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STANDARDS FOR TRAFFIC MANAGEMENT CENTER TO CENTER COMMUNICATIONS

Volume I:
Concept of Operations and Requirements

A Working Draft of the TMDD Steering Committee

By AASHTO and ITE

Document Number ____

TMDD Center-to-Center Concept of Operations and Requirements Standard- DRAFT Final

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- NTCIP C2C Working Group
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- IEEE Incident Management Group

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Foreword

This publication defines a high level Concept of Operations and Requirements for exchanging information between traffic management centers and other centers.

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INTRODUCTION

This publication provides the foundation of the Center-to-Center (C2C) Concept of Operations and Requirements for Advanced Traffic Management System (ATMS). It should be noted that the ATMS is a very complex system and there are many other standards that are necessary for development and center to center operations. This document, however addresses the most fundamental elements of an ATMS.

This document is intended for primarily the following:

- Transportation operations managers
- Transportation operations personnel
- Transportation engineers
- Transportation management procurement officers
- System integrators
- Device manufacturers

C2C communications can be used to:

- Provide event information to other centers
- Provide traffic and travel data to other centers
- Help coordinate operations within the defined C2C network
- Provide remote control of traffic control devices

The C2C environment is operationally diverse. All of the systems that exchange information do not serve the same functions but do use the base Traffic Management Data Dictionary (TMDD) data exchanged among centers. Even systems with the same functions may not operate identically. This diversity requires both a flexible approach to the required content in each data exchange and a rigorous definition of the data being exchanged.

The C2C environment is sparsely deployed. There have been few large integrated regional deployments, so operational experience is available only from a few sites. The time to fully deploy a regional or statewide system may be lengthy, covering 5 years or more. The overall approach to standards needs to support the replacement of nearly all C2C software over time.

The ITS standards development process uses a systems engineering process that requires a Concept of Operations document to define user needs. Further, the established system engineering process states that functional requirements must only be developed for those functions for which a need has been established.

The Concept of Operations (ConOps) and Requirements stage in this process is to identify and functionally describe the ways in which the system will be used. In the case of this document, this entails identifying the various ways in which those addressed above may use Center-to-Center connections to other centers to fulfill their duties. This Concept of Operations and Requirements provides the reader with:

1. A detailed description of the scope of this standard;
2. An explanation of what operations the Center-to-Center connections provide;

3. A starting point in the procurement process; and
4. An understanding of the perspective of the designers of the standard.

The Concept of Operations and Requirements are neutral as to the underlying C2C protocols, such as CORBA, DATEX, XML or other. The protocols are transparent to the system operators and no references to the specific features provided by an underlying protocol are part of the Concept of Operations.

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1.0 Document Introduction

1.1 Purpose

The purpose of this Volume I document is to identify and describe the needs for a Traffic Management Center (TMC) to provide services to External Centers via a communications interface. This subject area is frequently called External Traffic Management Center Communications (ETMCC).

This document serves as a guide to the development of and a bounding scope for:

- The ETMCC Functional Requirements;
- The ETMCC Generic Reference Data Model;
- The Message Set for ETMCC (MS-ETMCC), a DATEX-ASN Specific Reference Model for the ETMCC;
- The CORBA-Specific ETMCC Reference Model; and
- The XML-specific ETMCC Reference Model.

The message sets for ETMCC are provided in the companion volume of this document, Volume II - Message Sets. The following figure depicts the relationship between the volumes in the document.

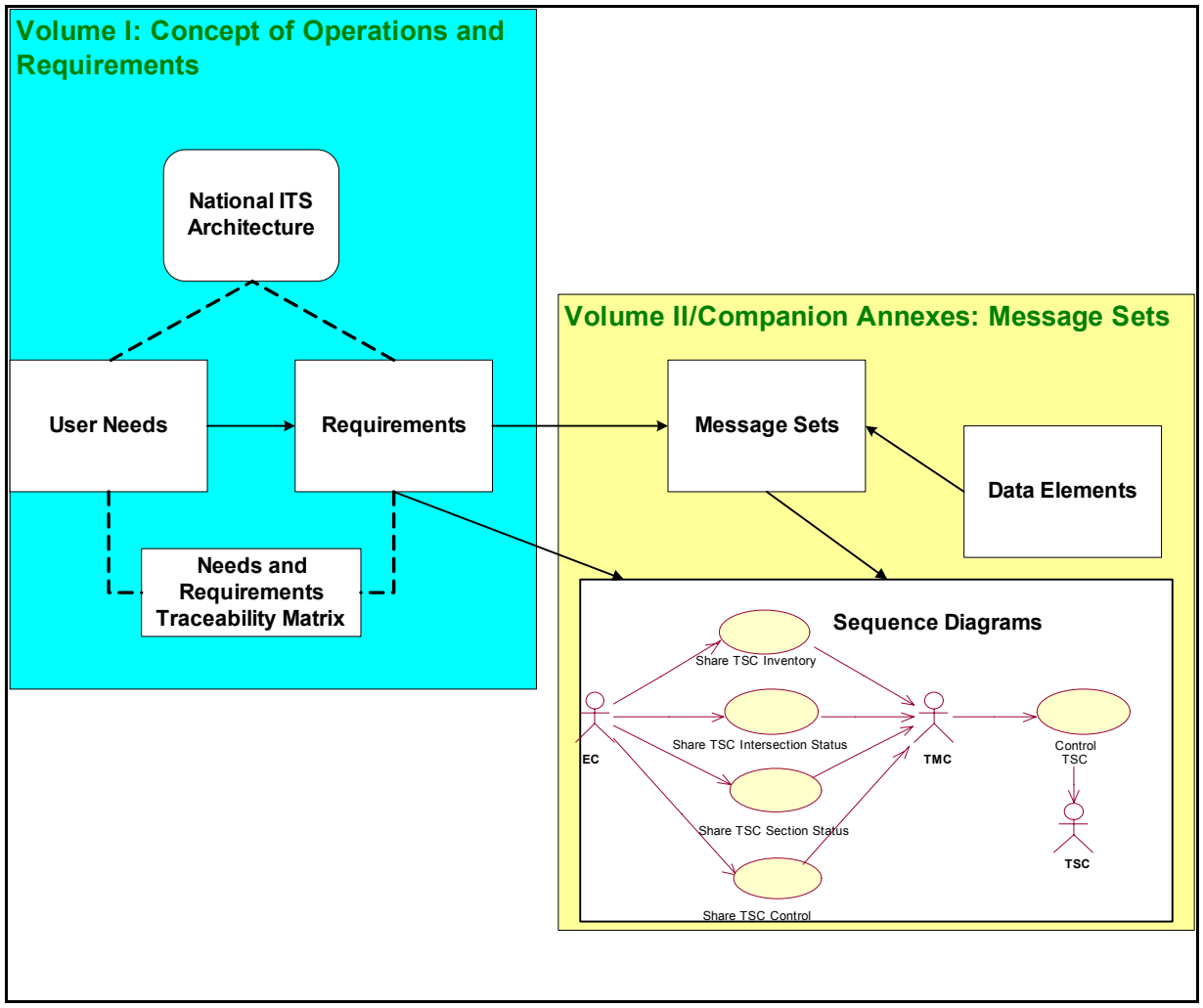

Figure 1. Relationship between Volume I and Volume II.

