included in the test plan, the ATMS web service was polled using the test software developed by the test team or the ATMS server web site. The resulting XML documents, which contain the TMDD messages, were captured and saved for analysis. At the same time, the network data packets sent and received during the test were saved and the number of captured data packets was recorded in the results of each test case. The network traffic between the test computer and the ATMS web server was identified by using the web servers IP address `[168.178.126.76]` as the filter.

3.4 Test Results

The live monitor testing was conducted over a five-day timeframe from June 22, 2007 through June 25, 2007. During this time, the live ATMS web service was polled once every hour, resulting in the capture of a total of 1,428 TMDD messages. The results of this testing reside in the *Live Monitoring* directory on the companion CD as XML text files and are recorded in the *tdLiveData* table in the test results database.

The controlled testing was carried out on July 25, 2007. All the test cases that are described in Appendix D were performed and passed, resulting in the capture of a total of 24 TMDD messages and their respective network data packets. The results of this testing reside in the *Test Cases* directory on the companion CD as XML text files and are recorded in the *tdTestData* table in the test results database.

Prior to analyzing the test results, raw test data were processed to create a table listing all the unique values of all the unique data elements that appear in the captured XML files. This processing was done for both the live and test data and recorded in the *tdLiveElements* and *tdTestElements* tables in the test results database, respectively. Formatting the raw data in this fashion facilitated the data analysis. Table 3.5 shows the number of unique element/value pairs that were identified for both the live and test raw data.

Table 3.5. Number of Unique Element/Value Pairs

	Raw Data Records (XML messages)	Processed Data Records (unique elements/values)
Live Data	1,428	43,260
Test Data	12	24,670

3.5 Data Analysis

The analysis of the resulting captured TMDD messages began by evaluating the properly-formed XML message and determining its completeness and correctness against the schemas for the TMDD standard. The content of each data element were also examined and compared to any ranges, usages, limits, or restrictions defined by the appropriate standard. Variations were noted.

The captured network data packets were framed to evaluate the content of the HTTP header and SOAP envelope and to verify the request-response protocol for both tested NTCIP 2306 communication profiles.

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4.0 OBSERVATIONS AND FINDINGS

This section presents the general test findings derived and determined from examination, interpretation, and analysis of all test data and information. It is organized into general findings that relate to the standards and specific findings that relate to a specific section or paragraph of each document.

4.1 General Findings

Item	1
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Messages and Data Frames
Comment	Discussion: When compared to other ITS Standards previously evaluated, the TMDD standard does not make use of the concept of messages and data frames, a categorization that could better identify which data structures are top-level message structures and which are components of messages. Recommendations: For clarity, a structure that represents a complete message structure should be classified as a message while the data structures that serve as components to the messages should be classified as data frames. Each unique data frame should be explained in a paragraph describing its intended use and identify all the messages or other data frames that utilize it. Appendix B contains a list of data elements that are not referenced in the standard. These should be reviewed for deprecation in future versions.

Item	2
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Stronger Configuration Control of the Standards Needed
Comment	Discussion: As documented in Table 3.2, the implemented schema used by the ATMS system does not correspond to a released version of the TMDD standard. The use of non-released versions of the standard message schema complicates the development, evaluation and acceptance of the ITS standards and can preclude interoperability between deployed systems. Recommendations: Stronger configuration control should be enforced on the ITS standards to ensure that incremental updates are not used for the development of deployed systems and that the standard document itself is consistent with the electronic support files, which in this case, consist of an XML schema.

Item	3
Document	TMDD – Volume II Companion Annexes
Page	General
Paragraph	General
Title	Naming Convention of List Items

Comment	Discussion: There are numerous data structures with names that suggest they are lists but in practice, these sequences are only members of a list array; they are not lists themselves. This is somewhat confusing since their names do not match their purpose. This applies to the following data structures:
	
	`DeviceList`
	`DetectorList`
	`LinkList`
	`LinkStatusList`
	`NodeList`
	`NodeStatusList`
	`SectionNodeList`
	`SectionLinkList`
	
	Recommendations: It would enhance the clarity of the standard if the `[List]` suffix were dropped from the name of each of these data structures, or at least be replaced with a suffix that identifies the data structures as being an item in a list rather than being the list itself.

Item	4
Document	TMDD – Volume I
Page	General
Paragraph	General
Title	Incorrect References in the Traceability Tables
Comment	Discussion: The paragraph numbers for the functional requirements in the traceability tables in Sections 5.0 and 6.0 of Volume 1 are incorrect. Recommendations: Update these tables to reflect the correct paragraph numbers.

Item	5
Document	TMDD – Volume II Companion Annexes
Page	General
Paragraph	General
Title	EventType and DateTimeZone

Comment	Discussion: The TMDD standard defines the following two data objects.
	`DateTimeZone::= ATIS.DateTimePair`
	`EventType::= ITIS.ITISEventType`
	
	Though defined in the TMDD standard, both of these data objects serve only to reference external data objects from the other standards. The purpose of this is not clear and leads to an unnecessary level of data abstraction.
	
	Recommendations: Both of these data objects should be deprecated and all references to them should be changed to reference the external objects. In the case of the date/time object, see the comments on using W3C standard time format.

Item	6
Document	TMDD, Vol. II
Page	General
Paragraph	General
Title	Volume II of the Standard is not consistent with other TMDD Volumes
Comment	Discussion: Volume II of the TMDD standard is out of date with the rest of the standards documents. The Volume 2 document is version 1.5 (Dec. 14, 2003) while Volume 1 and the Volume 2 annexes are version 2.1 (June 1, 2005). Recommendations: Volume 2 should be updated and made current with the rest of the TMDD standard.

Item	7
Document	TMDD, Vol.II
Page	General
Paragraph	General
Title	Value of Use Case Realization Diagrams is Unclear
Comment	Discussion: The realization diagrams provided in the standard seem to add little useful information in terms of understanding the standard or the features embodied within it. It is not clear as to what information they are intended to convey. Recommendations: The realization diagrams should include a legend and a description of usage or be removed.

Item	8
Document	TMDD, Vol. II
Page	General
Paragraph	General
Title	Sequence Diagrams should not include Message Schema
Comment	Discussion: The sequence diagrams for the TMDD dialogs include the schema for the messages that are being exchanged in the dialog. These same messages schemas are also defined in the companion annexes. There are many cases in the standard where message schemas defined in the sequence diagrams are different than those defined in the companion annexes. Having the schema defined in two locations has created this opportunity for discrepancies and confusion. Likewise, the messages schemas for the sub-messages are defined both in paragraph 2.17 and again in the companion annexes creating more discrepancies and confusion. Recommendations: For clarity, the TMDD message schemas should be defined in only one location in the standard. The definitions for the message schemas in the sequence diagrams should be removed from the TMDD dialogs and the paragraph defining the sub-messages should also be deprecated.

Item	9
Document	TMDD, Vol. II
Page	General
Paragraph	General
Title	Requirements Traceability Matrix does not reference Dialogs
Comment	Discussion: The Requirements Traceability Matrix (RTM) provides mapping between the user needs, functional requirements, and message schema definitions, but does not provide a references to the associated sequence diagrams for the TMDD dialogs. Also the RTM in Volume II is out of date with the rest of the standard and does not match the Needs and Requirements Traceability Matrix provided in Volume I. Recommendations: The RTM should be updated to correspond with the rest of the current TMDD standard and should provide mapping to the dialogs.

<table>
<tr><td>Item</td><td>10</td></tr>
<tr><td>Document</td><td>TMDD, Vol II Companion Annexes</td></tr>
<tr><td>Page</td><td>General</td></tr>
<tr><td>Paragraph</td><td>General</td></tr>
<tr><td>Title</td><td>Inconsistent Naming of Array Items in XML</td></tr>
<tr><td>Comment</td><td>
Discussion: When arrays are encoded in the XML notation, an additional tag name must be created for the array elements, which are not defined in the governing ASN.1 notation (see example below).

Example: The excerpts shown below illustrate both the ASN.1 and XML notation for the same data structure. In this case [event-lanes] is defined as an element array of [EventLane] data structures. In the XML notation, it is necessary to create the tag name [event-lane] for the array elements.

<pre>event-lanes SEQUENCE (SIZE(1..256)) OF EventLane OPTIONAL</pre>
<pre><xs:element name="event-lanes" minOccurs="0">
        <xs:complexType>
        <xs:sequence minOccurs="1" maxOccurs="256">
           <xs:element name="event-lane" type="EventLane" />
        </xs:sequence>
        </xs:complexType>
</xs:element></pre>
The naming of the array elements has not been done using a consistent naming convention, which can become confusing. The following table shows the different naming conventions used in the standard.

<table>
<tr><th>Array Name</th><th>XML Array Element Tag</th><th>Naming Convention</th></tr>
<tr><td>event-lanes</td><td>event-lane</td><td>The array name is plural and the element name is singular.</td></tr>
<tr><td>detection-lane</td><td>detection-lane-item</td><td>The array name is singular and the element tag appends “-item”</td></tr>
<tr><td>device-list</td><td>device</td><td>The element tag is singular and the array name appends “-list”</td></tr>
</table>

Recommendations: For clarity, only one naming convention should be adopted and used consistently throughout the standard. The first method described above is preferred.
</td></tr>
</table>

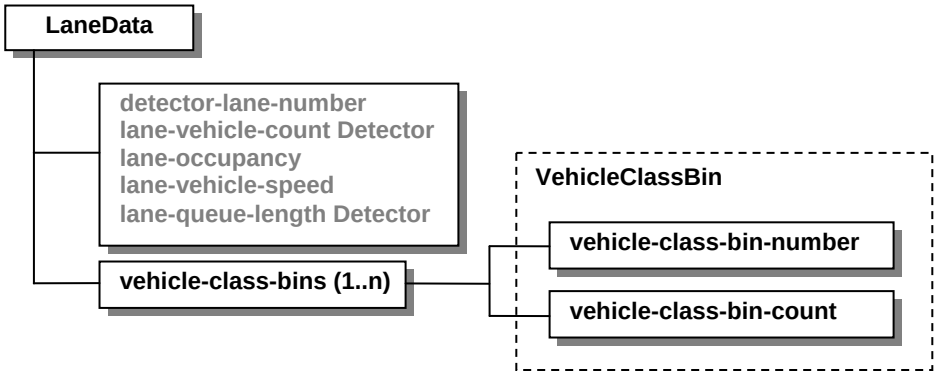
Item	11
Document	TMDD, Vol II Companion Annexes
Page	General
Paragraph	General
Title	Date/Time should use Industry Standard Format
Comment	Discussion: The industry is trending toward a combined date/time field expressed by the World Wide Web Consortium (W3C) rather than the TMDD `[DateTimeZone]` data object. The W3C date and time format leverages the International Standard Organization (ISO) 8601 standard for the representation of dates. It defines six levels of granularity in the date and time and provides for two methods of handling time zone offsets. This comment was received from numerous independent sources; each stating a level of frustration with the need to translate the TMDD date/time object to the standard W3C format used by the rest of their systems. This indicates that the date/time data frame of the standard, though adequate, is a less than effective solution. Recommendations: The data objects associated with the date and time information should be replaced with object structures that conform to the formats specified by the W3C established best practices.

Item	12
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Static and Dynamic Information
Comment	Discussion: To streamline the data flow, static information about devices should be limited to the device inventory messages, while the device status and data messages should be minimized to provide only dynamic data. For example, the `[organization-id]` and `[network-id]` elements included in the `[DetectorData]` data structure do not change over time; therefore including them in the detector data message is redundant and creates unnecessary overhead. Recommendations: The data objects that return dynamic information about devices should be reviewed to determine if static components exist in their schema. The merit of any such static components should then be evaluated to determine if it is feasible to remove them from the object schema or at least specify them as optional elements

<table>
<tr><td>Item</td><td>13</td></tr>
<tr><td>Document</td><td>TMDD, Rev. 2.1</td></tr>
<tr><td>Page</td><td>General</td></tr>
<tr><td>Paragraph</td><td>General</td></tr>
<tr><td>Title</td><td>Detector Types Added</td></tr>
<tr><td>Comment</td><td>Discussion: The developer customized the enumeration list for the [Detector-Type] data element as shown in the following table. Two additional detector-type categories were added to the standards existing ten types.

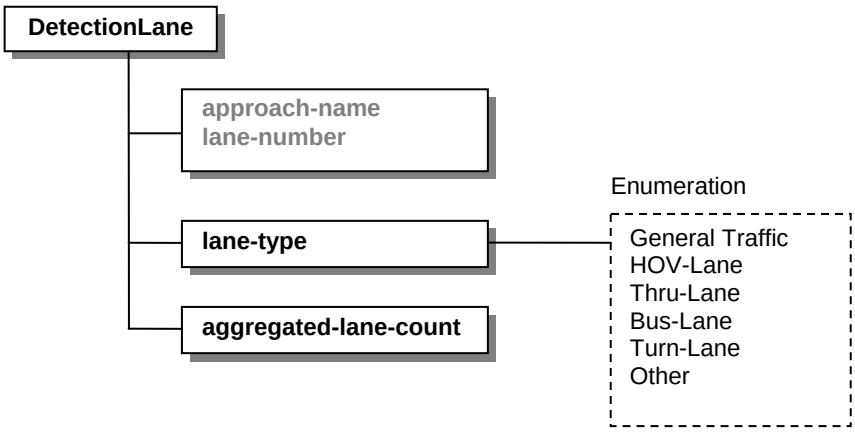
<table>
<tr><th>Standard Detector Types</th><th>Custom Detector Types</th></tr>
<tr><td>inductive loop
magnetic
magnetometers
pressure cells
microwave radar
ultrasonic
video image
laser
infrared
road tube</td><td>acoustic
micro-loop</td></tr>
</table>

Recommendations: The two additional detector types should be considered for addition to the standard enumeration for the [Detector-Type] data element.</td></tr>
</table>

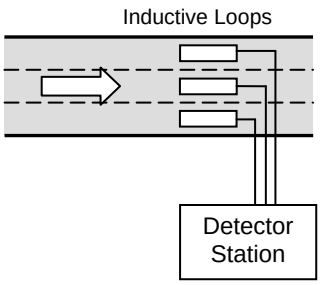
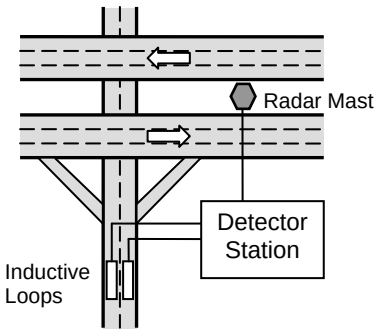
Item	14
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Vehicle Bin-Counts Added
Comment	Discussion: The developer required that vehicle classification bin counts[1] be provided for each detector station.[2] The `[lane-vehicle-count]` data element of the `[LaneData]` data object provides for a total vehicle count for each lane but there is no provision of vehicle counts categorized by classification bins. The developer added a custom data object to accommodate this need as shown in the following figure.  Recommendations: It was strongly felt that providing the vehicle counts for individual vehicle classifications is a common need of transportation agencies and organizations and should be provided for in the standard. The TMDD standard should be amended to include a functional requirement for vehicle classification bin counts to the user need for detector data sharing (3.3.5.3) and include a data structure in the message schema to accommodate this information.

[1] Classification bins refer to the grouping of vehicle counts by vehicle classification.

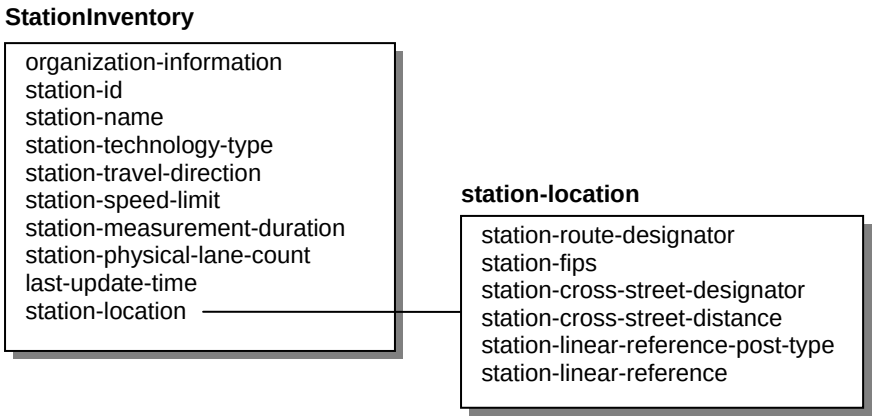
[2] This issue was identified by Traffic.com/NAVTEQ and previously submitted to the working group.