1.2 Center-to-Center and ETMCC Terms

The following terms are used throughout this document and need to be defined in the context of NTCIP C2C and the ETMCC.

Agency: Agency is the administrative organization that owns the control centers and assets in a center-to-center environment. The agency name in the TMDD Version 2.0 is the {AGENCY_Name_text}. An example would be the California Department of Transportation and might be represented in the system with the name “Caltrans”.

Center: The operations of each organization are broken up into centers. This does not denote a physical location, as different organizations may have their centers co-located and a single center could be physically distributed across multiple physical locations.

Center-to-Center (C2C): Communications between two or more central management systems. This includes peer-to-peer communications between any numbers of system computers in a many-to-many network.

Contact: A contact is a concept that fits either an individual person or a specific named role at an organization or in a center. Examples of named roles would be the key operator at a traffic management center or a police dispatcher for a city.

Entity: The abstract objects managed by a system are called entities. The Center-to-Center entities include event reports, devices, agencies, and response plans.

External Center (EC): An external center is a unique combination of an organization name and center name that uses the Center-to-Center services provided by another center.

Organization: An organization is the part of an agency at one site or center. An organization is a critical concept in C2C as most identifiers are created and allocated at the organization level. Examples of an organization include a state DOT district or a city transportation department.

Owner Center: The Traffic Management Center that has direct control of the devices

Traffic Management Center (TMC): The traffic management center (TMC) is the combination of the hardware and software located in the center; its operators and maintenance personnel; its policies and procedures; and its assets.

Other terms and definitions not listed above may be found in other existing standards including the following:

- SAE J2354, Message Sets for Advanced Traveler Information System (ATIS)
- IEEE 1512, Standard for Traffic Incident Management Message Sets for use by Emergency Management Centers
- NTCIP 1203, National Transportation Communications for ITS Protocol, Object Definitions for Dynamic Message Signs (DMS) – Version 02

2.0 ATMS Concepts for Center-to-Center

2.1 Scope

This document is intended to be consistent with the National ITS Architecture Version 4.0. The scope of this document is to identify and describe the standard services that may be provided by a Traffic Management Subsystem to other (external) center subsystems or system terminators of the National ITS Architecture. The external center subsystems may be Traffic Management Subsystems or virtually any of the other Center Subsystems identified in the National ITS Architecture. The external center subsystems may be located physically in the same building or at a remote location.

Figure 2 presents Traffic Management Subsystem Interconnect Diagram. This interconnect diagram is based on the architecture flows that define the scope of the ETMCC system. The diagram depicts the existing (solid lines) and future (dashed lines) interconnects between centers (subsystems or system terminators). Each type of center is shown only once, but multiples of each center type will exist in many cases. The table of architecture flows is presented in Section 5.

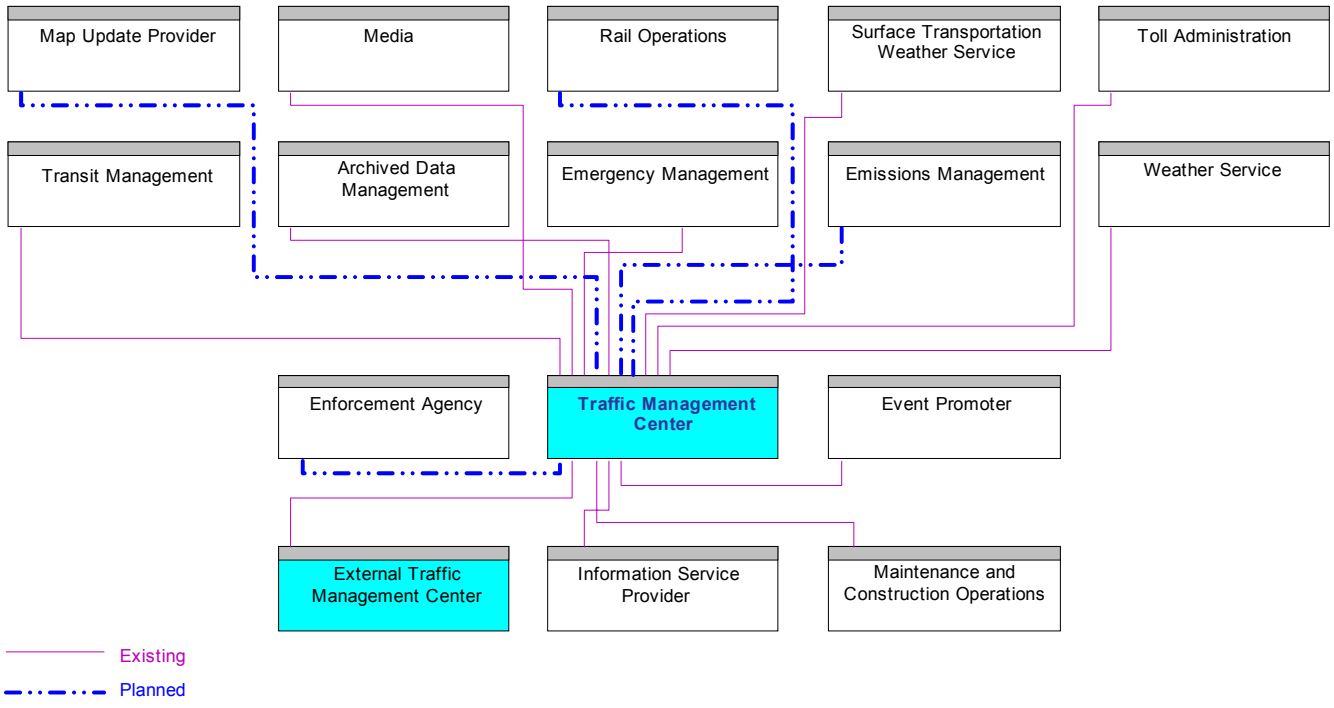

Figure 2. Traffic Management Subsystem Interconnect Diagram.