Item	15
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Detection Lane Details Added
Comment	Discussion: The `[DetectionLane]` data object does not provide a data element to identify the type of lane such as a High Occupancy Vehicle (HOV), thru lane, etc. Lane type is widely used by organizations and should be provided for in the standard. There is also no data element to provide the number of aggregated lanes reported by the detector. Many organizations sum volume, average speed, and occupancy across all lanes; therefore these metrics are only useful if the number of aggregated lanes is specified. Both of these pieces of information can be added to the detection lane configuration as shown in the following figure.[3]  Recommendations: The user need for detector inventory information (3.3.5.1) and its functional requirements should be amended to include a requirement for lane type and aggregated lane count. The data elements in the `[DetectionLane]` data structure should likewise be modified to accommodate the lane type and aggregated lane count information. The lane type should be an enumerated list of values; it may be possible to adapt the `[Ramp-lane-type]` data element to serve this purpose.

[3] These issues were identified by Traffic.com/NAVTEQ and previously submitted to the working group.

Item	16
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Detector System Models
Comment	Discussion: The standard assumes that a traffic detector is associated with only one direction and one link and that all lane data for a detector will be available in the same time collection period. Although this may be true for loop detectors with controllers, other types of detectors may monitor multiple roadways and/or multiple directions and may have devices that independently send lane-specific data at different time periods.[4] This issue is illustrated in figure below. It was found to be very difficult to fit the information from these more complex detector systems into the standards data model. This could lead different vendors to come up with different implementations or create custom objects to overcome this issue.  Example A – Detector station monitors a single roadway and direction using one type of detector.  Example B – Detector station monitors multiple roadways and directions using multiple technologies. Recommendations: The information model embodied in the traffic detector user needs (3.3.5), functional requirements and messages seems inadequate to encode the data provided by detector stations of complex traffic detection systems. This area of the standard should be reviewed with input from domain experts in the field of detector station design and data gathering with the intent to make this area of the standard more flexible and comprehensive.

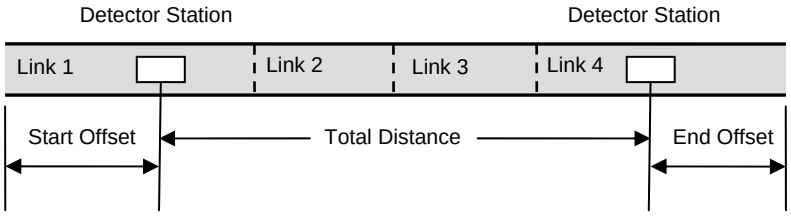
[4] This issue was identified by Traffic.com/NAVTEQ and previously submitted to the working group.

Item	17
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Detector Stations
Comment	Discussion: The [DetectorInventory] message in the standard relates traffic detectors with links, hence collecting information about activity on the link. However, the developer required the traffic detector data to be station-based to describe the activity at a point located on the link rather than for the link itself. The station-based method is a better way to model point-detection from the field and having the point-based traffic detector data in a link-based form rendered the data unusable for the user. The [DetectorInventory] message provides a data element for a station identifier but nothing in the standard defines the attributes of a detector station or how this element is to be used. To overcome this issue, the developer implemented a custom message to provide information about a detector station as shown in the following figure.  Recommendations: The standard does not provide a description of a detector station. The user has the need for traffic detector data based on detector stations rather than links. The standard should support both link based and station based models. A set of user needs for detector station inventory and status should be considered for addition to the need to provide traffic detector data (3.3.5) and implemented in a series of functional requirements and data objects.

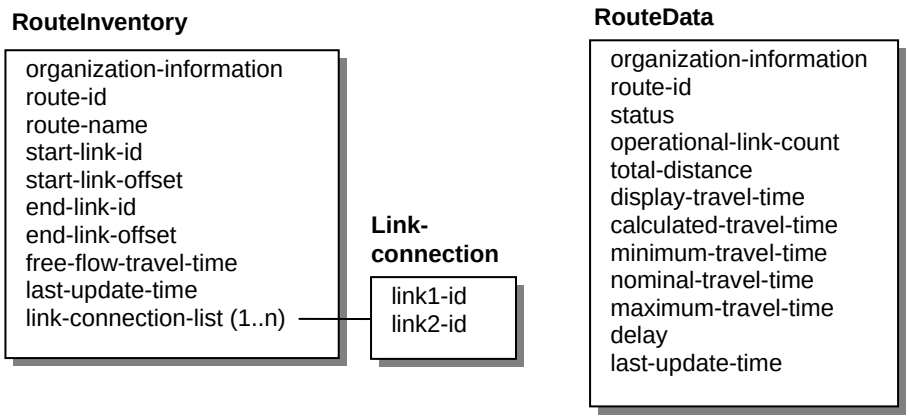
Item	18
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	External Device ID Required
Comment	Discussion: The developer implemented a custom data element `[external-device-id]` in the `[DMSInventory]` standard message along with the `[device-id]` standard element. The device identifier is a unique code that identifies a particular DMS within the system. However, when inventorying DMS devices from other systems, it is possible that a device identifier will be duplicated. The developer addressed this issue by creating a separate data element to provide the external devices identifier while leaving the local device identifier a unique value. Recommendations: The standard should account for the possibility of duplicate device identifiers between systems using this or another design solution. This issue may occur on other devices as well.

Item	19
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Practical Examples Needed
Comment	Discussion: Numerous comments were received by the test team about the need for practical examples in the standard for clarity. The standard does not provide any examples to illustrate and clarify the intended use of the data objects. Though the standard may provide solutions, the value of the standard is diminished if the developers are not clear on how to use them. Recommendations: Providing an informative explanation with examples to augment the normative descriptions of each element would greatly enhance understandability and promote commonality in implementations, which supports interoperability.

Item	20
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Route Travel Times
Comment	Discussion: The standard uses a link-node model, which allows for travel times to be determined for a link between nodes. However, the developer required that the travel times be determined between detector stations that are located somewhere on a link rather than for the links themselves, as illustrated in the following figure.



The standard does not provide messages to describe routes and travel time information is limited to links. To overcome this issue, the developer implemented custom messages to provide an inventory of routes, which are treated as a group of links, and data for the routes that provide the distance and travel time information as shown below.



The group of link connections describes a single continuous route, while the beginning and ending offsets provide the information needed to determine the total distance and travel times between the detector stations. The `[RouteInventory]` message provides the static description of the route and the `[RouteData]` message provides the dynamically changing travel times.

Recommendations: The standard does not provide for route descriptions however, there is a clear user need for this type of information exchange. A set of functional requirements should be considered for addition to the standard to meet this user need and implemented in a series of data objects. There is also a user need for travel times to be point-based rather than link-based. The standard should be revised to provide support for both of these models.

Item	21
Document	TMDD, Rev. 2.1
Page	General
Paragraph	General
Title	Data Quality
Comment	Discussion: The developer felt it would be useful to include data elements that provide for an indication of data quality for the measurements provided by the traffic detectors. The elements of the `[LaneData]` data object provide metrics about the activity on the lane such as volume, speed, occupancy, etc. To determine the data quality, an additional element is needed that indicates if the metrics are valid or invalid. For example, if zero occupancy is indicated, it is not known if it is because there is no traffic or because the detector has failed or produced an invalid reading.[5] The overall detector status can be retrieved using the `[DetectorStatus]` messages but this would result in an inordinate amount of overhead to retrieve this message to validate each detector reading. Recommendations: Data quality elements give organizations confidence in the data they are receiving from the field. It is reasonable to include elements into the data objects that provide measured readings to indicate the values validity. This feature should be considered for adoption into the standard where applicable.

[5] This issue was identified by Traffic.com/NAVTEQ and previously submitted to the working group.

Item	22
Document	NTCIP 2306, XML Application Profile
Page	General
Paragraph	General
Title	NTCIP 2306 Protocol
Comment	Discussion: The NTCIP 2306 standard is a supporting standard that specifies the protocol for communications between traffic management centers. It specifies the format for message encoding and transportation over the following three sub-profiles using the Web Service Definition Language (WSDL) document: 1) SOAP over HTTP 2) XML over HTTP 3) XML over FTP The communication messaging profiles for the ATMS web service are specified in a WSDL document that was developed in accordance to the NTCIP 2306 standard. The SOAP and XML over HTTP sub-profiles were tested. Testing of this standard is evaluated indirectly by the successful connection to the ATMS system and the transfer of information via the messages described in the TMDD standards. During testing, Battelle used the ATMS WSDL document to establish a connection to the web service using the SOAP over HTTP request-response profile using the Microsoft® Visual Basic .NET development environment. Connection was also established from the ATMS Center-to-Center web site using the XML over HTTP request-response profile. In both cases, there were no issues encountered with communicating over the respective protocol profiles. The examination of the network data packets that were captured during the testing did not reveal any deviations from the standard profiles. This led to a high-level of confidence that the encoding and transfer of the TMDD messages was occurring in accordance with the two NTCIP 2306 sub-profiles that were tested. The conclusion of the testing team was that there were no significant findings associated with the NTCIP 2306 standard. However, during the examination of the standard document, numerous minor omissions and typographical errors were noted as listed below. 1. Table 3.1, Section 1.0b: The *PortType* referenced to NTCIP 2306 section 6.5 appears to be erroneous. This section discusses the publication-subscription message transmission pattern. 2. Table 3.1, Section 2.0d: The XML text reference to NTCIP 2306 section 4.1.2 is incorrect; it should reference section 4.1.1. 3. Section 7.1.1: Neither the informative or normative text mentions the inclusion of the optional `<documentation>` that may follow the `<portType>` tag. Though optional, its permissible existence should be annotated here as it is in Section 7.1.3. 4. Section 7.1.2, Normative: List item 6 has a typo. (…attribute must by written…) should be (…attribute must be written…).

4.2 Specific Findings

Item	1
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.2.3.2 (vol. 1); ASN.1: ¶1.1.2 (vol. 2)
Title	ContactDetails
Comment	The XML notation for this data frame does not match the ASN.1 notation. The XML defines `[organization-id]` and `[organization-name]` data elements that are not mentioned in the ASN.1 notation. The XML notation should be changed to match the ASN.1.

Item	2
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.5.1 (vol. 2)
Title	CCTVInventoryRequest
Comment	In the ASN.1 notation, the `[Inventory-request]` element is capitalized; however in ASN.1, only the names of data types should be capitalized while the names of literals should begin with a lower-case character.

Item	3
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.5.1.2 (vol. 1); ASN.1: ¶1.5.2 (vol. 2)
Title	CCTVInventory
Comment	• In the ASN.1 notation, the `[Location]` element is capitalized; however in ASN.1 only the names of data types should be capitalized while the names of literals should begin with a lower-case character. • The ASN.1 notation defines the `[last-update-time]` data element as being a required feature; however the requirements paragraph specifies that that this information is optional and may be sent if it exists. The ASN.1 notation should be changed to comply with this requirement.

Item	4
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.5.3.3 (vol. 1); ASN.1: ¶1.5.6 (vol. 2)
Title	CCTVControlResponse
Comment	• In the ASN.1 notation, the `[Request-response]` element is capitalized; however in ASN.1, only the names of data types should be capitalized while the names of literals should begin with a lower-case character. • In the ASN.1 notation, the data type for the `[organization-id]` data element is `[OrganizationInformation].` The element name and type are inconsistent. This element should be typed as `[Organization-identifier],` or if the data type is correct, then the element name should be `[organization-information].` • The ASN.1 notation defines the `[operator-id]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines a `[cctv-lock-holder-id]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation and the definition for the `[Cctv-lock-holder-identifier]` data type should be deprecated. • The requirements paragraph lists a set of example responses to the CCTV control request including an Unknown device ID response. In the ASN.1, the data element for this information is a `[Device-acknowledge-control]` enumeration, which does not have a value for this response. An additional value should be added to this enumeration to accommodate this response.

Item	5
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.5.3.4, ¶4.3.5.3.5 (vol. 1)
Title	CCTV Cancel Control
Comment	There are no requirements specifying the contents of the CCTV cancel control message and the standard contains no ASN.1 notation that supports the requirements specified in these paragraphs.

Item	6
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.5.2.2 (vol. 1); ASN.1: ¶1.5.4 (vol. 2)
Title	CCTVDeviceStatus
Comment	• The ASN.1 notation defines the `[device-id]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement. • The requirements paragraph specifies that the name of the operator is optional information that may be sent if it exists. However, in the ASN.1 object definition, there is no data element defined for this information. The ASN.1 notation should be changed to comply with this requirement.

Item	7
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.5.4.2 (vol. 1); ASN.1: ¶1.5.5 (vol. 2)
Title	CCTVControlRequest
Comment	• The ASN.1 notation defines a `[request-date-time]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation. • The requirements paragraph specifies that the event and response plan identifiers are optional information that may be sent if they exist. However, in the ASN.1 object definition there is no data elements defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement.

Item	8
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.6.1.2 (vol. 1); ASN.1: ¶1.6.2 (vol. 2)
Title	VSInventory
Comment	• The ASN.1 notation defines a `[last-update-time]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation. • The requirements paragraph specifies that the number of video input and output channels is required information that shall be included in the message. However, in the ASN.1 object definition there are no data elements defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • This requirements paragraph indicates that there could be multiple video input and output channel descriptions described in the message. However, the ASN.1 notation only allows for one input and one output channel to be described. These data elements should be defined as arrays.

Item	9
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.6.2.2 (vol. 1); ASN.1: ¶1.6.4 (vol. 2)
Title	VSDeviceStatus
Comment	• The requirements paragraph specifies that the number of channel mappings is required information that shall be included in the message. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • This requirements paragraph indicates that there could be multiple input and output channel mappings described in the message. However, the ASN.1 notation only allows for one input and one output channel to be specified. These data elements should be defined as arrays.

Item	10
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.6.3.2 (vol. 1); ASN.1: ¶1.6.5 (vol. 2)
Title	CCTVSwitchCommandRequest
Comment	• The requirements paragraph specifies that the identifier for the owning organization and a request identifier are required information that shall be included in the message. However, in the ASN.1 object definition there are no data elements defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • This requirements paragraph specifies numerous types of optional information that may be included as part of the message if they exist. However, in the ASN.1 notation, there are no data elements defined for any of these items. Optional data elements should be added to the ASN.1 notation to comply with this requirement. • The message is prefixed with CCTV rather than VS, which is inconsistent with the other messages of this group.

Item	11
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.6.3.4, ¶4.3.6.3.5 (vol. 1)
Title	Video Switch Cancel Control
Comment	There are no requirements specifying the contents of the video switch cancel control message and the standard contains no ASN.1 notation that supports the requirements specified in these paragraphs.

Item	12
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.6.4.2 (vol. 1); ASN.1: ¶1.6.6 (vol. 2)
Title	CCTVSwitchCommandResponse
Comment	• The requirements paragraph specifies that the request identifier is required information that shall be included in the message. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • The message is prefixed with CCTV rather than VS, which is inconsistent with the other messages of this group.

Item	13
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.6.5 (vol. 1)
Title	Set Video Attributes
Comment	The standard contains no ASN.1 notation that supports the requirements specified in this paragraph or its sub paragraphs. There is only an XML object definition for a portion of the message specified for the contents of the video attributes. There should be ASN.1 object definitions created to embody the required and optional data elements specified for the video attributes request and response messages.

Item	14
Document	TMDD, Rev. 2.1
Page	26
Paragraph	ASN.1: ¶1.6.7 (vol. 2)
Title	CCTVVideoChannelData
Comment	• This data object does not map to any requirement specified in the standard. • The message is prefixed with CCTV rather than VS, which is inconsistent with the other messages of this group.

Item	15
Document	TMDD, Rev. 2.1
Page	26
Paragraph	ASN.1: ¶1.6.8 (vol. 2)
Title	ConnectionRequest
Comment	This data object does not map to any requirement specified in the standard.

Item	16
Document	TMDD, Rev. 2.1
Page	26
Paragraph	ASN.1: ¶1.6.9 (vol. 2)
Title	ConnectionRequestResponse
Comment	This data object does not map to any requirement specified in the standard.

Item	17
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.7.1.2 (vol. 1); ASN.1: ¶1.7.2 (vol. 2)
Title	DMSInventory
Comment	• The ASN.1 notation defines a `[device-link-id]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation. • The `[device-link-id]` data element is named inconsistently with other messages that use the same data element. In all other cases, `[link-id]` is used as the data element name.

Item	18
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.7.2.2 (vol. 1); ASN.1: ¶1.7.4 (vol. 2)
Title	DMSDeviceStatus
Comment	• The requirements paragraph specifies that the current status of the device beacon is required information that shall be included in the message. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • The requirements paragraph specifies that the beacon state and message priority items are optional information that may be sent if they exist. However, in the ASN.1 object definition there are no data elements defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines a `[message-source-mode]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation.

Item	19
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.7.4.2 (vol. 1); ASN.1: ¶1.7.5 (vol. 2)
Title	DMSControlRequest
Comment	The ASN.1 notation defines the `[dms-beacon-control]` data element as being a required feature; however the requirements paragraph specifies that that this information is optional and may be sent if it exists. The ASN.1 notation should be changed to comply with this requirement.

Item	20
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.7.4.5 (vol. 1)
Title	Contents of DMS Cancel Control Request
Comment	The standard contains no ASN.1 notation that supports the requirements specified in this paragraph. There should be an ASN.1 object definition created to embody the required and optional data elements specified for the DMS cancel control request message.

Item	21
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.7.3.3 (vol. 1); ASN.1: ¶1.7.6 (vol. 2)
Title	DMSControlResponse
Comment	• The requirements paragraph specifies that the name of the operator is required information that shall be included in the message. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • The `[request-status]` data element is named inconsistently with other messages that use the same data element. Commonly, in other cases `[request-response]` is used as the name of this data element.

Item	22
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.7.3.6 (vol. 1)
Title	Contents of DMS Cancel Control Response
Comment	The standard contains no ASN.1 notation that supports the requirements specified in this paragraph. There should be an ASN.1 object definition created to embody the required and optional data elements specified for the DMS cancel control response message.

Item	23
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.8.1.2 (vol. 1); ASN.1: ¶1.8.2 (vol. 2)
Title	ESSInventory
Comment	The ASN.1 notation defines a `[device-url]` and `[link-id]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, these data elements should be removed from the ASN.1 notation.

Item	24
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements**:** ¶4.3.8.2.2 (vol. 1); ASN.1: ¶1.8.4 (vol. 2)
Title	ESSStatus
Comment	The ASN.1 notation defines the `[avg-wind-direction]` data element as being a required feature; however the requirements paragraph specifies that that this information is optional and may be sent if it exists. The ASN.1 notation should be changed to comply with this requirement.

Item	25
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.9.1.2 (vol. 1); ASN.1: ¶1.9.2 (vol. 2)
Title	GateInventory
Comment	• The ASN.1 notation defines the `[last-update]` data element as being a required feature; however the requirements paragraph specifies that that this information is optional and may be sent if it exists. The ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines a `[device-url]` and `[link-id]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, these data elements should be removed from the ASN.1 notation.

Item	26
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.9.2.2 (vol. 1); ASN.1: ¶1.9.4 (vol. 2)
Title	GateStatus
Comment	The ASN.1 notation defines the `[operator-id]` and `[center-id]` data elements as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement.

Item	27
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.9.3.2 (vol. 1); ASN.1: ¶1.9.5 (vol. 2)
Title	GateControlRequest
Comment	The ASN.1 notation defines the `[operator-id]` and `[center-id]` data elements as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement.

Item	28
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.9.3.4 (vol. 1); ASN.1: ¶1.9.6 (vol. 2)
Title	GateControlResponse
Comment	The ASN.1 notation defines the `[operator-id]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement.

Item	29
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.9.3.6 (vol. 1)
Title	Contents of Gate Cancel Control Request
Comment	The standard contains no ASN.1 notation that supports the requirements specified in this paragraph. There should be an ASN.1 object definition created to embody the required and optional data elements specified for the gate cancel control request message.

Item	30
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.10.1.2 (vol. 1); ASN.1: ¶1.10.2 (vol. 2)
Title	HARInventory
Comment	• The requirements paragraph specifies that the current status of the device beacon is required information that shall be included in the message. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines a `[device-url]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation.

Item	31
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.10.2.2 (vol. 1); ASN.1: ¶1.10.4 (vol. 2)
Title	HARStatus
Comment	The ASN.1 notation defines the `[organization-information]` data element as being a required feature; however the requirements paragraph specifies that that this information is optional and may be sent if it exists. The ASN.1 notation should be changed to comply with this requirement.

Item	32
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.10.3.2 (vol. 1); ASN.1: ¶1.10.5 (vol. 2)
Title	HARControlRequest
Comment	The ASN.1 notation defines `[operator-id]` and `[center-id]` data elements and the `[command-request-priority]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement.

Item	33
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.10.3.4 (vol. 1); ASN.1: ¶1.10.6 (vol. 2)
Title	HARControlResponse
Comment	• The ASN.1 notation defines a `[operator-last-revised]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation. • In the ASN.1 notation, the data type name for the `[operator-id-responding]` data element is misspelled as: `[Device-organization-operator-identifer]`.

Item	34
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.10.3.7 (vol. 1)
Title	Contents of HAR Cancel Control Request
Comment	The standard contains no ASN.1 notation that supports the requirements specified in this paragraph. There should be an ASN.1 object definition created to embody the required and optional data elements specified for the HAR cancel control request message.

Item	35
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.11.1.2 (vol. 1); ASN.1: ¶1.11.2 (vol. 2)
Title	LCSInventory
Comment	The ASN.1 notation defines a `[device-url]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation.

Item	36
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.11.2.2 (vol. 1); ASN.1: ¶1.11.4 (vol. 2)
Title	LCSStatus
Comment	The ASN.1 notation defines the `[operator-id]` and `[center-id]` data elements as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement.

Item	37
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.11.3.2 (vol. 1); ASN.1: ¶1.11.5 (vol. 2)
Title	LCSControlRequest
Comment	The ASN.1 notation defines the `[center-id]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement.

Item	38
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.11.3.4 (vol. 1); ASN.1: ¶1.11.6 (vol. 2)
Title	LCSControlResponse
Comment	The requirements paragraph specifies that the name of the owning operator is required information that shall be included in the message. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement.

Item	39
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.11.3.7 (vol. 1)
Title	Contents of Lane Control Cancel Request
Comment	The standard contains no ASN.1 notation that supports the requirements specified in this paragraph. There should be an ASN.1 object definition created to embody the required and optional data elements specified for the lane control cancel request message.

Item	40
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.12.1.2 (vol. 1); ASN.1: ¶1.12.2 (vol. 2)
Title	RampMeterInventory
Comment	• The ASN.1 notation defines the `[ramp-location]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines a `[node-id]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation. • The requirements paragraph specifies that the make and model of the controller as optional information that may be sent if they exist. However, in the ASN.1 object definition there are no data elements defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • The requirements paragraph specifies that the message will provide a table of pre-stored timing plans as an optional data object. However, in the ASN.1 object definition the data element for the timing plan is a single value, rather than a table. The structure of the ASN.1 notation should be changed to comply with this requirement. • In the ASN.1 notation, the data type name for the `[contact-details]` element is misspelled as: `[ontactDetails]`.

Item	41
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.12.2.2 (vol. 1); ASN.1: ¶1.12.4 (vol. 2)
Title	RampMeterStatus
Comment	The ASN.1 notation defines the `[operator-id]` and `[center-id]` data elements as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement.

Item	42
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.12.3.4 (vol. 1); ASN.1: ¶1.12.6 (vol. 2)
Title	RampMeterControlResponse
Comment	• The requirements paragraph specifies that the name of the owning operator is required information that shall be included in the message. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • The `[ramp-id]` data element is named inconsistently with other messages that use the same data element. In all other cases, `[device-id]` is used as the data element name.

Item	43
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.12.3.7 (vol. 1)
Title	Contents of Ramp Meter Control Cancel Request
Comment	The standard contains no ASN.1 notation that supports the requirements specified in this paragraph. There should be an ASN.1 object definition created to embody the required and optional data elements specified for the ramp meter control cancel request message.

Item	44
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.13.1.2 (vol. 1); ASN.1: ¶1.13.2 (vol. 2)
Title	SignalControlInventory
Comment	The ASN.1 notation defines a `[intersection-approaches]` data element array; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation.

Item	45
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.13.2.2 (vol. 1); ASN.1: ¶1.13.4 (vol. 2)
Title	IntersectionDeviceStatus
Comment	The ASN.1 notation defines the `[center-id]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement.

Item	46
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.13.3.2 (vol. 1); ASN.1: ¶1.13.5 (vol. 2)
Title	SectionStatus
Comment	The ASN.1 notation defines the `[center-id]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines the `[last-update-time]` data element as being a required feature; however the requirements paragraph specifies that that this information is optional and may be sent if it exists. The ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines a `[link-id-list]` data element array; however the requirements paragraph only specifies a list of intersections in the messages, which is provided by the `[node-id-list]` data element array. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation. • The ASN.1 notation defines a `[network-id]`, `[network-name]`, `[section-name]` and `[operator-last-revised]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, these data elements should be removed from the ASN.1 notation.

Item	47
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.13.4.2 (vol. 1); ASN.1: ¶1.13.6 (vol. 2)
Title	SignalControlRequest
Comment	The ASN.1 notation defines a `[response-plan-id]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation.

Item	48
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.13.4.7 (vol. 1)
Title	Contents of Cancel Signal Control Request
Comment	The standard contains no ASN.1 notation that supports the requirements specified in this paragraph. There should be an ASN.1 object definition created to embody the required and optional data elements specified for the cancel signal control request message.

Item	49
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.13.5.2 (vol. 1); ASN.1: ¶1.13.8 (vol. 2)
Title	SectionControlModeRequest
Comment	The ASN.1 notation defines the `[operator-id]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement.

Item	50
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.13.5.3 (vol. 1); ASN.1: ¶1.13.8 (vol. 2)
Title	SectionTimingPlanRequest
Comment	• The ASN.1 notation defines the `[operator-id]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines a `[response-plan-id]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation.

Item	51
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.13.5.5 (vol. 1); ASN.1: ¶1.13.9 (vol. 2)
Title	SectionControlResponse
Comment	• The ASN.1 notation defines the `[section-id]` data element as being optional; however the requirements paragraph specifies that this information is required and shall be included in the message. The ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines the `[device-id]` data element; however the requirements paragraph makes no mention of this information. This data element is not applicable to this response message and should be removed from the ASN.1 notation. • The requirements paragraph specifies that the event identifier associated with the request is optional information that may be sent if it exists. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • The requirements paragraph specifies optional content for a response plan identifier associated with the current request. This is inconsistent with the two request messages, which request to change either the section control mode or the section timing plan. Rather than a response plan identifier, the requirements paragraph should specify optional content for the control mode or section timing plan identifier. The ASN.1 is implemented in this fashion.

Item	52
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.13.5.7 (vol. 1)
Title	Contents of Cancel Section Control Request
Comment	The standard contains no ASN.1 notation that supports the requirements specified in this paragraph. There should be an ASN.1 object definition created to embody the required and optional data elements specified for the cancel section control request message.

Item	53
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.14.1.6 (vol. 1); ASN.1: ¶1.14.4 (vol. 2)
Title	LinkInventory
Comment	The requirements paragraph specifies that the other names for the link and the road surface conditions are optional information that may be sent if they exist. However, in the ASN.1 object definition there are no data elements defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement.

Item	54
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.14.5 (vol. 2)
Title	NodeStatusRequest
Comment	In the ASN.1 notation, the data type for the `[organization-id]` data element is `[OrganizationInformation]`. The element name and type are inconsistent. This element should be typed as `[Organization-identifier]`, or if the data type is correct, then the element name should be `[organization-information]`.

Item	55
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.14.2.2 (vol. 1); ASN.1: ¶1.14.6 (vol. 2)
Title	NodeStatus
Comment	• In the ASN.1 notation, the data type for the `[organization-id]` data element is `[OrganizationInformation]`. The element name and type are inconsistent. This element should be typed as `[Organization-identifier]`, or if the data type is correct, then the element name should be `[organization-information]`. • The requirements paragraph specifies that the date and time of the last change to this information is required information that shall be included in the message. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • In the ASN.1 notation, the data type name for the `[operator-id]` data element is misspelled as: `[Organization-center-operator-identifer]`.

Item	56
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.14.3.2 (vol. 1); ASN.1: ¶1.14.8 (vol. 2)
Title	LinkStatus
Comment	• In the ASN.1 notation, the data type for the `[organization-id]` data element is `[OrganizationInformation]`. The element name and type are inconsistent. This element should be typed as `[Organization-identifier]`, or if the data type is correct, then the element name should be `[organization-information]`. • The requirements paragraph specifies that the date and time of the last change to this information is required information that shall be included in the message. However, in the ASN.1 object definition there is no data element defined for this information. The structure of the ASN.1 notation should be changed to comply with this requirement. • In the ASN.1 notation, the data type name for the `[operator-id]` data element is misspelled as: `[Organization-center-operator-identifer]`.

Item	57
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.14.8 (vol. 2)
Title	LinkStatusList
Comment	• The data type for the `[restriction-weight]` element is named incorrectly. It should be `[Link-restriction-weight-vehicle]`, which is the correct ASN.1 name for this data element (FADD_ID 3028). • For consistency, the `[restriction-weight]` data element should be named `[restriction-weight-vehicle]`, as is the case for other instances of this data type. • For consistency, the `[direction]` element should be named `[link-direction]`, as is the case for other instances of this data type.

Item	58
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.14.4.2 (vol. 1); ASN.1: ¶1.14.9 (vol. 2)
Title	LinkData
Comment	The ASN.1 notation defines a `[link-restrictions]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation.

Item	59
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.14.9 (vol. 2)
Title	LinkDataQuantity
Comment	The XML notation for this data frame does not match the governing ASN.1 notation. The `[data-link-state]` and `[link-restrictions]` data elements are required objects in the ASN.1 notation but are optional in the XML.

Item	60
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.15.1.2 (vol. 1); ASN.1: ¶1.15.2 (vol. 2)
Title	DetectorInventory
Comment	• The ASN.1 notation defines the `[detector-type]` and `[detection-lane]` data elements as being required features; however the requirements paragraph specifies that this information is optional and may be sent if it exists. The ASN.1 notation should be changed to comply with this requirement. • The ASN.1 defines a `[station-id]` data element in both the `[DetectorInventory]` and the `[DetectorDetails]` data structures. This is redundant. The requirements paragraph specifies that a station identifier may be included for each individual detector, which makes the `[DetectorDetails]` data structure the appropriate place for this information. The `[station-id]` data element should be deleted from the `[DetectorInventory]` data structure. • The XML notation for the `[DetectorDetails]` data frame does not match the ASN.1 notation. The XML does not define the `[station-id]` data element.

Item	61
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.15.4 (vol. 2)
Title	DetectorStatus
Comment	The `[organization-owning]` and `[organization-requesting]` elements are typed as `[OrganizationInformation]`; however they are annotated with the FADD_ID 3343, which identifies the `[Organization-identifier]` data element. This is inconsistent. If the data type is correct, then the FADD_ID annotations should be removed, otherwise the data types should be changed.

Item	62
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Requirements: ¶4.3.15.3.2 (vol. 1); ASN.1: ¶1.15.6 (vol. 2)
Title	DetectorData
Comment	• The requirements paragraph specifies that the period of accumulation is required information that shall be included in the message. However, in the ASN.1 object definition this information is optional. The structure of the ASN.1 notation should be changed to comply with this requirement. • The ASN.1 notation defines a `[network-id]`, `[station-id]`, `[detector-status]` and `[detector-lane-number]` data element; however the requirements paragraph makes no mention of this information. If this information is to be part of this message, a requirement for it should be annotated in the requirements paragraph; otherwise, this data element should be removed from the ASN.1 notation.

Item	63
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.3.1, ¶1.3.2, ¶1.3.3 (vol. 2)
Title	AreaLocation
Comment	The data type for the `[area-id]` element is named incorrectly. The correct name should be `[Event-location-area-identifier]`, which is the ASN.1 name for this data element (FADD_ID 3809).