2.2 Areas not covered in this document

The following areas of operations are not included in this document. Some of these operations have already been supported in other standards and some could be part of future enhancement to TMDD standard.

2.2.1 Operations Supported by Other standards

The following areas are not primary focuses of this TMDD standard. Traffic management applications should be developed using TMDD in conjunction with other standards that address related aspects of the subject operations. The TMDD standard will refer to these related standards, where applicable:

1. **Parking Management** – TMDD will refer to the following standards for parking lot information:
   - SAE J2354 –Message Sets for Advanced Traveler Information System (ATIS), October 2000.
   - ITE TCIP, Transit Communications Interface Profiles—Standard on Incident Management Objects
2. **Response Plans** – TMDD will refer to the following standard for the use of response plans:
   - IEEE 1512, Standard for Traffic Incident Management Message Sets for use by Emergency Management Centers

2.2.2 Operations Considered for Future Enhancement of TMDD

The following areas have been recommended by the TMDD Steering Committee to be considered in the future updates to TMDD standards:

- Archived data
- Maintenance and construction (some supports exist in the current version)
- Road network probe information
- Signal preemption
- Transit priority
- Further definition of XML schemas

2.3 Background

Figure 2 describes the relationship among the key standards related to implementing ETMCC.

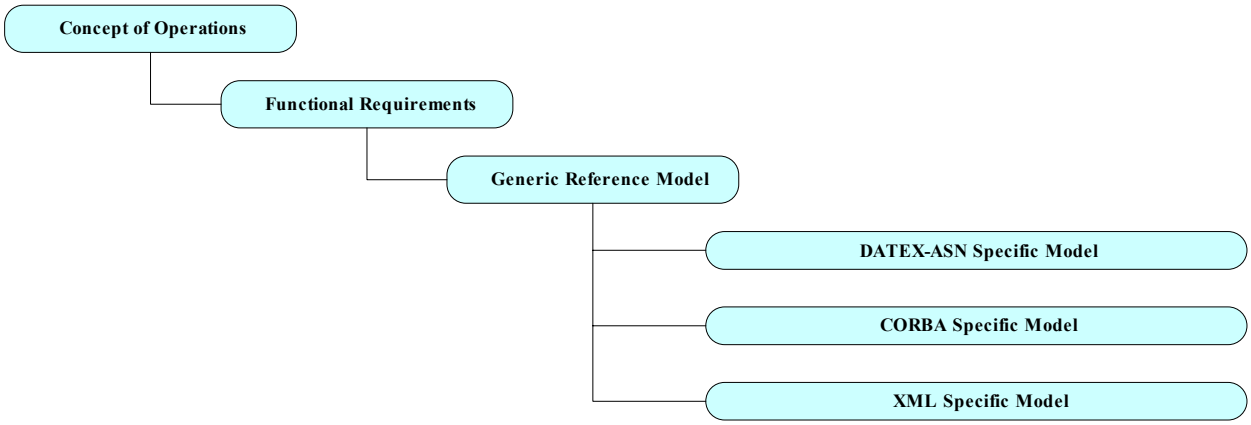

Figure 3. Relationship among various ETMCC standards.

Section 3 of this document (Supported Operations) identifies and describes each operation needed from a Traffic Management Subsystem, and serves as the Concept of Operations. Section 4 of this document (Functional Requirements) enhances the description of each service by defining the precise requirements related to each service.

The Generic Reference Model (published in a separate document) then provides a protocol-independent, high-level definition of how the services will be provided via a communications interface. There are a variety of protocol-specific interface standards that define the details of how to implement the interface.

This layered approach to the ETMCC Standards was developed due to the variety of existing TMC implementations, and support for more than one C2C protocol in NTCIP. This approach facilitates the exchange of messages through gateways connecting disparate systems. In addition, this layered approach will facilitate the migration to other protocols in the future as the telecommunications industry continues to advance its technology.

This document does not seek to define operations that occur entirely within one center. It also provides only the minimum required system content for interoperability with other centers and seeks to be neutral on the specific implementation of the software within a center.

2.4 Operational Policies and Constraints

2.4.1 Administrative Structure and Entity Naming

In order to understand the Concept of Operations presented in this document, it is first important to understand the administrative structure assumed by the document. The top level of administrative structure is the Agency. The next level down is a Center, which belongs to an Agency. All Devices are owned and/or operated by the Center. All of these items are examples of Entities. A typical arrangement of the above entities is shown in Figure 4.

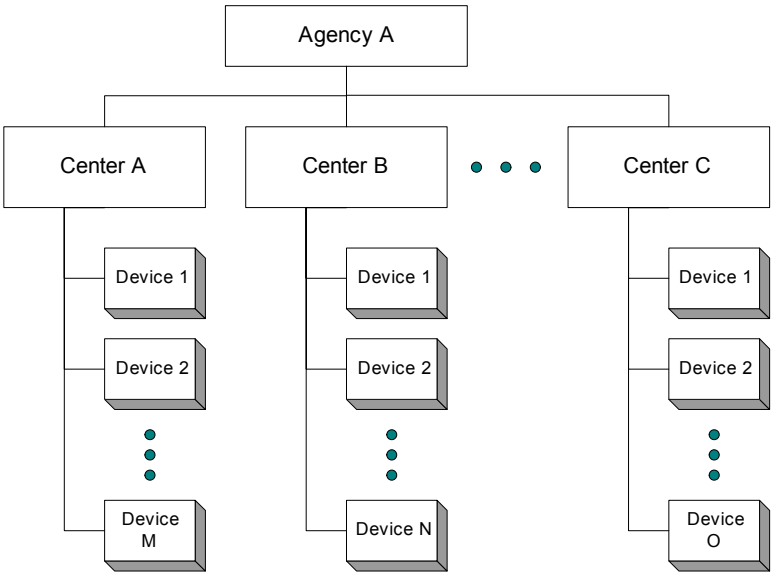

Figure 4. Typical arrangement of agency, center, and device configuration and naming

Within the center-to-center network, there must be one or more mechanisms to uniquely identify each Entity. This requires planning and forethought in order to ensure that the mechanisms will provide uniqueness and a logical structure while also allowing for system expansion.

A standard naming mechanism is defined in NTCIP 1104[1] (Center-to-Center Naming Convention Specification). That standard requires center-to-center object (entity) names to be comprised of seven parts: country ID, state ID, owner ID (Agency Name), center ID, entity kind, entity type, and entity instance, as follows.