Item	64
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.3.1, ¶1.3.2 (vol. 2)
Title	ProjectReferences
Comment	The data type for the `[permit-reference]` element is named incorrectly. It should be `[Event-planned-permit-reference]`, which is the correct ASN.1 name for this data element (FADD_ID 3379).

Item	65
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.3.3 (vol. 2)
Title	RequestFilter
Comment	The data type for the `[confidence-level]` element is named incorrectly. It should be `[Event-description-confidence-level]`, which is the correct ASN.1 name for this data element (FADD_ID 3300).

Item	66
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.3.3 (vol. 2)
Title	RequestType
Comment	The ASN.1 notation incorrectly identifies the data type for the `[event-id]` data element. The data type should be `[Event-identifier]`; however it is labeled `[Event-identifiers]`.

Item	67
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.3.1, ¶1.3.2 (vol. 2)
Title	EventLane
Comment	The ASN.1 notation and the XML notation do not match. The ASN.1 notation defines the data element `[lanes-affected]`, but in the XML notation this element is named `[event-lanes-affected]`. The XML notation should be changed to match the governing ASN.1 notation.

Item	68
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.3.1 (vol. 2)
Title	EventDescription
Comment	The `[phrase]` element has the data type `[EventCategories]`, which is not defined in the standard. Possibly, it should be `[EventType]`, which is defined in the standard.

Item	69
Document	TMDD, Rev. 2.1
Page	General
Paragraph	ASN.1: ¶1.3.2 (vol. 2)
Title	ElementDescription
Comment	The XML notation for this data frame does not match the ASN.1 notation. The data types for the `[phrase]` and `[cause]` data elements are incorrect in the XML notation. They both should be typed as `[EventType]` objects.

Item	70
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Page 87 (vol. 2)
Title	DeviceControlResponse
Comment	This message is defined in XML notation only; there is no ASN.1 notation for it. It is not referenced anywhere in the standard and should be deprecated.

Item	71
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Page 89 (vol. 2)
Title	DeviceTypeInventoryRequest

Comment	The XML notation for this message does not include the element name syntax as is the case with all the other top level messages. See excerpt below.
	
	`<xs:element name="deviceTypeInventoryRequest"_`
	`type="DeviceTypeInventoryRequest"/>`

Item	72
Document	TMDD, Rev. 2.1
Page	General
Paragraph	Page 88 (vol. 2)
Title	DeviceStatusList
Comment	This message is defined in XML notation only; there is no ASN.1 notation for it. It is not referenced anywhere in the standard and should be deprecated.

Item	73
Document	TMDD, Rev. 2.1
Page	General
Paragraph	FADD_ID: 3350
Title	Element: Contact-mobile-phone-number
Comment	The naming convention for this data element is inconsistent with the other *Phone* elements. For consistency it should be: `[Contact-phone-number-mobile]`.

Item	74
Document	TMDD, Rev. 2.1
Page	General
Paragraph	FADD_ID: 3898
Title	Element: Ess-avg-wind-gust-speed
Comment	There is no unit of measurement specified for this data element.

5.0 CONCLUSION

As stated in the Section 3.0 of this final report, the overall goal of the ITS Standards Testing Program is to assess and evaluate the suitability, effectiveness, interoperability and interchangeability of standards. The measure of these three key elements is essential in understanding whether or not a particular standard is ready for field use. The conclusion is therefore stated in terms of these measures.

5.1 Suitability

The suitability of the TMDD standard to meet the operational user needs was assessed by mapping the messages implemented by the UDOT deployment to their intended user needs and evaluating if the actual needs of UDOT were met. The TMDD suitability was assessed to be marginal with the need to extend the message schema to accommodate additional needs not addressed by the standard. The TMDD standard is deficient in the areas of point-based detector stations, route inventory and status, and travel time information resulting in extensive custom solutions to fill these gaps. There are also many instances where the message schema does not coincide with the functional requirements set forth in the standard.

5.2 Effectiveness

For these same reasons, the TMDD standard was assessed to be only marginally effective with significant deficiencies in the documentation and traceability between the user needs, standard dialogs and message schemas as discussed in the detailed findings in this report. Also, clarity of use appears to have been a recurring issue experienced by the developers. Providing an informative explanation with practical examples to augment the normative descriptions of each message would enhance the understandability and effectiveness of the standard.

5.3 Interoperability and Interchangeability

The TMDD standard employed a systems engineering approach to the development of center-to-center communications and defines user needs, functional requirements, communication dialogs, and messages schemas. However the interrelation among these elements is not adequately defined due to the Requirements Traceability Matrix (RTM) being obsolete and incomplete. The RTM maps the relationship between the user needs, functional requirements and message schemas, but is missing references to the standard dialogs. Also, many of the paragraph number references do not coincide with the rest of the TMDD standard. As such, an assessment of the dialogs support for interoperability cannot be adequately evaluated.

Deficiencies with the RTM also preclude the use of the systems engineering aspects of the TMDD standard. The UDOT deployment overcame these issues by implementing a customized web service design to exchange the TMDD messages. This deployment, though effective, and sufficient to meet the needs of UDOT and the consumers of the information provided by them, demonstrates that interoperability based on the merit and content of the TMDD standard has not been achieved.

5.4 Other Key Observations

Configuration control used in the standards development process needs to be more stringent to prevent deployments from being developed using incremental versions of the standards. The use of these non-released versions complicates the development, evaluation and acceptance of the ITS standards. Similarly, identification and distribution of the standards volumes need to be addressed. As it relates to the TMDD, version and date mismatches, coupled with ambiguous naming conventions and the lack of a simple identifier (e.g. NTCIP 2306 or SAE J2354) make identifying the proper volumes to be used difficult. This extends to their publication on the website, as the ISTT was not even aware of the Volume II "Message Tables …" relationship to the other V2.1 volumes until after a large portion of the evaluation had been conducted.

5.5 Observations on Supporting Standards (NTCIP 2306)

Two of the sub-profiles defined in the NTCIP 2306 standard were tested by means of capturing, framing and examining the network data packets to and from the ATMS web service. No discrepancies were found in the encoding and transportation of the TMDD messages over either protocol. Other than some minor omissions and typographical errors, there were no significant findings associated with the NTCIP 2306 standard.

APPENDIX A

TMDD COVERAGE AND IMPLEMENTATION

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APPENDIX A: TMDD COVERAGE AND IMPLEMENTATION

TMDD Message Groups

The following table lists the TMDD user-needs defined by the standard and identifies which user-needs are implemented by ATMS. The TMDD message groups that embody each implemented user-need are described in the next table.

User Need ID	User Need Description	Implemented by TransSuite
2.5.1.1	Providing User Login	No
2.5.1.2	Supporting Authentication	No
2.5.1.3	Processing Security Token	No
3.2.2.1	The Need for Agency Information Sharing	No
3.2.2.2	The Need for Organization Information Sharing	Yes
3.2.2.3	The Need for Contact Information Sharing	Yes
3.3.1.1	The Need for Current Event Information	Yes
3.3.1.2	The Need for Event Action Log Information	No
3.3.1.3	The Need for Event Recap	No
3.3.2.1	The Need for Planned Event Information	Yes
3.3.2.2	The Need for Planned Event Action Log Information	No
3.3.2.3	The Need for Planned Event Timeline Schedule Information	Yes
3.3.2.4	The Need for Planned Event Recap	No
3.3.3.1	Share Forecast Weather Events	No
3.3.3.2	Share Forecast Road Conditions	No
3.3.3.3	The Need for Forecast Event Information	No
3.3.3.4	The Need for Forecast Event Action Log Information	No
3.3.3.5	The Need for Forecast Event Timeline Schedule Information	No
3.3.3.6	The Need for Forecast Event Recap	No
3.3.4.1	The Need for Network Inventory Information	Yes
3.3.4.2	The Need for Node Inventory Information	Yes
3.3.4.3	The Need for Link Inventory Information	Yes
3.3.4.4	The Need for Node Status Information	Yes
3.3.4.5	Link Status Request	Yes
3.3.4.6	The Need for Link Data Sharing	Yes
3.3.5.1	The Need for Detector Inventory Information	Yes
3.3.5.2	Detector Status Request	No
3.3.5.3	The Need for Detector Data Sharing	Yes
3.4.3.1	The Need for CCTV Inventory Sharing	Yes
3.4.3.2	The Need for CCTV Status Sharing	No

User Need ID	User Need Description	Implemented by TransSuite
3.4.3.3	Processing CCTV Control Transmission	No
3.4.3.4	Processing CCTV Control Receipt	No
3.4.4.1	The Need for Video Switch Inventory Sharing	No
3.4.4.2	The Need for Video Switch Status Sharing	No
3.4.4.3	Processing Video Switch Control Receipt	No
3.4.4.4	Processing Video Switch Control Transmission	No
3.4.4.5	Setting Video Switch Attributes	No
3.4.5.1	The Need for DMS Inventory Sharing	Yes
3.4.5.2	The Need for DMS Status Sharing	Yes
3.4.5.3	DMS Control Request	No
3.4.5.4	Processing DMS Control Request	No
3.4.6.1	The Need for ESS Inventory Sharing	Yes
3.4.6.2	The Need for ESS Status Sharing	Yes
3.4.7.1	The Need for Gate Inventory Sharing	No
3.4.7.2	The Need for Gate Status Sharing	No
3.4.7.3	Capability to Remotely Control Gates	No
3.4.8.1	The Need for HAR Inventory Sharing	No
3.4.8.2	The Need for HAR Status Sharing	No
3.4.8.3	Provide Remote HAR Control	No
3.4.9.1	The Need for Controllable Lanes Inventory Sharing	No
3.4.9.2	The Need for Controllable Lanes Status Sharing	No
3.4.9.3	Provide Remote Lane Control	No
3.4.10.1	The Need for Ramp Meter Inventory Sharing	No
3.4.10.2	The Need for Ramp Meter Status Sharing	No
3.4.10.3	Capability to Control Ramp Meter	No
3.4.11.1	The Need for Signal System Inventory Sharing	No
3.4.11.2	The Need for Intersection Status Sharing	No
3.4.11.3	The Need for Section Status Sharing	No
3.4.11.4	Capability to Control Intersections	No
3.4.11.5	Capability to Control Sections	No

TMDD Message Groups

The following table identifies the TMDD message groups defined by the standard and identifies which message groups are implemented by ATMS. The messages are organized into 15 major messages groups designated A1-A15. The messages contained in each message group embody the implementation of the user-needs and functional requirements.

TMDD Message Groups	Group Designator	Implemented by TransSuite
Administrative Messages	A1	Yes
Security Messages	A2	No
Event Messages	A3	Yes
Device Messages	A4	No
CCTV Messages	A5	Yes
Video Switch Messages	A6	No
DMS Messages	A7	Yes
ESS Messages	A8	Yes
Gate Control Messages	A9	No
Highway Advisory Radio Messages	A10	No
Lane Control Signals Messages	A11	No
Ramp Meter Messages	A12	No
Traffic Signal Control Messages	A13	No
Traffic Network Data Messages	A14	Yes
Traffic Detector Messages	A15	Yes

TMDD Messages

The following table identifies the TMDD messages defined by the standard, cross references each of them to the TMDD message group to which they belong, and identifies which messages are implemented by ATMS.

TMDD Messages	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
ActionLog			●													No
AuthenticationRequest		●														No
AuthenticationResponse		●														No
BasicEventUpdate			●													Yes
CCTVControlRequest					●											No
CCTVControlResponse					●											No
CCTVDeviceStatus					●											No
CCTVInventory					●											Yes
CCTVInventoryRequest					●											No
CCTVStatusRequest					●											No
CCTVSwitchCommandRequest						●										No
CCTVSwitchCommandResponse						●										No
CCTVVideoChannelData						●										No
ConnectionRequest						●										No
ConnectionRequestResponse						●										No
ContactDetails	●															No
DetectorData															●	Yes
DetectorDataRequest															●	No
DetectorInventory															●	Yes
DetectorInventoryRequest															●	No
DetectorStatus															●	No
DetectorStatusRequest															●	No
DeviceTypeInventoryRequest				●												No
DeviceTypeInventoryResponse				●												No
DMSControlRequest							●									No
DMSControlResponse							●									No
DMSDeviceStatus							●									Yes
DMSInventory							●									Yes
DMSInventoryRequest							●									No
DMSStatusRequest							●									No
ESSInventory								●								Yes
ESSInventoryRequest								●								No
ESSStatus								●								Yes
ESSStatusRequest								●								No
EventFilterRequest			●													No
FullEventUpdate			●													No

TMDD Messages	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
GateControlRequest									●							No
GateControlResponse									●							No
GateInventory									●							No
GateInventoryRequest									●							No
GateStatus									●							No
GateStatusRequest									●							No
HARControlRequest										●						No
HARControlResponse										●						No
HARInventory										●						No
HARInventoryRequest										●						No
HARStatus										●						No
HARStatusRequest										●						No
IntersectionDeviceStatus													●			No
IntersectionStatusRequest													●			No
LCSControlRequest											●					No
LCSControlResponse											●					No
LCSInventory											●					No
LCSInventoryRequest											●					No
LCSStatus											●					No
LCSStatusRequest											●					No
LinkData														●		Yes
LinkInventory														●		Yes
LinkStatus														●		Yes
LinkStatusRequest														●		No
NodeInventory														●		Yes
NodeStatus														●		Yes
NodeStatusRequest														●		No
OrganizationInformation	●															Yes
RampMeterControlRequest												●				No
RampMeterControlResponse												●				No
RampMeterInventory												●				No
RampMeterInventoryRequest												●				No
RampMeterStatus												●				No
RampMeterStatusRequest												●				No
SectionControlModeRequest													●			No
SectionControlResponse													●			No
SectionStatus													●			No
SectionTimingPlanRequest													●			No
SecurityTokenRequest		●														No
SecurityTokenResponse		●														No
SignalControlInventory													●			No

TMDD Messages	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
SignalControlInventoryRequest													●			No
SignalControlModeRequest													●			No
SignalControlResponse													●			No
SignalControlTimingPlanRequest													●			No
TrafficNetworkInventory														●		Yes
TrafficNetworkRequest														●		No
VSDeviceStatus						●										No
VSInventory						●										No
VSInventoryRequest						●										No
VSStatusRequest						●										No

TMDD Data Frames

The following table identifies the TMDD data frames defined by the standard, cross references each of them to the TMDD message group to which they belong, and identifies which data frames are implemented by ATMS.

TMDD Data Frame	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
AdditionalText			●													Yes
AlternateRouteDetail			●													No
AreaLocation			●													No
DataCollectionPeriod															●	Yes
DataExtent			●													No
DataIncidentDetails			●													No
DataInformation			●													No
DataLinkRestrictions			●											●		No
DataLinkState			●											●		Yes
DataParking			●													No
DataRoadWeather			●													No
DataSurfaceConditions			●													No
DataTimeZone	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	Yes
DetectionLane															●	Yes
DetectorDetails															●	Yes
DetectorInventoryList															●	No
DetectorList															●	No
DetectorReport															●	Yes
DeviceInventoryRequest					●	●	●	●	●	●	●	●	●			No
DeviceList				●	●	●	●	●	●	●	●	●	●			No
DeviceLocation				●	●	●	●	●	●	●	●	●	●			No
DeviceReference			●													No
DeviceStatusRequest					●	●	●	●	●	●	●	●	●			No
ElementDescription			●													No
EventAdvice			●													No
EventComments			●													No
EventDescription			●													Yes
EventDetail			●													Yes
EventElementDetail			●													No
EventHeadline			●													No
EventIndicator			●													No
EventLane			●													No
EventLocation			●													Yes
EventPeriod			●													No
EventQualifier			●													No
EventQuantity			●													No
EventReference			●													Yes
EventSource			●													No
EventTimes			●													Yes

TMDD Data Frame	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
EventType			●													Yes
FullReportText			●													No
LandmarkLocation			●													No
LaneData															●	Yes
LinkDataQuantity														●		Yes
LinkList														●		Yes
LinkLocation			●													Yes
LinkStatusList														●		Yes
MessageHeader			●													Yes
NodeList														●		Yes
NodeStatusList														●		Yes
OtherReference			●													No
PointOnLink			●													Yes
ProjectReferences			●													No
RecurrentTime			●													No
RelatedLocation			●													No
RequestFilter			●													No
RequestHeader			●													No
RequestLocation			●													No
RequestTimes			●													No
RequestType			●													No
SectionLinkList													●	●		No
SectionNodeList													●	●		No
ValidPeriod			●													Yes

TMDD Data Elements

The following table identifies the TMDD data elements defined by the standard, cross references each of them to the TMDD message group to which they belong.[6], and identifies which data elements are implemented by ATMS.

TMDD Data Element	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
Cctv-error					●											No
Cctv-image-supported					●											Yes
Cctv-lock-holder-identifier					●											No
Cctv-request-command					●	●										No
Cctv-titling-text					●	●										No
Cctv-url					●											No
Cctv-video-channel-input-identifier						●										No
Cctv-video-channel-input-name						●										No
Cctv-video-channel-output-identifier						●										No
Cctv-video-channel-output-name						●										No
Contact-email-address	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-identifier	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-mailing-address-city	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-mailing-address-country	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-mailing-address-line1	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-mailing-address-line2	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-mailing-address-state	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-mailing-address-zip	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-mobile-phone-number	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-pager-identifier	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-pager-number	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-person-name	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-person-title	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-phone-alternate	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-phone-fax	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-phone-number	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Contact-radio-unit-identifier	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Controller-firmware													●			No
Controller-firmware-release-version													●			No
Controller-master-identifier													●			No
Controller-model													●			No
Controller-response-state													●			No
Controller-serial-number													●			No
Controller-sync-time													●			No

[6] The TMDD standard defines 505 data elements, however of these only 233 elements are used. The remaining data elements are likely vestiges of the standards development and evolution process. For clarity, this table lists only the 233 elements used by the standard, while leaving it understood that the remaining elements do not map to any of the TMDD message groups. The unused data elements are listed in Appendix B of this document.

TMDD Data Element	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
Detector-end-time															●	Yes
Detector-identifier															●	Yes
Detector-intersection-approach-name															●	No
Detector-lane-number														●	●	Yes
Detector-link-identifier															●	Yes
Detector-name															●	Yes
Detector-occupancy															●	Yes
Detector-start-time															●	Yes
Detector-station-identifier															●	Yes
Detector-status															●	Yes
Detector-type															●	Yes
Detector-vehicle-count															●	Yes
Detector-vehicle-queue-length															●	No
Detector-vehicle-speed															●	Yes
Device-acknowledge-control					●	●	●		●	●	●	●	●			No
Device-beacon										●						No
Device-command-end-time					●		●		●	●	●	●	●			No
Device-command-request-priority					●		●		●	●	●	●	●			No
Device-control-type					●	●										Yes
Device-identifier		●	●	●	●	●	●	●	●	●	●	●	●			Yes
Device-link-identifier			●	●	●	●	●	●	●	●	●	●	●	●		Yes
Device-location-elevation								●								No
Device-location-height								●								No
Device-mobility-type								●								No
Device-name		●		●	●	●	●	●	●	●	●	●	●			Yes
Device-node-identifier					●							●				Yes
Device-operational-status					●		●	●	●	●	●					Yes
Device-operation-type								●								Yes
Device-organization-operator-identifier								●	●	●			●			Yes
Device-request-identifier		●		●	●		●		●	●	●	●	●			No
Device-type			●	●									●			No
Device-url							●	●	●	●	●	●				No
Dms-sign-type			●				●									Yes
Ess-avg-wind-gust-speed			●													No
Ess-probability			●													No
Ess-uv-index			●													No
Event-access-level			●													No
Event-action-description			●													No
Event-action-log-element-identifier			●													No
Event-action-request-flag			●													No
Event-action-type			●													No
Event-alternate-route-type			●													No
Event-area-name			●													No
Event-broadcast-channel-number			●													No
Event-category			●													No

TMDD Data Element	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
Event-description			●													Yes
Event-description-confidence-level			●													No
Event-description-language			●													No
Event-description-notes-and-comments			●													No
Event-description-priority-level			●													No
Event-description-time			●											●		No
Event-detection-method			●											●		Yes
Event-effective-period-qualifier			●													No
Event-forecast-element-identifier			●													No
Event-frequency-am			●													No
Event-frequency-fm			●													No
Event-headline-element			●													No
Event-holiday-day			●													No
Event-identifier			●									●	●			Yes
Event-incident-buses-involved-count			●													No
Event-incident-cars-involved-count			●													No
Event-incident-human-fatalities-count			●													No
Event-incident-human-injuries-count			●													No
Event-incident-human-major-injuries-count			●													No
Event-incident-human-minor-injuries-count			●													No
Event-incident-status			●													No
Event-incident-trucks-involved-count			●													No
Event-incident-vehicles-involved			●													No
Event-landmark-name			●													No
Event-landmark-point-name			●													No
Event-lanes-affected			●								●					No
Event-lanes-total-affected			●													No
Event-lanes-total-lanes			●													No
Event-lanes-type			●													No
Event-length-affected			●													No
Event-link-categories			●													No
Event-location-area-identifier			●											●		No
Event-location-coordinates-above-altitude			●													No
Event-location-coordinates-below-altitude			●													No
Event-location-cross-street-begin-identifier			●													No
Event-location-cross-street-begin-name			●													No
Event-location-landmark-type			●													No
Event-location-rank			●													No
Event-location-roadway-name			●													Yes
Event-message-number			●													Yes
Event-message-type-identifier			●													Yes
Event-message-type-version			●													Yes
Event-parking-number-of-spaces			●													No
Event-parking-occupancy			●													No
Event-planned-permit-reference			●													No

TMDD Data Element	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
Event-point-name			●													No
Event-project-description			●													No
Event-project-reference			●													No
Event-proportion-affected			●													No
Event-quantity-range			●													No
Event-report-medium			●													No
Event-request-focus			●													No
Event-response-plan-identifier			●				●		●	●	●	●	●			No
Event-schedule-element-identifier			●													No
Event-signed-destination			●													No
Event-speed-vehicle-estimated			●											●		No
Event-timeline-duration		●														No
Event-timeline-estimated-duration			●													Yes
Event-timeline-schedule-days-of-the-week			●													No
Event-timeline-schedule-times			●													No
Event-update			●													Yes
Event-update-operator-last-revised									●	●	●	●	●			No
Gate-request-command									●							No
Gate-status									●							No
Har-characteristics										●						No
Har-message										●						No
Har-request-command										●						No
Intersection-name													●			No
Intersection-signal-control-mode													●			No
Lane-current-state											●					No
Lane-request-command											●					No
Link-alignment			●													No
Link-alternate-route-delay			●											●		No
Link-begin-node-identifier														●		Yes
Link-capacity														●		Yes
Link-capacity-existing			●											●		No
Link-data-stored														●		Yes
Link-data-type														●		Yes
Link-delay			●											●		No
Link-density			●											●		No
Link-direction			●	●	●	●	●	●	●	●	●	●	●	●	●	Yes
Link-end-node-identifier														●		Yes
Link-headway			●											●		No
Link-identifier													●	●	●	Yes
Link-jurisdiction														●		No
Link-lane-count									●		●					No
Link-lanes-number-open														●		No
Link-length														●		Yes
Link-level-of-service														●		No
Link-location-linear-reference			●	●	●	●	●	●	●	●	●	●	●	●	●	Yes

TMDD Data Element	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
Link-location-linear-reference-version				●	●	●	●	●	●	●	●	●	●		●	No
Link-measurement-duration															●	Yes
Link-median-type														●		No
Link-name											●			●		Yes
Link-occupancy			●											●		Yes
Link-oversaturated-flag														●		No
Link-oversaturated-threshold														●		No
Link-ownership			●											●		No
Link-priority-type														●		No
Link-restriction-axle-count			●											●		No
Link-restriction-height			●											●		No
Link-restriction-length			●											●		No
Link-restriction-weight-axle			●											●		No
Link-restriction-weight-vehicle			●											●		No
Link-restriction-width			●											●		No
Link-route-designator			●	●	●	●	●	●	●	●	●	●	●	●	●	No
Link-shoulder-width-left														●		No
Link-shoulder-width-right														●		No
Link-speed-average			●											●		Yes
Link-speed-limit			●											●		Yes
Link-speed-limit-advisory			●											●		No
Link-speed-limit-truck			●											●		Yes
Link-status														●		Yes
Link-surface-condition														●		No
Link-travel-time			●											●		No
Link-travel-time-increase			●											●		No
Link-type														●		Yes
Link-volume			●											●		Yes
Meter-metering-type												●				No
Meter-status												●				No
Network-identifier				●	●	●	●	●	●	●	●	●	●	●	●	No
Network-name													●	●		No
Network-section-count														●		No
Node-identifier													●	●	●	Yes
Node-links-number														●		No
Node-name												●	●	●		No
Node-status														●		Yes
Node-type														●		No
Organization-center-identifier	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Organization-center-name	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Organization-center-operator-identifier					●		●		●	●	●	●	●	●		Yes
Organization-function	●	●	●		●	●	●	●	●	●	●	●	●	●	●	No
Organization-identifier	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	Yes
Organization-location-fips	●	●	●		●	●	●	●	●	●	●	●	●	●	●	Yes
Organization-name	●	●	●		●	●	●	●	●	●	●	●	●	●	●	Yes

TMDD Data Element	TMDD Message Group															Implemented by TransSuite
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	
Preempt-name													●			No
Ramp-current-state												●				No
Ramp-exit-roadway-name												●				No
Ramp-lane-number												●				No
Ramp-lane-type												●				No
RampMeter-control-type												●				No
Section-identifier				●	●	●	●	●	●	●	●	●	●	●	●	No
Section-link-count													●	●		No
Section-name													●			No
Section-node-count													●	●		No
Section-signal-control-mode													●			No
Security-authentication-confirmation		●														No
Security-authentication-rejection-reason		●														No
Security-password		●			●	●	●		●	●		●	●			No
Security-token-identifier		●														No
Security-token-use		●														No
Security-user-name		●			●	●	●		●	●		●	●			No
TimingPlan-identifier												●	●			No
TimingPlan-name													●			No

Implemented TMDD Messages

The TMDD messages are made up of a group of data frames and elements of which some are required members of the message while others are optional. The following tables list the TMDD messages that are implemented by the TransSuite system and identifies which members are required and implemented.

BasicEventUpdate

Member Name	Required	Implemented
message-header	Yes	Yes
event-reference	Yes	Yes
project-references	No	No
event-indicators	No	No
headline-phrase	Yes	Yes
event-detail	Yes	Yes

CCTVInventory

Member Name	Required	Implemented
organization-information	Yes	Yes
device-id	Yes	Yes
device-name	No	Yes
location	Yes	Yes
control-type	Yes	Yes
request-command	Yes	No
cctv-image	Yes	Yes
cctv-url	No	No
cctv-titling-text	No	No
network-id	No	No
link-id	No	No
node-id	No	No
route-designator	No	No
linear-reference	No	Yes
linear-reference-version	No	No
last-update-time	Yes	Yes
contact-details	No	No

DetectorData

Member Name	Required	Implemented
organization-id	Yes	Yes
network-id	No	No
collection-period	Yes	Yes

DetectorInventory

Member Name	Required	Implemented
organization-id	Yes	Yes
network-id	No	No
station-id	No	Yes
detector-list	Yes	Yes

DMSDeviceStatus

Member Name	Required	Implemented
organization-information	Yes	Yes
operator-id	Yes	Yes
device-id	Yes	Yes
dms-device-status	Yes	Yes
dms-current-message	Yes	Yes
message-time-remaining	No	Yes
message-source-mode	No	Yes
associated-event-id	No	No
last-comm-time	No	Yes

DMSInventory

Member Name	Required	Implemented
organization-information	Yes	Yes
device-id	Yes	Yes
device-name	No	Yes
dms-sign-type	Yes	Yes
last-update-time	No	Yes
device-link-id	No	No
link-direction	No	Yes
dms-beacon-type	Yes	Yes
device-location	Yes	Yes
route-designator	No	No
linear-reference	No	No
linear-reference-version	No	No
contact-details	No	No
signTechnology	No	Yes
signHeightPixels	No	No
signWidthPixels	No	No
device-url	No	No

ESSInventory

Member Name	Required	Implemented
organization-information	Yes	Yes
device-id	Yes	Yes
device-name	No	Yes
link-id	No	No
device-location	No	Yes
device-location-elevation	No	No
device-location-height	No	No
route-designator	No	No
linear-reference	No	No
linear-reference-version	No	No
network-id	No	No
device-operation-type	No	Yes
device-mobility-type	No	No
device-url	No	No
last-update-time	Yes	Yes
contact-details	No	No

ESSStatus

Member Name	Required	Implemented
center-id	No	No
operator-id	Yes	Yes
device-id	Yes	Yes
device-status	Yes	Yes
device-name	No	Yes
avg-wind-direction	Yes	Yes
avg-wind-speed	No	Yes
wind-situation	No	No
air-temperature	No	Yes
precip-yes-no	No	Yes
solar-radiation	No	No
visibility	No	Yes
visibility-situation	No	No
surface-status	No	Yes
pave-treat-type	No	No

LinkData

Member Name	Required	Implemented
organization-id	Yes	Yes
network-id	Yes	No
link-data-quantity	No	Yes
last-update-time	No	No

LinkInventory

Member Name	Required	Implemented
organization-information	Yes	Yes
network-id	Yes	No
link-list	Yes	Yes
last-update-time	No	No

LinkStatus

Member Name	Required	Implemented
organization-id	Yes	Yes
network-id	Yes	No
link-status-list	Yes	Yes
operator-id	Yes	No

NodeInventory

Member Name	Required	Implemented
organization-information	Yes	Yes
network-id	Yes	No
node-list	Yes	Yes
last-update	No	No

NodeStatus

Member Name	Required	Implemented
organization-id	Yes	Yes
network-id	Yes	No
node-status	Yes	Yes
operator-id	Yes	No

OrganizationInformation

Member Name	Required	Implemented
organization-id	Yes	Yes
organization-name	No	Yes
organization-location	No	Yes
organization-function	No	No
center-id	No	No
center-name	No	No
last-update-time	No	No
contact-details	No	No

TrafficNetworkInventory

Member Name	Required	Implemented
organization-information	Yes	Yes
network-id	Yes	Yes
node-id-list	Yes	No
link-id-list	Yes	No
network-name	No	No
network-section-count	No	No
last-update-time	No	No

Implemented TMDD Data Frames

Each TMDD data frame is made up of a group of other data frames and elements of which some are required members of the frame while others are optional. The following tables list the TMDD data frames that are implemented by the TransSuite system and identifies which members are required and implemented.