Entity Name =
{CountryID}/{StateID}/{OwnerID}/{CenterID}/{EntityKind}/{EntityType}/{EntityInstance}

Each part of the name is a variable-length character string, and a slash character separates the parts. The following is an example of an entity name using the NTCIP 1104 naming convention.

US/CT/CTDOT/BridgeportOpsCenter/Device/DMS/12

Entity kinds include Device, Event, Center, Vehicle, and Person. Device entity types include CCTV Camera, Dynamic Message Sign, Environmental Sensor Station, Lane Closure Gate, Highway Advisory Radio, Ramp Meter, Traffic Detector, and Traffic Signal.

2.4.2 Administrative Agreements

Administrative agreements define which center is responsible for issuing and updating event reports for specified networks and areas. Administrative agreements may be formal or informal.

A Center's area of responsibility may be an entire geographic region (e.g. a state) or selected facilities within a region (e.g. all state-designated highways; a specified turnpike facility).

[1] At the time this document was written the current Draft of NTCIP 1104 did not yet reflect this naming agreement.

Centers may delegate some or all of their responsibilities to other centers for specified locations and periods.

2.4.3 Exchange Agreements

An Exchange Agreement defines the information to be shared between Centers, and the allowable uses of that information. The Exchange Agreement may define operating procedures, responsibilities of the various parties, legal aspects, etc. Other issues may also be agreed at the discretion of the information exchange partners. Exchange Agreements may be formal or informal.

The Exchange Agreement should specify any restrictions on relaying the information to third parties, including:

- Whether the information can be passed on to travel information systems by the external center
- Whether the information can be passed on to other third party centers
- Whether all or parts of some reports shall *not* be passed on to certain users.

The sending center controls what information is sent. Some information or report content may be intended only for certain users. Receiving centers should be able to limit access to specified information or report content to selected groups, e.g. in events which involve homeland security implications.

2.4.4 Agency Security Policy

Most agencies have well-defined security policies and procedures covering a variety of system security issues. These policies may be further augmented by more restrictive policies at the Center level, especially when multiple agencies co-reside in a single center. This leads to the necessity to allow the security policy governing any given Center to be derived from various sources and also blocks the widespread adoption of a single approach to security across the nation. The ETMCC standards must be compatible with the varied policies that are used among different organizations. It is left to each organization to establish its own policy for sharing data or device control with centers that have different security policies.

2.4.5 Time Synchronization Constraints

Some type of time synchronization between C2C systems is required but this can be achieved independently on each system or with an open or proprietary time system service. This document assumes that centers will maintain time synchronization and that certain center-to-center functions could require centers to be synchronized within two seconds (allowing for + or – one second at each center).

2.5 Operational Environment

The figure below shows a conceptual picture for the operational environment being defined.

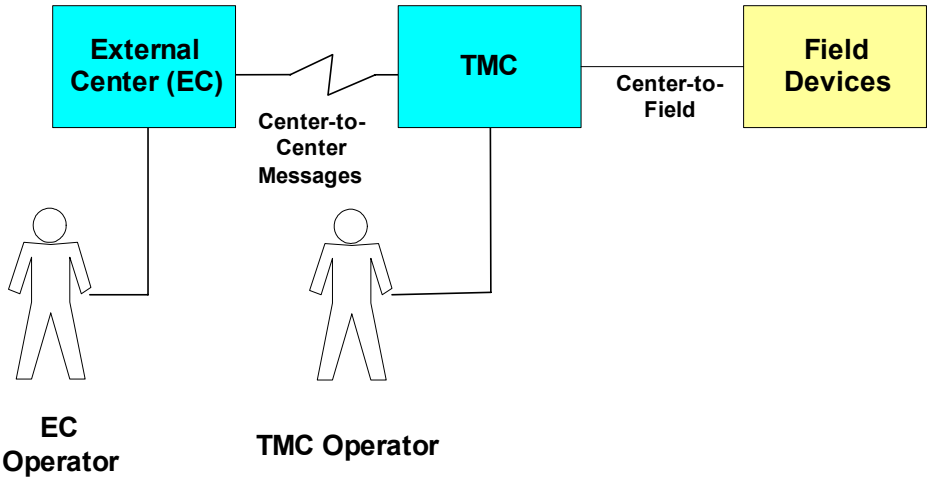

Figure 5. ETMCC Environment

Based on the above context picture, this standard is concerned with identifying the communication needs between an External Center and a TMC.

2.5.1 Security Needs

Some of the data and operations available via the ETMCC interface are quite sensitive and need to be protected against improper use. Other data is less sensitive. In general the various operations that can be performed across the ETMCC interface fall into one of the following levels of security needs:

1. The most basic security needs are a rudimentary need to authenticate the system users, provide access permissions by user name, and to track their actions. At this level there is no concern regarding others spying on the communications as the content is not sensitive.
2. Operations that affect the operation of traffic control devices need a higher level of security. It is critical in such exchanges that the identity of the requester be authenticated and the message itself is authenticated and unaltered from the original request.
3. Operations that deal with the exchange of sensitive information need additional security. Such exchanges require that the identity of the requester be authenticated and all communications with the requester be done with a level of privacy so that unauthorized personnel cannot view this information.

The security data exchange establishes a context for other C2C relationships to exist. To establish a context for the security data the following definitions are needed:

- Login – The process where an authorized user becomes recognized by the system. It is based on a user name and password and is the basis for establishing the identity of a user.
- Communications Login – The login between systems that starts the flow of packets of information. For DATEX/ASN this must occur before any communication can happen so it cannot be the basis for allowing any specific DATEX/ASN message, information exchange, or device control to occur.

- Authentication – The process by which the identity of someone is established with a very high degree of certainty.
- Security Token – A security identifier generated (or given) by the owner of an asset to those who have been authenticated. The security token, much like the bus tokens of another era in transportation, allows one to use the service being provided.
- Operating System Software – This is the software that establishes and maintains the system environment to be used by the application software. Examples include Windows 2000 and Lynx.
- Application Software – The ITS software providing the features and functions used by the system operators in performing their jobs.
- Agency Security Policy – Most agencies have well-defined security policies and procedures covering a variety of system security issues. If insufficient for the organization role and security needs the agency policy can be augmented by more restrictive policies at the organization level. In addition to having and following a security policy, it is implied that the organization is audited for policies and procedures and keeps records of their adherence.

In order to provide the above functions, information exchange between centers must support the following user needs.