AdditionalText

Member Name	Required	Implemented
description	Yes	Yes
language	No	No

DataCollectionPeriod

Member Name	Required	Implemented
detection-time-stamp	Yes	Yes
start-time	No	Yes
end-time	No	Yes
measurement-duration	No	Yes
station-id	No	Yes
detector-reports	Yes	Yes

DataLinkState

Member Name	Required	Implemented
delay	No	No
alternate-route-delay	No	No
headway	No	No
travel-time	No	No
capacity-existing	No	No
travel-time-increase	No	No
speed-average	No	Yes
speed-vehicle-estimated	No	No
description-time	No	No
density	No	No
occupancy	No	Yes
volume	No	Yes

DateTimeZone

Member Name	Required	Implemented
<ATIS.DateTimePair>	Yes	Yes

DetectionLane

Member Name	Required	Implemented
approach-name	No	No
lane-number	No	Yes

DetectorDetails

Member Name	Required	Implemented
detector-id	Yes	Yes
station-id	No	Yes
detector-name	No	Yes
detector-location	No	No
route-designator	No	No
linear-reference	No	No
linear-reference-version	No	No
detector-link-id	No	Yes
link-direction	No	No
detector-type	Yes	Yes
detection-lane	Yes	Yes
last-update-time	No	Yes

DetectorReport

Member Name	Required	Implemented
detector-id	Yes	Yes
detector-name	No	No
detector-status	Yes	Yes
lane-data	Yes	Yes

EventDescription

Member Name	Required	Implemented
phrase	No	Yes
qualifier	No	No
related-location	No	No
additional-text	No	Yes

EventDetail

Member Name	Required	Implemented
schedule-element-id	No	No
event-descriptions	Yes	Yes
event-locations	Yes	Yes
event-times	Yes	Yes
event-lanes	No	No

EventLocation

Member Name	Required	Implemented
area-location	No	No
location-on-link	No	Yes
landmark	No	No

EventReference

Member Name	Required	Implemented
event-id	Yes	Yes
event-update	Yes	Yes
response-plan-id	No	No

EventTimes

Member Name	Required	Implemented
update-time	Yes	Yes
valid-period	Yes	Yes
sequence-time	No	No
start-time	No	Yes
alternate-start-time	No	No
alternate-end-time	No	No
recurrent-times	No	No

EventType

Member Name	Required	Implemented
<ITIS.ITIS.ITISEventType>	Yes	Yes

LaneData

Member Name	Required	Implemented
detector-lane-number	No	Yes
lane-vehicle-count	No	Yes
lane-occupancy	No	Yes
lane-vehicle-speed	No	Yes
lane-queue-length	No	No

LinkDataQuantity

Member Name	Required	Implemented
link-id	Yes	Yes
lane-number	No	No
link-data-stored	No	Yes
detection-method	No	Yes
link-data-type	No	Yes
data-link-state	Yes	Yes
link-restrictions	Yes	No

LinkList

Member Name	Required	Implemented
link-id	Yes	Yes
link-name	No	Yes
route-designator	No	No
link-type	Yes	Yes
link-begin-node-id	Yes	Yes
begin-node-location	Yes	Yes
link-end-node-id	Yes	Yes
end-node-location	Yes	Yes
linear-reference	No	Yes
link-length	No	Yes
link-capacity	No	Yes
link-speed-limit	No	Yes
link-speed-limit-truck	No	Yes
link-jurisdiction	No	No
link-owner	No	No
left-shoulder-width	No	No
right-shoulder-width	No	No
lane-separator	No	No

LinkLocation

Member Name	Required	Implemented
link-ownership	Yes	No
link-designator	Yes	No
link-id	No	No
primary-location	Yes	Yes
secondary-location	No	No
link-direction	Yes	No
link-alignment	No	No
linear-reference-version	No	No
alternate-designation	No	No

LinkStatusList

Member Name	Required	Implemented
link-id	Yes	Yes
link-name	No	Yes
link-status	Yes	Yes
direction	No	No
lanes-number-open	No	No
priority-type	No	No
restriction-axle-count	No	No
restriction-height	No	No
restriction-length	No	No
restriction-weight	No	No
restriction-width	No	No
restriction-weight-axle	No	No
surface-condition	No	No
saturation-flag	No	No
oversaturated-threshold	No	No
level-of-service	No	No

MessageHeader

Member Name	Required	Implemented
organization-sending	Yes	Yes
organizations-receiving	No	No
organizations-responding	No	No
message-type-id	Yes	Yes
message-type-version	Yes	Yes
message-number	Yes	Yes
message-time-stamp	Yes	Yes

NodeList

Member Name	Required	Implemented
node-id	Yes	Yes
node-name	No	No
node-type	No	No
node-location	Yes	Yes
node-links-number	No	No

NodeStatusList

Member Name	Required	Implemented
node-id	Yes	Yes
node-name	No	No
node-status	Yes	Yes

PointOnLink

Member Name	Required	Implemented
geo-location	Yes	Yes
linear-reference	No	No
link-name	No	No
point-name	No	No
cross-street-designator	No	No
cross-street-name	No	No
signed-destination	No	No
location-rank	No	No
landmark-location	No	No
upward-area-reference	No	No

ValidPeriod

Member Name	Required	Implemented
expected-end-time	No	Yes
estimated-duration	No	Yes
effective-periods	No	No

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APPENDIX B

UNREFERENCED TMDD DATA ELEMENTS

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Agency-function
Agency-identifier
Agency-location-fips
Agency-name
Alarm-event-identifier
Alarm-generated-date
Alarm-generated-time
Alarm-identifier
Alarm-message
Alarm-other
Alarm-receipt-date
Alarm-receipt-time
Alarm-retry-time-interval
Alarm-snooze-time-interval
Artery-identifier
Artery-intersection-count
Artery-name
Artery-time-space-identifier
Artery-time-space-name
Cctv-other
Contact-other-information
Controller-cabinet-identifier
Controller-fault-number
Controller-fault-type
Controller-identifier
Controller-other
Controller-ring-type
Detector-class
Detector-direction
Detector-marginal-performance-factor
Detector-measurement-date
Detector-operation-mode
Detector-other
Detector-section-identifier
Device-beacon-state
Device-communication-link-identifier
Device-location-latitude
Device-location-longitude
Device-organization-maintenance-identifier
Device-other
Dms-other
Dms-sign-direction
Ess-error
Ess-other
Ess-request-command
Event-active-events
Event-description-advice-alternate-route
Event-description-advice-instruction-mandatory
Event-description-advice-instruction-recommend
Event-description-advice-suggestion
Event-description-advice-warning
Event-description-author
Event-description-confidence-level-author
Event-description-notes-and-comments-author
Event-description-priority-level-author
Event-description-type-closure
Event-description-type-delay-status-cancellation
Event-description-type-device-status
Event-description-type-disaster
Event-description-type-disturbances
Event-description-type-event
Event-description-type-incident
Event-description-type-incident-response-equipment
Event-description-type-incident-response-status
Event-description-type-lane-roadway
Event-description-type-location-generic
Event-description-type-mobile-situation
Event-description-type-obstruction
Event-description-type-parking-information
Event-description-type-pavement-condition
Event-description-type-precipitation
Event-description-type-qualifier-generic
Event-description-type-responder-group-affected
Event-description-type-roadwork
Event-description-type-special-event
Event-description-type-sporting-events
Event-description-type-system-information
Event-description-type-temperature
Event-description-type-traffic-conditions
Event-description-type-transit-mode
Event-description-type-traveler-group-affected
Event-description-type-unusual-driving
Event-description-type-vehicle-group-affected
Event-description-type-visibility-air-quality
Event-description-type-weather-condition
Event-description-type-wind
Event-description-type-winter-driving-index
Event-description-type-winter-driving-restrictions
Event-incident-details
Event-incident-human-injury-type
Event-incident-manner-of-collision
Event-incident-police-report-identifier
Event-incident-property-damage
Event-incident-severity
Event-incident-vehicles-involved-count
Event-location-coordinates-altitude
Event-location-coordinates-latitude
Event-location-cross-street-end
Event-location-cross-street-end-identifier
Event-location-cross-street-occurrence
Event-location-entrance-ramp-begin
Event-location-entrance-ramp-end
Event-location-exit-ramp-begin
Event-location-exit-ramp-end
Event-location-linear-distance-offset-begin
Event-location-linear-distance-offset-end
Event-location-linear-percentage-offset-begin
Event-location-linear-percentage-offset-end
Event-location-linear-reference-post-type
Event-location-lrms-node-valence
Event-location-lrms-offset-type
Event-location-lrms-origin-node-order

Event-location-lrms-street-name-index-flag
Event-location-lrms-street-name-info-flag
Event-location-non-motorist
Event-location-relation-to-junction
Event-location-roadway-identifier
Event-location-roadway-side
Event-location-type
Event-organization-notified-identifier
Event-organization-reported-identifier
Event-organization-required-identifier
Event-organization-responding-identifier
Event-organization-response-status
Event-organization-sending-identifier
Event-other
Event-response-alternate-route
Event-response-plan-author
Event-response-plan-type
Event-timeline-cleared-and-recovering-date
Event-timeline-cleared-and-recovering-time
Event-timeline-confirmed-and-responding-date
Event-timeline-confirmed-and-responding-time
Event-timeline-end-date
Event-timeline-end-time
Event-timeline-first-arrival-at-scene-date
Event-timeline-first-arrival-at-scene-time
Event-timeline-schedule-dates
Event-timeline-schedule-end-date
Event-timeline-schedule-end-time
Event-timeline-schedule-item
Event-timeline-schedule-start-date
Event-timeline-schedule-start-time
Event-timeline-schedule-type
Event-timeline-start-date
Event-timeline-start-time
Event-update-date
Event-update-time
Event-update-type
Event-utc-date
Event-utc-time
Gate-direction
Gate-error
Gate-other
Gate-type
Har-call-sign
Har-other
Intersection-approach-count
Intersection-control-type
Intersection-crossstreet-name
Intersection-identifier
Intersection-main-street-phase-green
Intersection-other
Intersection-side-street-phase-green
Link-begin-node-latitude
Link-begin-node-longitude
Link-data-methodology
Link-design-speed
Link-end-node-latitude
Link-end-node-longitude
Link-left-turn-pocket-lane-number
Link-left-turn-pocket-length
Link-measurement-end-time
Link-movement-type
Link-other
Link-pavement-type
Link-restriction-class
Link-right-turn-pocket-lane-number
Link-right-turn-pocket-length
Link-signal-cycle-delay
Link-stop-delay
Location-road-address
Meter-mainline-speed-threshold
Meter-other
Node-jurisdiction
Node-jurisdiction-identifier
Node-latitude
Node-longitude
Node-other
Node-ownership
Node-transfer-point-identifier
Organization-contact-person-on-site-name-or-id
Organization-equipment-identifier
Organization-equipment-type
Organization-other
Organization-person-on-site-title
Organization-resource-identifier
Organization-sub-organization-function
Organization-sub-organization-identifier
Organization-sub-organization-name
Organization-traffic-equipment-latitude
Organization-traffic-equipment-location
Organization-traffic-equipment-longitude
Organization-type
Organization-vehicle-identifier
Organization-vehicle-latitude
Organization-vehicle-location
Organization-vehicle-longitude
Organization-vehicle-type
Phase-left-turn-control-type
Phase-right-turn-control-type
Phase-signal-state
Phase-vehicle-clearance-interval
Predicted-hov-lane-vehicle-count
Predicted-hov-lane-violation
Predicted-link-average-queue-length
Predicted-link-average-speed
Predicted-link-max-queue-length
Predicted-phase-volume
Prediction-begin-time
Prediction-end-time
Prediction-time
Preempt-alert-action
Preempt-detector-identifier

Preempt-filter-limit
Preempt-preempt-count
Probe-location-confidence-factor
Probe-number-detected-vehicles
Probe-number-tagged-vehicles
Probe-other
Probe-reader-identifier
Probe-reader-location-latitude
Probe-reader-location-longitude
Probe-reference-locator-identifier
Probe-reference-locator-latitude
Probe-reference-locator-longitude
Probe-tag-type
ProbeVehicle-average-speed
ProbeVehicle-class
ProbeVehicle-destination-identifier
ProbeVehicle-destination-name
ProbeVehicle-origin-identifier
ProbeVehicle-origin-name
ProbeVehicle-other
ProbeVehicle-random-identifier
ProbeVehicle-timein
ProbeVehicle-time-of-call
ProbeVehicle-time-out
ProbeVehicle-travel-time
Ramp-exit-designator-number
Ramp-exit-roadway-number
RampMeter-begin-queue-adjustment-threshold
Ramp-other
Section-other
System-identifier
System-name
Time-local-date
Time-local-time
Time-offset
TimingPlan-date-detected
TimingPlan-outdated-flag
TimingPlan-outdated-retention-time
TimingPlan-time-detected
Trsp-detector-failed-performance-factor
Trsp-frequency-factor
Trsp-inhibit-fail-controller
Trsp-inhibit-fail-detector
Trsp-plan-change-inhibit
Trsp-plan-change-threshold
Trsp-plan-identifier
Trsp-startup-inhibit
Trsp-weighting-factor

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APPENDIX C

TMDD INTERVIEW QUESTIONNAIRE

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APPENDIX C: TMDD INTERVIEW QUESTIONNAIRE

General Questions

Question	Response	Remarks / Analysis / Action Items
1. Completeness		
1.1. Were there any other ITS standards used in the ATMS system other than the two addressed by this questionnaire? Specify.	TransCore Yes – Used other standards referenced by TMDD such as ATIS and ITIS. ATMS system was developed in the summer of 2005 and prior to the release of the version of the standard being tested. TransCore would like to use the latest standard, but they have partners that are using their data so migrating is difficult.	No Findings.
1.2. Are there any legacy messages that you think should be considered as industry standard messages?	TransCore No. TransCore views the standards as an adjunct to the system rather than the root of its communication protocol. It could not serve as a root because it is missing items necessary for doing operation or maintenance tasks (see example). However, these tasks are probably out of scope of the purpose of the standard, but still necessary to build an entire system.	Example: There is nothing in the standard for inventory or status of a controller or cabinet out on the road. Operations and maintenance tasks would need this level of detail. Although the standard is intended to share information, nobody outside UDOT would need to know which controller provides a particular set of detector data.

Question	Response	Remarks / Analysis / Action Items
1.3. Are there any tasks you would like to accomplish, but cannot using the standard?	TransCore There was nothing in the standard to allow a user to request everything in the system. The request messages are based on a list of ID that you want information for, but there no method to request data for all devices without knowing the IDs. To get the inventory and status of all the devices in the system, TransCore implemented a series of custom messages that wrap the standard TMDD messages to create an array. (See example) There was discussion about providing access to archived information. This has been requested for research, statistics and training purposes. It is not clear if archived data would be useful in C2C communications so this may fall outside the scope of the TMDD standard. Traffic.COM There is nothing in the standard to provide vehicle counts broken up by vehicle classification. Agencies sometimes provide traffic detector information for aggregated lanes; however the standard does not provide a field to indicate the number of lanes aggregated in the data.	When requesting a device inventory it should not be required to send a list of device ID in the request message. Though this should be an option, it should also be possible to pass a flag in the request message to retrieve all devices in the system. Example: To get an inventory of all CCTV devices, the TransCore *MSG_CCTVInventoryList* messages returns an array of TMDD standard *CCTVInventory* messages. It was necessary to implement custom data objects to pass vehicle counts by vehicle classification. This feature should be part of the standard. The standard assumes that lane data will be returned for each individual lane. The standard should also support information for an aggregated set of lanes. Adding a data element for the number of aggregated lanes to the *LaneData* data frame would provide the flexibility for this capability.

Question	Response	Remarks / Analysis / Action Items
1.4. Did you need to implement any custom messages/data elements?	TransCore Yes, there are three custom messages implemented. StationInventory – The *DetectorInventory* message in the standard provides a *StationID* element but nothing in the standard defines what a detector station is. This message was created to provide information about a detector station such as location, nearest cross street, milepost, linear reference, etc. RouteInventory – The link/node model described in the standard uses travel times for links between nodes. However, for TransCore, travel times are between two detector stations located somewhere on a link. This message was created to provide an inventory of routes, which are treated as a group of links, for which travel times are produced. RouteData – This message was created to provide the distance and travel-time information for the routes provided in the *RouteInventory* message. Traffic.COM Yes. For example, fields were added to provide aggregated lane count for traffic detectors, volume counts by vehicle classification, and lane status for data validity.	The standard is silent on the concept of detector stations, which appears to be a significant gap in the standard. Custom messages had to be created in the UDOT deployment to provide this information. The standard should be modified to include messages to provide this coverage. The ATIS route objects were considered, but they are transient and are used to give directions between two points, which also was not a good match for the TransCore needs.
1.5. Are there messages/frames/elements available you could have used but chose not to? Why?	TransCore No.	No Findings.

Question	Response	Remarks / Analysis / Action Items
1.6. Are there messages/frames/elements available that you cannot conceive of using in a traffic management system? Why?	TransCore No. Battelle There are three data frames and nearly 300 data elements defined in the standard that are not used by any of the messages.	Unused data elements cloud the clarity of the standard. Data elements that are not referenced by the standard messages should be reviewed to determine if any need for them still exists. If not they should be depreciated.
2. Clarity		
2.1. Are the standards clear?	TransCore There were issues in clarity but it was understood that early standards were evolving and that was to be expected. Traffic.COM The lack of practical examples in the standard made it difficult to understand how to encode data in many areas.	Numerous comments were made about the need for practical examples to be included in the standard to aid in understanding.
2.2. Are the standards unambiguous?	See Question 2.1.	
2.3. Are there any messages/frames/elements that are confusing or inappropriate in the standards?	TransCore There were some but most or all of them have been addressed in the current standard.	No Findings.
2.4. Were there any areas of the standards that were not understandable? (their purpose or implementation)	TransCore No. Traffic.COM Yes, need examples to clarify.	No Findings.