2.5.1.1 Providing User Login

User login is the first operational concept. In the ITS environment it is typically a one-step or a two-step process.

2.5.1.2 Supporting Authentication

The authentication interrogation and replay includes information that is passed to identify a requester and establish the identity of a requester. This information is scheme-neutral, which means that the content of the authentication question is not prescribed by the information being passed.

2.5.1.3 Processing Security Token

This includes the information that is passed to request a security token from a protected service and to grant or reject a request for a security token. The token becomes part of the information passed to request to use a protected service. A sample usage can be found in the DMS control request information.

2.6 Modes of Operation

There are four modes of Operation when it comes to C2C communications. They are the startup of a C2C connection, a running C2C connection, a degraded C2C connection, and a disconnected C2C connection.

2.6.1 Connection Startup

This operating mode begins when systems are trying to connect or regain an interrupted connection. This always precedes information flowing from system-to-system and is followed by the Running Connection mode.

2.6.2 Running Connection

This operating mode would be considered the normal state of most C2C connections. In this mode, the information between centers is flowing and C2C functionality is working. This state follows a successfully completed Startup state. During this mode, information that was not received while the connection was not running could also be recovered. The system design and protocol determine how this is done and what information is recovered.

2.6.3 Degraded Connection

This operating mode is when some or all of the information is being lost in the C2C connection. The connection may or may not fall back into Startup – depending on the specific protocol and detection mechanism for information breaks. Many factors, such as protocol choice and the type of network service determine if sensitive operating functions are degraded. The behavior of any one system or regional group of systems is system specific.

2.6.4 Disconnected Connection

This operating mode is when the connection between centers is down and the systems are not trying to connect with one another. All of the available Center-to-Center information is being lost. An example of this would be if an operations center is closed for an extended period of time and the C2C connection is disabled.

2.7 User Classes

Classes of operators are important to C2C operations only to the extent that they expose the need to have levels of access to information. The user classes typically found in the ATMS environment are:

- Data Users – This type of operator may use data for specific purposes typically determined by an agreement with the data provider.
- Operations Users – This class of user may look at the information from a device or service and may also contribute to it (e.g., changing timing plans of a signal controller or posting a message to a DMS). This class of user may also share device control as provided by other centers and may use sensitive information by agreement with the information provider.

2.8 Support Environment

Except as otherwise noted, the content of this document is neutral as to the support environment for the regional systems.

3.0 Supported Operations

3.1 Introduction

This Section describes the major categories of services that External Centers need from a TMC, namely (1) manage assets, (2) manage transportation related information, and (3) control the operation of traffic control devices.

3.2 User Need to Manage Assets and Other Entities

Sharing inventory information is a prerequisite for providing other functions like sharing device status, sharing device data, and sharing device control. Also, many agencies use this information when determining the possible detailed actions that can be taken while performing their duties (e.g., determining which signs to post a message on).

Thus, the user needs to be able to determine the location and identity of all the assets (e.g., devices, systems, operators, etc.) known by the system at any time. Virtually all of this data changes over time; however, the rate of change varies by type of asset (e.g., mobile devices change more often than fixed ones) and by information (e.g., location data for mobile entities change more frequently than details like the cellular phone number).

Other information is needed as a prerequisite to sharing asset information. This information includes system information, agency information, center information, and user information.

3.2.1 Provide Inventory Sharing

When combined with the various communication environments that exist, the inventory information may be best achieved through subscriptions for some deployments. Other deployments may best achieve inventory sharing by specific queries in other environments. Further, a given external center may only be interested in a subset of the entire system inventory. Subscriptions are optional. TMDD is using subscription for EVENTS but Request-Response for Devices. Subscriptions for devices and events are separately selectable. Subscriptions for information about centers are considered similar to a device. Center login will determine what devices can be controlled. Note that if a center wants to support devices - all must be supported for subscriptions. A list of assets and/or other entities supported by the TMDD and this Concept of Operations includes:

- Traffic network
- Closed Circuit Television cameras
- Closed Circuit Television switches
- Dynamic message signs
- Environmental sensor stations
- Lane Closure Gates and swing bridges
- Highway advisory radio and low power FM stations
- Lane control signals
- Ramp meters
- Traffic detectors

- Traffic signals

Note – For Parking Lot information and Response Plans the users may refer to the current versions of the following standards, respectively:

- J2354 Message Sets for Advanced Traveler Information System (ATIS)
- 1512 Standard For Traffic Incident Management Message Sets for use by Emergency Management Centers

3.2.2 Provide information on Agencies, Centers, Systems, and Users

To support the exchange of other types of data it is important to share information about the agencies, centers, and systems that are connected. Additionally, this information can be used to help operations personnel to contact the other centers with which they do not often coordinate. Also, the user information for each center is important as a prerequisite for other system functions like shared control.

These functions also provide the critical building blocks for supporting the scenarios to provide control and to maintain systems in the center-to-center environment.

In order to provide the above functions, information exchange between centers must support the following user needs.

3.2.2.1 The Need for Agency Information Sharing

Agency information sharing provides a top-level administrative structure for the participants in the C2C environment. The participants would typically extend beyond those agencies with C2C network systems to the agencies that provide information to neighboring agencies by telephone, fax, internet or other remote inputs. Companies have the same information attributes as agencies and therefore use the same messages.

3.2.2.2 The Need for Organization Information Sharing

Organization information sharing provides a site-level structure for the participants in the C2C environment. The participants would typically be all the centers that directly or indirectly contribute to or use the C2C data.

3.2.2.3 The Need for Contact Information Sharing

Contact information sharing provides the details about how to contact people associated with the data in the system.

3.3 User Need to Manage Information

Centers need to be able to access status information about the various entities managed by connected centers. The status information includes data entered manually by the operations staff as well as data automatically collected. Based on the center's use of the data and the type of data, a center may desire constant updates on virtually all entities (for example, a traveler information system), or may only need status information for selected entities upon request (for example, a geographically remote center may only be interested in major status changes or major events or the center may only be able to handle a certain amount of data).

Information that requires management includes:

- Events (planned, current or forecast)
- Traffic, weather and road conditions
- Operational status of devices

3.3.1 Share Current Event Information

Centers need to share event information about current events including incidents, obstructions, traffic conditions, weather conditions, evacuations, homeland security events and natural and man-made disasters. Agency responses to these events must also be exchanged with authorized users.

Managing event information is one of the most challenging problems in ITS due to the fact that events can have inter-relationships with other events. For example, a traditional view of an incident might be a single collision of two vehicles. The event may be associated with a wide range of other factors including:

- Previous events
- Weather events or roadway conditions
- Traffic regulation such as closures or restrictions
- Congestion
- Planned event managed by the same or different agency

Operators and/or automated algorithms at external centers (especially emergency management, transit management, and other traffic management centers) may need to access any or all of this information from the TMC in order to:

- Properly manage their resources and/or
- Assist them in coordinating potential joint responses.

However, bandwidth constraints may limit the exchange of data in some cases; thus the system must allow the operators in external centers to have the ability to receive data upon request, even though their centers may not normally subscribe to the data and may have bandwidth limitations.

In addition, centers may request a recap of an event including the event's action log, if available.

In order to provide the event information discussed above, information exchange between centers must support the following user needs:

3.3.1.1 The Need for Current Event Information

Current event information is exchanged between centers so that events can be known to other centers, which may need to react operationally with internal response plans. Published event information includes a location, duration and a description. Centers that share action logs can exchange action log elements as well.

3.3.1.2 The Need for Event Action Log Information

Action log elements can be published with an event to show timeline history or to associate other information such as updates to ITS devices in response to the event.

3.3.1.3 The Need for Event Recap

Upon request, a recap of current events that had been updated since a specified date and time is exchanged between centers. Centers that share Action Logs can recap on action log elements created during the specified period as well. Also, where event histories are available, a full history of all event updates issued since a specified date and time can be exchanged between centers. The full history includes event updates now superseded by current event information.

3.3.2 Share Planned Event Information

Centers need to be able to share planned event information in order to facilitate coordination among neighboring organizations that impact each other. Planned construction and special events are two planned events that are most common and are explained below.

Centers need access to information regarding a planned construction event or planned special event information in order to have a response plan or coordination plan in place, if necessary, to handle increased congestion, provide alternate routes and other activities. There is a need for coordination of information including timeline schedules, location, and activities, especially between neighboring centers. The start and end of scheduled activities, and expected delays are also important traveler information components. Planned construction events and planned special events (including sporting events, parades, marathons, and VIP visits) can span multiple centers and may require additional coordination between centers. Due to the fact that planned special events can have an effect on traffic before the scheduled event begins, after the scheduled event ends, or as a result of a delayed or extended scheduled event, these planned events are closely monitored. Both planned construction events and planned special events must be updated and published as deviations in timeline schedules occur (possibly caused by weather conditions, traffic conditions or other planned events).

Some centers handle planned events separately from current events and may exchange both, separating planned and current descriptions of continuing circumstances like construction. Other centers treat the current event and its planned evolution as elements of a single event. Centers need a way to know which approach is being used so they can interpret incoming information correctly.

In order to provide the planned event information discussed above, information exchange between centers must support the following user needs:

3.3.2.1 The Need for Planned Event Information

Planned Event information is exchanged between centers so that events can be known to other centers, which may need to react operationally with internal coordination plans. Published event information includes a location, a description, a projected start and end and optionally, timeline schedule elements. Centers that share action logs can exchange action log elements as well.

3.3.2.2 The Need for Planned Event Action Log Information

Action log elements can be published with a planned event to show timeline history, schedule changes or to associate other information such as updates to ITS devices in a response to the planned event.

3.3.2.3 The Need for Planned Timeline Schedule Information

Timeline schedule elements can be published with a planned event to show planned intervals or schedules in which a planned event will take place.

3.3.2.4 The Need for Planned Event Recap

Upon request, a recap of planned events that had been updated since a specified date and time is exchanged between centers. Centers that share action logs can recap on action log elements created during the specified period as well. Also, where planned event histories are available, a full history of all planned event updates issued since a specified date and time can be exchanged between centers. The full history includes planned event updates now superseded by current planned event information.

3.3.3 Share Forecast Event Information

Some centers need to be able to share forecasts of expected event evolution where these are available. Other centers cannot handle forecasts and need to be able to separate forecasts from current events and planned events. These include:

3.3.3.1 Share Forecast Weather Events

Centers need to exchange forecast events including warnings of winter storms, hurricanes and floods that impact travel and may trigger response plans such as evacuations or closures.

3.3.3.2 Share Forecast Road Conditions

Centers need to exchange road condition forecasts that describe expected driving conditions an intervals over the next 24 to 48 hours, to help coordinate agency responses and to support traveler information.

In order to provide the forecast event information discussed above, information exchange between centers must support the following user needs:

3.3.3.3 The Need for Forecast Event Information

Forecast event information is exchanged between centers so that forecasts can be known to other centers, which may need to react operationally. Forecast event information includes a location, forecast time, a description, and optionally timeline schedule elements. Centers that share Action Logs can exchange action log elements that relate to forecast events as well.

3.3.3.4 The Need for Forecast Event Action Log Information

Action log elements can be published with a forecast event to show forecast changes or to associate other information such as updates to ITS devices in a response to the forecast event.

3.3.3.5 The Need for Planned Timeline Schedule Information

Timeline schedule elements can be published with a forecast event to show forecasted road conditions at different time intervals.

3.3.3.6 The Need for Forecast Event Recap

On request, a recap of forecast events that had been updated since a specified date and time is exchanged between centers. Centers that share Action Logs can recap on action log elements created during the specified period as well. Also, where event histories are available, a full history of all event updates issued since a specified data and time can be exchanged between centers. The full history includes forecast event updates now superseded by subsequent forecasts.

3.3.4 Provide Traffic Network Data

A traffic network represents a regional entity or system. A node is the smallest data element that is unique within a network. Nodes provide a geographic location that can represent begin and end points of a link, the location of a device, an intersection, or the location of an incident.

When a center elects to participate in a C2C environment, it must publish network inventory information including a list of nodes and links that compose the traffic network. Link data sharing provides operations centers within the network with status of links in the traffic network. The center must also publish associated nomenclature and location referencing that can be recognized across center boundaries

Note – Operational requirements for nodes are described in details under Traffic Signal Control and Ramp meter.

In order to provide the above functions, information exchange between centers must support the following user needs:

3.3.4.1 The Need for Network Inventory Information

Network inventory sharing provides operation centers within the C2C network a list of nodes and links that compose the traffic network.

3.3.4.2 The Need for Node Inventory Information

Node inventory sharing provides operations centers within the network a unique identification for all points in the traffic network.

3.3.4.3 The Need for Link Inventory Information

Link inventory sharing provides operations centers within the network a unique identification and description of all links in the traffic network.

3.3.4.4 The Need for Node Status Information

Node status sharing provides operations centers within the network a status for a node in the traffic network. This will include current state of the node (e.g., open, closed, or restricted).