Question	Response	Remarks / Analysis / Action Items
2.5. Were there any messages or elements of the standards that were open-ended or could be interpreted in more than one way?	TransCore No.	No Findings.
2.6. Were there any areas of the standards where you needed or sought guidance or clarification? • what's the data purpose/meaning • how it is encoded • units of measure • etc.	TransCore Used an early version of the standard and needed clarification then, but feels that the current version is vastly improved over the version originally used. Traffic.COM Yes, clarification was needed in many areas of the standard, but little guidance was received mainly because there is little industry knowledge and experience to draw on.	The TMDD standard would benefit from examples that illustrate how real-life system configurations are encoded into the data objects.
3. Effectiveness		
3.1. Are the standards effective in the exchange of information of a traffic management system to other centers or information service providers?	TransCore Yes. Traffic.COM The TMDD standards' effectiveness is limited due to lack of practical examples. A great deal of effort is required to fit the real-world traffic detector data into the standard model and it is not felt that interoperability can be achieved by the standard on its own merits.	The real-world detector systems often use a point-based detector-station model, which does not fit well into the standard's link-based detector model. The detector message group should be modified to support this model more effectively.

Question	Response	Remarks / Analysis / Action Items
3.2. What area could messages/frames/elements be added or changed to improve the effectiveness of the standards in providing traffic management information?	TransCore Needed to provide lane-by-lane classification bin counts for detectors. Added a *vehicle-class-bins* data object to the *LaneData* frame. TransCore felt that this information should be included as part of the standard.	Note: Class bins refer to the grouping of vehicles by length or vehicle classification. UDOT uses four class bins and produces a vehicle count for each bin as measured by each detector.
3.3. Did the use of the ITS standards simplify the procurement specification process?	TransCore No. The standards were in an early phase of development when procurement was done. Future procurements might specify standards, but training or consulting would be necessary to select the appropriate standards to specify. Agencies know what they want to do, but are not knowledgeable enough about the standards to specify their usage.	No Findings.
3.4. To what level of detail were the ITS standards specified in procuring your system? • specific standards / versions • specific messages / data elements • etc.	TransCore None.	No Findings.

Question	Response	Remarks / Analysis / Action Items
3.5. Did the use of the ITS standards simplify your life cycle process for requirements, design, build, evaluate and deploy?	TransCore Yes. The intent of using the standards was to try to not reinvent the wheel and to support the use of the standards and to be involved in their development. Traffic.COM No. They made them much more difficult. But if the standards were clearer and more flexible and comprehensive, they would simplify the process. However, the TMDD standard did provide a structure framework to work with.	See question 3.1.
4. Suitability		
4.1. Are the messages/frames/elements suitable for implementation of the traffic management system?	TransCore Yes. Traffic.COM The traffic detector data in the TMDD standard is link-based which does not fit well with real-world point-based detectors. The detector data should be based on detector stations. Point-based detector data in a link-based form in unusable.	See question 3.1.
4.2. Are there any areas of the standard that seem either deficient or out of scope of its purpose?	TransCore No.	

Question	Response	Remarks / Analysis / Action Items
4.3. Are there any messages/frames/elements that could be added or changed that would improve the suitability of the standard in providing traffic management information?	TransCore Yes. See question 1.3, 1.4, and 3.2. Traffic.COM Static data should be limited to the inventory messages. For example, the *organization-id* and *network-id* field is in both the detector inventory and data messages. However, since this is static data it should only be in the inventory messages which are normally only read once. To streamline the data feed; the detector data messages should only return dynamic data.	To reduce undue overhead, the standard messages should not include static information in dynamic messages.
4.4. Do you feel that there were any programmatic, technical, or operational impacts on you (positive or negative) because of the use of the ITS standards?	TransCore Overall positive. There were challenges but the standards eliminated the need to invent protocols which got developers "many rungs up the ladder" which is very positive. Traffic.COM From a programmatic standpoint, it was a struggle to switch existing data feeds to use the TMDD standard. Usually both legacy data feeds and the TMDD data feeds need to be maintained. From a technical standpoint, it was a struggle to fit the data from the existing data feeds into the TMDD standard traffic detector messages.	See question 3.1.

Question	Response	Remarks / Analysis / Action Items
4.5. Did you adapt your operational needs to the standards? Were adaptation recognized as having a positive or negative effect?	TransCore The use of the standards influenced how TransCore collected and structured their data and made their data richer. For example, coordinate information was added to the detectors to support more of the standard. It is expected that the future implementation of the *FullEventUpdate* message will have will influence change on how operators do things. Traffic.COM If *Event* data was being used, it would change their process, but event data is not integrated at this time.	No Findings.

Documentation Questions

Question	Response	Remarks / Analysis / Action Items
5. References		
5.1. Were the references to other external documents or material listed in the standards, if any, complete and useable?	TransCore Yes. Note that an earlier version of the standard was used.	The use of the earlier version of the standard means that the message schema will not necessary match that of the standard being evaluated.
5.2. Were there any superfluous references?	TransCore Unknown.	No Findings.
5.3. Did you or members of your team consult any of the external references and, if so, did they contribute positively to your understanding of the standards?	TransCore Yes.	No Findings.
6. Terms and Definitions		
6.1. Did the glossaries of terms, definitions, and acronyms meet your needs in understanding and using the standards?	TransCore Unknown.	No Findings.
6.2. Are there any definitions, terms, or acronyms that need to be added or revised?	TransCore No.	No Findings.
6.3. Were there any superfluous definitions, terms, or acronyms?	TransCore No.	No Findings.

Question	Response	Remarks / Analysis / Action Items
7. Figures and Tables		
7.1. Did the figures and tables in the standards aid in your understanding of the standard and its intended use?	TransCore No. They were non-existent at the time.	No Findings.
7.2. Are there any figures, tables, or terms that need to be added or revised?	TransCore Unknown.	No Findings.

Schema Questions

Question	Response	Remarks / Analysis / Action Items
8. Schema		
8.1. Were there any cases where you sub-ranged any data elements or enumerations in the standards? Why? • Increase the range • Decrease the range	TransCore The *Detector-type* enumeration was modified to include a value for *Acoustic* and *Micro-Loop*.	These detector types should be included in the standard.
8.2. Were there any cases where you changed the array size of any data array elements in the standards? Why?	TransCore No. Battelle In the earlier version of the standard, the arrays were unbound; however in the current version the upper array bounds have been added.	No Findings.
8.3. Were there any cases where you changed the data type of any data elements in the standards? Why?	TransCore No.	No Findings.
8.4. Were there any cases where you did not implement a data frame/element that was required by the standard? Why?	TransCore Yes. The *BasicEventUpdate* was changed significantly but this was not required by the project and is not well supported by the implementation. It is missing features required by the standard mainly because some information elements were not available. The *FullEventUpdate* messages is planned to be implemented in the future.	

Question	Response	Remarks / Analysis / Action Items
8.5. Why was it necessary to create a wrapper XSD to manage the TMDD messages rather than just using the messages provided by TMDD directly? Should these messages be part of the standard?	TransCore The wrapper was created because at the time of implementation the standard was not clear on how to structure the WSDL. This solution was a "best guess" on how to package and deliver the TMDD messages and should not be part of the standard.	No Findings.
8.6. SDO – The standard defines the *DateTimeZone* frame as an ATIS *DateTimePair* object. Why was this done rather than just using the external ATIS object directly?	TransCore Recommends using the ISO standard for time. SDO Don't Know. Note in findings.	The W3C standard for data and time, which is based on the ISO 8601 standard, should be adopted by the ITS standards.
8.7. SDO – The standard defines the *EventType* frame as an ITIS *ITISEventType* object. Why was this done rather than just using the external ITIS object directly?	SDO Don't Know. Note in findings.	Note in Findings.
8.8. SDO – The standard defines three data frames in XML representation only (not in ASN.1) that are, in turn, not referenced anywhere else in the standard. They are: *DeviceControlResponse* *DeviceStatusList* *SetVideoAttributes* What is the purpose/status of these frames? (Legacy frames? Available for future use or for use by other standards?)	SDO Only the ASN.1 notation is considered the standard so these rouge XML notations are probably artifacts of the standards development process.	These rouge data frames should be deleted.

Question	Response	Remarks / Analysis / Action Items
8.9. SDO – There are 505 data elements defined in the TMDD standard, however only 233 of them are referenced by a data frame or message. What is the purpose/status of these other data elements? (Legacy elements? Available for future use or for use by other standards?)	TransCore The data dictionary was created before the messages and enviably some elements are not used. It is probably very likely that some of the elements are being referenced by other standards so they should not be pulled out. SDO Don't Know. The working groups are reluctant to delete elements incase someone is using them. Battelle Any unreferenced data elements will be noted in the findings to be evaluated by the working group.	Note the un-referenced data elements in the findings.

ATMS Specific Questions

Question	Response	Remarks / Analysis / Action Items
9. TMDD		
9.1. ¶ 2.1.1.1.1.1. This paragraph does not list the *linear-reference* element among its supported optional elements; however the example XML includes it. Which is correct?	TransCore Added at a later time, the documentation needs to be updated. The XML messages from the live system are the best source of valid examples.	The XML for the *DMSInventory* message from the live system contains the *linear-reference* tag but it is always empty. It also contains an *external-device-id* tag that is not in the standard.
9.2. ¶ 2.1.1.1.2.2. The example XML includes the *organization-information* element that is not mentioned in this paragraph or referenced in the TMDD XSD file. Which is correct?	TransCore TransCore introduced and additional wrapper tag whereas it should have been the *center-id* element.	The XML for the *ESSStatus* message from the live system uses the *organization-information* tag instead of the *center-id* tag.
9.3. ¶ 2.1.1.1.3.1. This paragraph says that all required elements are supported; however the example XML does not use the *control-type*, *request-command* or *cctv-image* elements that are required by the TMDD XSD file. Which is correct?	TransCore At the time this was done, there was no control information and the UDOT was not comfortable sharing the *cctv-image* element. The documentation needs to be updated.	The XML for the *CCTVInventory* message from the live system includes the *control-type* and *cctv-image* tags but does not use the *request-command* tag.
9.4. ¶ 2.1.1.1.4.1. The example XML uses the tag *organization-information*; however the TMDD XSD file uses *organization-id*. Which is correct?	TransCore TransCore used the *organization-information* frame rather than just the *organization-id* tag.	The XML for the *DetectorInventory* message from the live system uses the *organization-information* tag rather than the *organization-id* tag.
9.5. ¶ 2.1.1.1.4.1. This paragraph does not list the *lane-number* element among its supported optional elements; however the example XML includes it. Which is correct?	TransCore TransCore used the *lane-number* element tag. The documentation needs updated.	The XML for the *DetectorInventory* message from the live system includes the *lane-number* tag.

Question	Response	Remarks / Analysis / Action Items
9.6. ¶ 2.1.1.1.4.2. The example XML uses the *organization-information* sequence; however the TMDD XSD file uses *organization-id* element. Which is correct?	TransCore TransCore used the *organization-information* frame rather than just the *organization-id* tag.	The XML for the *DetectorData* message from the live system uses the *organization-information* tag rather than the *organization-id* tag.
9.7. ¶ 2.1.1.1.4.2. The example XML uses the tag *lane-number*; however the TMDD XSD file uses *detector-lane-number*. Which is correct?	TransCore TransCore used the *lane-number* element tag rather than the *detector-lane-number* tag.	The XML for the *DetectorData* message from the live system uses the *lane-number* tag rather than the *detector-lane-number* tag.
9.8. ¶ 2.1.1.1.4.2. This paragraph does not list the *lane-number* element among its supported optional elements; however the example XML includes it. Which is correct?	See question 9.7	
9.9. ¶ 2.1.1.1.5.1. Part A of the message uses the *trafficNetworkRequest* tag in the example XML which is typed in the C2C wrapper XSD file as *trafficNetworkInventory*. Which is correct?	TransCore The tag appears to be incorrect.	The XML for the part A message from the live system uses the *trafficNetworkRequest* tag for the *trafficNetworkInventory* data frame.
9.10. ¶ 2.1.1.1.5.1. The *trafficNetworkInventory* sequence requires the *node-id-list* element and *link-id-list* element which are not used in the ATMS as noted in the paragraph. Why were these required elements not used? Should they be required?	TransCore The *NodeInventory* is provided in part B of the message and the *LinkInventory* is provided in part C of the message. The tags are *node-list* and *link-list,* respectively.	The TransCore C2C message wraps the *TrafficNetworkInventory*, *NodeInventory* and *LinkInventory* messages together into a single message. As such, the *node-id-list* and *link-id-list* elements would be redundant in this type of implementation.

Question	Response	Remarks / Analysis / Action Items
9.11. ¶ 2.1.1.1.5.2. The TMDD XSD file uses the *organization-id* tag which has the data type of *OrganizationInformation* while the example XML uses the *organization-information* tag for this sequence. Which is correct?	TransCore The standard lists the *organization-id* tag for an *OrganizationInformation* data frame which is confusing and appears to be an inconsistency in the standard.	The XML for the *NodeStatus* message from the live system uses the *organization-information* tag rather than the *organization-id* tag.
9.12. ¶ 2.1.1.1.5.2. The *operator-id* element is required in the *NodeStatus* sequence in the TMDD XSD; however it is placed in the *NodeStatusList* sequence in the example XML. Which is correct?	TransCore The *operator-id* element is placed in the wrong sequence. It should be in the *NodeStatus* sequence as defined by the standard.	No Findings.
9.13. ¶ 2.1.1.1.5.3. The TMDD XSD file uses the *organization-id* tag which has the data type of *OrganizationInformation* while the example XML uses the *organization-information* tag for this sequence. Which is correct?	TransCore The standard lists the *organization-id* tag for an *OrganizationInformation* data frame which is confusing and appears to be an inconsistency in the standard.	The XML for the *LinkStatus* message from the live system uses the *organization-information* tag rather than the *organization-id* tag.
9.14. ¶ 2.1.1.1.5.3. The *operator-id* element is required in the *LinkStatus* sequence in the TMDD XSD; however it is placed in the *LinkStatusList* sequence in the example XML. Which is correct?	TransCore The *operator-id* element is placed in the wrong sequence. It should be in the *LinkStatus* sequence as defined by the standard.	No Findings.
9.15. ¶ 2.1.1.1.5.4. The TMDD XSD file uses the *organization-id* tag which has the data type of *OrganizationInformation* while the example XML uses the *organization-information* tag for this sequence. Which is correct?	TransCore The standard lists the *organization-id* data element, but an *OrganizationInformation* data frame is implemented instead.	The XML for the *LinkData* message from the live system uses the *organization-information* tag and an *OrganizationInformation* data frame.

Question	Response	Remarks / Analysis / Action Items
9.16. ¶ 2.1.1.1.5.4. The example XML uses the *link-status-list* tag; however the TMDD XSD uses the *link-data-quantity* tag for this sequence. Which is correct?	TransCore The tag appears to be incorrect.	The XML for the *LinkData* message from the live system uses the *link-status-list* tag but then uses the *link-data-quantity-item* tag for the items in the list which are *LinkDataQuantity* objects.
9.17. ¶ 2.1.1.1.5.4. The *volume*, *occupancy* and *speed-average* elements from the *DataLinkState* frame are included in the example XML but are not listed in this paragraph among the other supported optional elements. Are there other optional elements that are supported?	TransCore This is a documentation error. There are no other implement elements of the *DataLinkState* data frame other than *volume*, *occupancy* and *speed-average*.	No Findings.
9.18. ¶ 2.1.1.1.6.1. The *EventReference* frame uses the *event-identifier* tag in the example XML; however the TMDD XSD uses *event-id* instead. Which is correct?	TransCore The *BasicEventUpdate* message is not a good candidate for testing the TMDD standard because it deviates significantly from the standard. This is due to incompatibility with the content of the data tracked in the ATMS system and that required by the standard. It is missing features required by the standard mainly because some information elements were not available while other custom elements were added. TransCore concedes that this implementation is not optimal and is in the process of implementing the *FullEventUpdate* message in accordance to the standard but does not expect to have this in place until October 2007.	It is recommended that the *BasicEventUpdate* message be removed from the test plan since it deviates significantly from the standard and there is no plan to update it.