3.3.4.5 Link Status Request

A link status request provides operations centers with a request for status of links. This will include current state of the link (e.g., open, closed, or restricted). A link status request will force a link status message to be distributed. The link status message is frequent.

3.3.4.6 The Need for Link Data Sharing

Link data sharing provides operations centers within the network a general status of links in the traffic network. Link data can be derived from multiple sources and is defined by the field detection that is supporting operations for the operations center. Link Data can be fused from many sources and applied to the appropriate links or roadways on the traffic network to provide information to operations centers to assist in reporting incidents or slowdowns

3.3.5 Provide Traffic Detector Data

Traffic detectors that measure traffic volume, occupancy, speeds, or are used for toll collection within a center may also be used for traffic information exchange between centers. Traffic detection data may be passed to traveler information systems, or shared between traffic management centers, requiring that systems and centers provide vehicle detections to other centers.

Traffic data includes the dissemination or sharing of detector based link status that can be received from multiple field sources including probes, radar and loops. The traffic data can be attributed to the underlying link node based traffic network.

Detection devices such as loops or probes are often associated with nodes and links on the traffic network.

In order to provide the above functions, information exchange between centers must support the following user needs:

3.3.5.1 The Need for Detector Inventory Information

Detector inventory sharing provides operations centers unique identification of detection devices in the traffic network.

3.3.5.2 Detector Status Request

A detector status request provides operations centers with a request for status of detection devices. A detector status request will force a detector status message to be distributed. The detector status message is infrequent.

3.3.5.3 The Need for Detector Data Sharing

Detector data sharing provides operations centers with actual traffic data from the detectors. This information may include traffic data such as volume, occupancy, and speed of the vehicles associated with the detector. Depending on the availability and needs, the subject data could be provided as raw or averaged data.

3.4 User Need for Status and Control of Traffic Devices

An External Center may desire to monitor traffic conditions and/or to control traffic through the use of traffic devices. These devices include:

- CCTV cameras
- Video switches
- Dynamic message signs
- Environmental sensor stations
- Lane Closure Gates
- Highway advisory radio
- Lane control signals
- Ramp meters
- Traffic signals

3.4.1 Provide Information on the Status of Traffic Devices

External Centers may find it necessary to monitor the status of various traffic devices that are managed by another center in order to monitor traffic conditions, monitor state of the network, and to provide traveler information.

Data that should be accessible for each device include:

- Communications status (e.g., connected, disconnected, failed)
- Operational status (e.g., working, not-available)
- Current operational state information (e.g., the current message for a sign, the current phase for a signal, etc.)

This information can then be used by external centers to ensure:

- That consistent information is disseminated to the public,
- That requests for modified control of these devices is appropriate given the larger context (i.e., so that an operator does not attempt to override a high priority message with a low priority message), and
- That an operator does not begin an action that requires the use of an inoperable device.

3.4.2 Provide Control of Traffic Devices

An External Center may desire to control traffic through the use of traffic control devices connected to the TMC. Among the many reasons an External Center may wish to do this (and a TMC may wish to allow it), two stand out as undisputed. The first reason is that many traffic control centers do not stay open 24 hours a day, seven days a week. The second reason is that emergency conditions sometimes require the evacuation of an operations center. The following is a more detailed description of these reasons:

- Scheduled Closing of Operations Centers – Most traffic operations centers are scheduled to be open when the value of the operations are high compared to the cost of keeping them closed. For some centers, this means that they are closed during the night and/or during weekends. Nonetheless, conditions may arise during these periods that require active traffic management. In these cases, the center may wish to allow another, perhaps regional, center to have limited control of its equipment.

- Evacuation of Operations Centers – One of the most important uses of ITS devices is to manage traffic during natural disasters and other emergency situations that require the evacuation of the civilian population. For example, during a hurricane evacuation that the operations center could be closed down, the traffic along the evacuation routes may be controlled via remote terminals.

Whether the need is for one of these or other reasons, an External Center may wish to request actions for an individual device or actions to be issued on multiple devices and/or device types. There may also be a desire to initiate a predefined plan that might affect many devices. Of course, all of these needs are predicated by the need to be able to discover new devices as they are added to the system.

An external center operator may need to request actions before an accident or other cause is identified. Sometimes the situation is outside the field of view of a system and only the effects can be seen. For whatever reason, the need is to act on any information the center operations staff may acquire and regardless of whether the reason is known to the control system.

Typical examples of visible operator activities include putting messages on DMS or changing the timing of a ramp meter. Typical examples of plan-based actions include changing signal timing on an arterial or closing a reversible HOV lane.

Due to the various liability concerns involved with controlling traffic control devices, each agency will need to establish their own institutional policies defining under what conditions an External Centers may exert control upon a device. These policies may include:

- A human in the loop to manually process the request
- A computer to automatically approve/deny the request
- Some combination of a human and computer to process the request

Thus, the messaging standards should allow a mechanism by which an External Center may make a request for controlling a traffic control device and receive a response for this request; however, the standards should remain neutral as to the institutional policies that a specific agency may wish to put in place in order to approve or deny the request.

3.4.2.1 Preconditions

The Center-to-center communications concept of operations (and hence the requirements) included herein assumes that the various external TMC's (ETMC) already "*know"* about the characteristics of the device (e.g. sign type, lines, pixels). There is no intent or requirement for the ETMC to "retrieve" the characteristics of the specific device that it seeks to control.

It is a requirement that the ETMC be able to retrieve an inventory of the available devices over the C2C link, it is not a requirement that the full and complete characteristics of the device be available over this link. Thus, for devices such as a DMS, the ETMC must already "*know"* about the number of lines, sign type (line matrix, full matrix, character matrix) and "*know*" the number of rows and columns for each line, character, or the full matrix. Further, for DMS, there is no intent to read-back the fonts or be able to change the fonts available. Thus, the ETMC only knows that the device exists at a relatively high level.

Where detailed information is required for device configuration and management, the MS/ETMCC assumes that one would log into the TMC system directly as a TMC operator with full access to the device configuration. The intent of the C2C interaction is to cooperatively manage devices for regional incident mitigation and traffic management. Even in the case for

off-hours operational support, the access to the device characteristics and configuration information is limited to the same general level of operation at the C2C level.