Question	Response	Remarks / Analysis / Action Items
9.19. ¶ 2.1.1.1.6.1. Some required elements are not used while other custom elements have been added that contain similar information. Why was this done? Should the required elements that are not supported be optional? Should the custom elements that were added be part of the standard?	See question 9.18	

9.20. ¶ 2.1.1.1.6.1. In the example XML, some elements are missing wrapper tags that are defined in the TMDD XSD. For example:
 	
Example XML has:
 	
`<event-descriptions>`
 	
`</event-descriptions>`
`<incident>513</incident>`
`<description>xxx</description>`
However, the hierarchy of element names in the TMDD XSD file are:
 	
`<event-descriptions>`
 	
`<event-description>`
 	
`<phrase>`
 	
`</phrase>`
`<incident>513</incident>`
`<additional-text>`
`</event-description>`
`</additional-text>`
`<description>xxx</description>`
Should all the element names defined in the XSD be included in the XML file?
	See question 9.18	

Question	Response	Remarks / Analysis / Action Items
10. NTCIP		
10.1. ¶ 6.2. This paragraph requires the *name* attribute to be included in the <*definitions*> tag; however the TransCore C2C WSDL does not include this attribute. Is this a useless requirement?	SDO This is a best practice. This is an optional requirement to make the WSDL semantically correct.	No Findings.
10.2. ¶ 6.2. This paragraph lists a series of namespaces that are required to be included; however the TransCore C2C WSDL only includes some of them. Should some or all of these namespaces not be required?	SDO Based on the updated version of the standard, the namespaces are optional.	No Findings.
10.3. ¶ 6.4. This paragraph requires all message names to be prefixed with *MSG_*; however the TransCore C2C WSDL uses *OP_* instead. Is this a useless requirement?	TransCore This is a naming convention. SDO This is a best practice.	No Findings.

APPENDIX D

TEST CASES AND RESULTS

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Test Case: TC001	**Description:** DMS Inventory – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the DMS Inventory web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ShareDMSInventoryInformation	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC001.xml 80 packets
	Overall Result:	Passed

Test Case: TC002	**Description:** DMS Inventory – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the DMS Inventory web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_DMSInventoryList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC002.xml 84 packets
	Overall Result:	Passed

Test Case: TC003	**Description:** DMS Status – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the DMS Status web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ShareDMSStatusInformation	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC003.xml 61 packets
	Overall Result:	Passed

Test Case: TC004	**Description:** DMS Status – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the DMS Inventory web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_DMSDeviceStatusList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC004.xml 66 packets
	Overall Result:	Passed

Test Case: TC005	**Description:** ESS Inventory – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the ESS Inventory web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ShareESSInventoryInformation	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC005.xml 68 packets
	Overall Result:	Passed

Test Case: TC006	**Description:** ESS Inventory – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the ESS Inventory web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_ESSInventoryList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC006.xml 71 packets
	Overall Result:	Passed

Test Case: TC007	**Description:** ESS Status – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the ESS Status web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ShareESSStatusInformation	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC007.xml 62 packets
	Overall Result:	Passed

Test Case: TC008	**Description:** ESS Status – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the ESS Status web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_ESSStatusList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC008.xml 68 packets
	Overall Result:	Passed

Test Case: TC009	**Description:** Detector Inventory – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Detector Inventory web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ShareTrafficDetectorInventoryInformation	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC009.xml 2267 packets
	Overall Result:	Passed

Test Case: TC010	**Description:** Detector Inventory – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Detector Inventory web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_DetectorInventoryList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC010.xml 2292 packets
	Overall Result:	Passed

Test Case: TC011	**Description:** Detector Data – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Detector Data web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ShareTrafficDetectorData	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC011.xml 1149 packets
	Overall Result:	Passed

Test Case: TC012	**Description:** Detector Data – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Detector Data web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_DetectorDataList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC012.xml 1152 packets
	Overall Result:	Passed

Test Case: TC013	**Description:** Traffic Network Inventory (Link and Node) – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Traffic Network web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ProvideTrafficNetworkInventoryInformation	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC013.xml 838 packets
	Overall Result:	Passed

Test Case: TC014	**Description:** Traffic Network Inventory (Link and Node) – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Traffic Network web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_TrafficNetworkInventoryResponseList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC014.xml 843 packets
	Overall Result:	Passed

Test Case: TC015	**Description:** Node Status – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Node Status web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ProvideNodeStatus	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC015.xml 300 packets
	Overall Result:	Passed

Test Case: TC016	**Description:** Node Status – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Node Status web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_NodeStatusList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC016.xml 300 packets
	Overall Result:	Passed

Test Case: TC017	**Description:** Link Status – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Link Status web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ProvideLinkStatus	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC017.xml 181 packets
	Overall Result:	Passed

Test Case: TC018	**Description:** Link Status – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Link Status web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_LinkStatusList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC018.xml 188 packets
	Overall Result:	Passed

Test Case: TC019	**Description:** Link Data – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Link Data web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ProvideLinkData	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC019.xml 422 packets
	Overall Result:	Passed

Test Case: TC020	**Description:** Link Data -SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Link Data web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_LinkDataList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC020.xml 416 packets
	Overall Result:	Passed

Test Case: TC021	**Description:** CCTV Inventory – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the CCTV Inventory web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ShareCCTVInventoryInformation	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC021.xml 434 packets
	Overall Result:	Passed

Test Case: TC022	**Description:** CCTV Inventory – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Link Data web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_CCTVInventoryList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC022.xml 435 packets
	Overall Result:	Passed

Test Case: TC023	**Description:** Basic Event Update – HTTP POST	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the CCTV Inventory web service using the HTTP POST protocol as described in the general procedures from the following link. OP_ProvideBasicEventUpdate	
3	Save the XML document and the packet information from the network monitor. Enter the number of packets received.	TC023.xml 222 packets
	Overall Result:	Passed

Test Case: TC024	**Description:** Basic Event Update – SOAP	
Step Number	**Test Procedure**	**Result**
1	Enable network monitoring software as described in the general procedures.	
2	Invoke the Link Data web service using the SOAP protocol as described in the general procedures using the TMDD – TransSuite testing software by clicking on the following button. **MSG_TranscoreBasicEventUpdateList**	
3	Save the packet information from the network monitor. Enter the number of packets received.	TC024.xml 223 packets
	Overall Result:	Passed

APPENDIX E

CONTENTS OF THE COMPANION CD ROM

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The companion CD ROM that accompanies this report contains an electronic copy of the entire set of test results collected during the conduct of the test procedure and live monitoring of the ATMS system.

The following is a list of the contents of the CD ROM.

Test Software

This directory contains the software that was used to monitor and test the ATMS system and to capture and store the result XML files.

Test Results\Database

This directory contains a Microsoft® Access database that contains all of the test results. The database has been compressed into a ZIP file to allow it to fit on the CD. The **ATMS.zip** file contains the Access database that has all the test results for the TMDD testing and live monitoring. When unzipped it is 965392 KB.

Test Results\Test Cases

This directory contains all of the test results from the test cases defined in Appendix D. In each case the file name corresponds to the test case number to which it applies. Each of these messages is also recorded in the database.

Test Case XML Files	DataCom Analyzer Capture Files	
TC001.xml	TC001.cfa	TC001.frm
TC002.xml	TC002.cfa	TC002.frm
TC003.xml	TC003.cfa	TC003.frm
TC004.xml	TC004.cfa	TC004.frm
TC005.xml	TC005.cfa	TC005.frm
TC006.xml	TC006.cfa	TC006.frm
TC007.xml	TC007.cfa	TC007.frm
TC008.xml	TC008.cfa	TC008.frm
TC009.xml	TC009.cfa	TC009.frm
TC010.xml	TC010.cfa	TC010.frm
TC011.xml	TC011.cfa	TC011.frm
TC012.xml	TC012.cfa	TC012.frm
TC013.xml	TC013.cfa	TC013.frm
TC014.xml	TC014.cfa	TC014.frm
TC015.xml	TC015.cfa	TC015.frm
TC016.xml	TC016.cfa	TC016.frm
TC017.xml	TC017.cfa	TC017.frm
TC018.xml	TC018.cfa	TC018.frm
TC019.xml	TC019.cfa	TC019.frm
TC020.xml	TC020.cfa	TC020.frm
TC021.xml	TC021.cfa	TC021.frm
TC022.xml	TC022.cfa	TC022.frm
TC023.xml	TC023.cfa	TC023.frm
TC024.xml	TC024.cfa	TC024.frm

Test Results\Live Monitoring

This directory contains all of the captured messages from the live monitoring of the HCRS system. In each case the name of the file identifies the date and the time that the XML message was captured. Each of these messages is also recorded in the database.

MSG_CCTVInventoryList_6-22-2007_182121.xml
MSG_CCTVInventoryList_6-22-2007_192207.xml
MSG_CCTVInventoryList_6-22-2007_202235.xml
MSG_CCTVInventoryList_6-22-2007_212304.xml
MSG_CCTVInventoryList_6-22-2007_222328.xml
MSG_CCTVInventoryList_6-22-2007_232355.xml
MSG_CCTVInventoryList_6-23-2007_002419.xml
MSG_CCTVInventoryList_6-23-2007_012441.xml
MSG_CCTVInventoryList_6-23-2007_022507.xml
MSG_CCTVInventoryList_6-23-2007_032534.xml
MSG_CCTVInventoryList_6-23-2007_042556.xml
MSG_CCTVInventoryList_6-23-2007_052621.xml
MSG_CCTVInventoryList_6-23-2007_062645.xml
MSG_CCTVInventoryList_6-23-2007_072810.xml
MSG_CCTVInventoryList_6-23-2007_082846.xml
MSG_CCTVInventoryList_6-23-2007_092918.xml
MSG_CCTVInventoryList_6-23-2007_102951.xml
MSG_CCTVInventoryList_6-23-2007_113038.xml
MSG_CCTVInventoryList_6-23-2007_123116.xml
MSG_CCTVInventoryList_6-23-2007_133153.xml
MSG_CCTVInventoryList_6-23-2007_143229.xml
MSG_CCTVInventoryList_6-23-2007_153300.xml
MSG_CCTVInventoryList_6-23-2007_163330.xml
MSG_CCTVInventoryList_6-23-2007_173401.xml
MSG_CCTVInventoryList_6-23-2007_183428.xml
MSG_CCTVInventoryList_6-23-2007_193500.xml
MSG_CCTVInventoryList_6-23-2007_203530.xml
MSG_CCTVInventoryList_6-23-2007_213600.xml
MSG_CCTVInventoryList_6-23-2007_223629.xml
MSG_CCTVInventoryList_6-23-2007_233658.xml
MSG_CCTVInventoryList_6-24-2007_003727.xml
MSG_CCTVInventoryList_6-24-2007_013756.xml
MSG_CCTVInventoryList_6-24-2007_023826.xml
MSG_CCTVInventoryList_6-24-2007_033854.xml
MSG_CCTVInventoryList_6-24-2007_043922.xml
MSG_CCTVInventoryList_6-24-2007_053950.xml
MSG_CCTVInventoryList_6-24-2007_064020.xml
MSG_CCTVInventoryList_6-24-2007_074051.xml
MSG_CCTVInventoryList_6-24-2007_084119.xml
MSG_CCTVInventoryList_6-24-2007_094147.xml
MSG_CCTVInventoryList_6-24-2007_104217.xml
MSG_CCTVInventoryList_6-24-2007_114246.xml
MSG_CCTVInventoryList_6-24-2007_124316.xml
MSG_CCTVInventoryList_6-24-2007_134345.xml
MSG_CCTVInventoryList_6-24-2007_144413.xml
MSG_CCTVInventoryList_6-24-2007_154442.xml
MSG_CCTVInventoryList_6-24-2007_164509.xml
MSG_CCTVInventoryList_6-24-2007_174540.xml
MSG_CCTVInventoryList_6-24-2007_184607.xml
MSG_CCTVInventoryList_6-24-2007_194635.xml
MSG_CCTVInventoryList_6-24-2007_204707.xml
MSG_CCTVInventoryList_6-24-2007_214738.xml
MSG_CCTVInventoryList_6-24-2007_224807.xml
MSG_CCTVInventoryList_6-24-2007_234835.xml
MSG_CCTVInventoryList_6-25-2007_004905.xml
MSG_CCTVInventoryList_6-25-2007_014936.xml
MSG_CCTVInventoryList_6-25-2007_025007.xml
MSG_CCTVInventoryList_6-25-2007_035036.xml
MSG_CCTVInventoryList_6-25-2007_045105.xml
MSG_CCTVInventoryList_6-25-2007_055137.xml
MSG_CCTVInventoryList_6-25-2007_065206.xml

MSG_CCTVInventoryList_6-25-2007_075237.xml
MSG_CCTVInventoryList_6-25-2007_085306.xml
MSG_CCTVInventoryList_6-25-2007_095335.xml
MSG_CCTVInventoryList_6-25-2007_105417.xml
MSG_CCTVInventoryList_6-25-2007_115451.xml
MSG_CCTVInventoryList_6-25-2007_125527.xml
MSG_CCTVInventoryList_6-25-2007_135601.xml
MSG_CCTVInventoryList_6-25-2007_145629.xml
MSG_CCTVInventoryList_6-25-2007_155701.xml
MSG_CCTVInventoryList_6-25-2007_165733.xml
MSG_CCTVInventoryList_6-25-2007_175806.xml
MSG_CCTVInventoryList_6-25-2007_185835.xml
MSG_CCTVInventoryList_6-25-2007_195904.xml
MSG_CCTVInventoryList_6-25-2007_205932.xml
MSG_CCTVInventoryList_6-25-2007_220004.xml
MSG_CCTVInventoryList_6-25-2007_230036.xml
MSG_CCTVInventoryList_6-26-2007_000108.xml
MSG_CCTVInventoryList_6-26-2007_010137.xml
MSG_CCTVInventoryList_6-26-2007_020207.xml
MSG_CCTVInventoryList_6-26-2007_030237.xml
MSG_CCTVInventoryList_6-26-2007_040309.xml
MSG_CCTVInventoryList_6-26-2007_050336.xml
MSG_CCTVInventoryList_6-26-2007_060403.xml
MSG_CCTVInventoryList_6-26-2007_070430.xml
MSG_CCTVInventoryList_6-26-2007_080456.xml
MSG_CCTVInventoryList_6-26-2007_090526.xml
MSG_CCTVInventoryList_6-26-2007_100556.xml
MSG_CCTVInventoryList_6-26-2007_110626.xml
MSG_CCTVInventoryList_6-26-2007_120655.xml
MSG_CCTVInventoryList_6-26-2007_130726.xml
MSG_CCTVInventoryList_6-26-2007_140757.xml
MSG_CCTVInventoryList_6-26-2007_150826.xml
MSG_CCTVInventoryList_6-26-2007_160856.xml
MSG_CCTVInventoryList_6-26-2007_170922.xml
MSG_CCTVInventoryList_6-26-2007_180950.xml
MSG_CCTVInventoryList_6-26-2007_191018.xml
MSG_CCTVInventoryList_6-26-2007_201044.xml
MSG_CCTVInventoryList_6-26-2007_211109.xml
MSG_CCTVInventoryList_6-26-2007_221134.xml
MSG_CCTVInventoryList_6-26-2007_231201.xml
MSG_CCTVInventoryList_6-27-2007_001226.xml
MSG_CCTVInventoryList_6-27-2007_011252.xml
MSG_CCTVInventoryList_6-27-2007_021335.xml
MSG_CCTVInventoryList_6-27-2007_031405.xml
MSG_CCTVInventoryList_6-27-2007_041435.xml
MSG_CCTVInventoryList_6-27-2007_051504.xml
MSG_CCTVInventoryList_6-27-2007_061533.xml
MSG_CCTVInventoryList_6-27-2007_071602.xml
MSG_CCTVInventoryList_6-27-2007_081629.xml
MSG_CCTVInventoryList_6-27-2007_091658.xml
MSG_CCTVInventoryList_6-27-2007_101730.xml
MSG_CCTVInventoryList_6-27-2007_111756.xml
MSG_CCTVInventoryList_6-27-2007_121825.xml
MSG_CCTVInventoryList_6-27-2007_131854.xml
MSG_CCTVInventoryList_6-27-2007_141925.xml
MSG_CCTVInventoryList_6-27-2007_151956.xml
MSG_CCTVInventoryList_6-27-2007_162029.xml
MSG_CCTVInventoryList_6-27-2007_172058.xml
MSG_DetectorInventoryList_6-22-2007_182138.xml
MSG_DetectorInventoryList_6-22-2007_192217.xml
MSG_DetectorInventoryList_6-22-2007_202245.xml
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