3.4.3 Provide CCTV Camera Status and Control

Closed Circuit Television (CCTV) cameras are used to help view the surface transportation system. CCTV devices can be used to:

- Verify the existence of traffic congestion reports
- Determine what assistance may be needed by the incident
- Monitor the progress of incidents, construction, and special events
- Determine when the residual congestion from and incident is cleared
- Provide visual images to the public as to the state of the roadway
- Determine what type of Emergency Services are needed to be dispatched

In order to provide the above functions, information exchange between centers must support the following user needs:

3.4.3.1 The Need for CCTV Inventory Sharing

Inventory information is exchanged between centers so that CCTVs that are being operated by a center can become known to other centers. The inventory information that is published includes data items such as location and camera attributes.

3.4.3.2 The Need for CCTV Status Sharing

Status information is provided for each camera that a center is publishing to other centers (see The Need for CCTV Inventory information section). Status information includes the operational status of a camera as well as the current output of the camera (in snapshot format). This information can be used to determine if a camera is available for use as well as determine the current view of the CCTV device.

3.4.3.3 Processing CCTV Control Transmission

Control transmission is when a center sends a request to change the direction of a camera that is controlled by another center. When a transmission request is submitted, the transmitting center expects to receive a response from the remote center indicating if the camera position was updated or rejected.

3.4.3.4 Processing CCTV Control Receipt

Control receipt is when requests to change the viewing direction of a camera are received from another center. When a control request is received the center that controls the camera must make a determination if the change in direction will be supported or rejected. Multiple techniques to support direction requests (e.g. direction, preset, relative position change, etc.) can be supported by each camera device. A response shall be sent to the center that originated the request.

3.4.4 Provide Video Switch Status and Control

Video Switch (VS) capability is used to route the video from a source device to a display device. Video switch devices can be used to:

- Display the output of a video device on an output device (e.g. local monitor, video wall, etc.)
- Provide visual images to the public as to the state of the roadway
- Record the video onto a storage device
- Alter the attributes of a video steam in order to effectively utilize available communications bandwidth

In order to provide the above functions, information exchange between centers must support the following user needs:

3.4.4.1 The Need for Video Switch Inventory Sharing

Inventory information is exchanged between centers so that video switches that are being operated by a center can become known to other centers. The inventory information that is published includes data items such as number of video inputs and outputs supported by the switch.

3.4.4.2 The Need for Video Switch Status Sharing

Status information is provided for any connections (i.e. a mapping between an input and an output) that are currently implemented by the video switch.

3.4.4.3 Processing Video Switch Control Receipt

Control receipt is when requests to establish a video connection (i.e. route a video input to a video output) are received from another center. When a control request is received the center that controls the video switch must make a determination if the connection request can be implemented or rejected.

3.4.4.4 Processing Video Switch Control Transmission

Control transmission is when a center sends a connection request for a video switch that is controlled by another center. When a transmission request is submitted, the transmitting center expects to receive a response from the remote center indicating if the connection was established or rejected.

3.4.4.5 Setting Video Switch Attributes

A center can request that the attributes associated with a video stream (e.g. frames per second) be altered so that available communications bandwidth can be efficiently utilized. The requesting center expects to receive a response from the remote center indicating if the requested attributes can be supported.

3.4.5 Provide DMS Status and Control

Dynamic Message Signs (DMS) are used to help manage the surface transportation system. Dynamic Message Signs can be used to:

- Provide travelers information that help the travelers select routes
- Inform travelers about traffic congestion
- Inform travelers about travel times
- Inform travelers about roadway or traffic conditions

- Inform travelers about planned activities that may affect traffic conditions
- Provide information about transportation alternatives
- Provide other public service announcements

When a center elects to participate in a C2C environment, it must publish inventory information about the DMS signs that it will allow other centers to access for status and for the display of messages. Potential uses that other centers may have for the inventory and status information include locating devices on map and determining the consistency of the sign message with the other information being provided to motorists.

If another center determines that it needs to request a message on a DMS, the other center will send a DMS change request. When the request is received the system will act upon the request with any of the following:

- A human in the loop to manually process the request
- A computer that automatically approves/denies the request
- Some combination of a human and computer to process the request.

The C2C messages are not prescriptive in how a center acts upon a request to display a message on a sign. The C2C messages only address the transmission of the request and the resulting response that must be sent back to the requesting center. Once a message has been accepted and displayed, the message can be terminated utilizing several different approaches:

- Message “times out”: the initial display message request can specify a period of time the message is to be displayed.
- Message is canceled by the requesting center: the center that requested a message can request that the displayed message be canceled.
- Message is canceled by the owning center: DMS owner can cancel the message or can allow another message request to replace the message. When this happens the remote center is sent a message to inform them that the message has been canceled.

Two device control techniques are supported in this Concept of Operations. The first is via the NTCIP MULTI string and the second is by message numbers. The details of these are as follows:

- NTCIP MULTI String: A MULTI string will be sent from one center in the DMS message request, a MULTI string allows a significant amount of formatting (e.g. multiple pages, flashing, etc) to be included along with the text.
- Message Number: For signs that support fixed messages, a capability for a remote center to request the supported messages will be implemented and message display requests can be implemented using message IDs (rather than MULTI strings).

The message number approach to displaying a message is included for those centers which have signs that only can display fixed messages. It is irrelevant to the C2C messages whether or not the fixed message library is maintained at either the sign or the sign master software or somewhere in the control center software. A remote center requests to get the fixed messages that are supported for a specific sign and the owning center will return the messages along with unique numeric IDs for each of the messages supported.

In order to provide the above status and control functions, information exchange between centers must support the following user needs:

3.4.5.1 The Need for DMS Inventory Sharing

Inventory information is exchanged between centers so that DMSs that are being operated by a center can become known to other centers. The inventory information that is published includes data items such as location and sign attributes. Note that as the deployment of portable DMSs increases, it is possible for the location of a DMS to vary based on where the device is deployed.

3.4.5.2 The Need for DMS Status Sharing

Status information is provided for each sign that a center is publishing to other centers (see 3.4.2.1 inventory information). Status information includes the operational status of a sign as well as the contents of the display of the sign.

3.4.5.3 DMS Control Request

Control transmission is when a center sends a request to display a message on a sign that is controlled by another center. When a transmission request is submitted, the transmitting center expects to receive a response from the remote center indicating if the message was displayed, queued, or rejected.

3.4.5.4 Processing DMS Control Request

Control receipt is when requests to post a message are received from another center. When a control request is received the center that controls the sign must make a determination if the message will be displayed, queued, or rejected. Message display requests can be either freeform messages (in NTCIP MULTI format) or messages from a library associated with the sign. A response shall be sent to the center that originated the request describing the action taken on the control request.

3.4.6 Provide Environment Sensor Data

Environmental Sensor Stations (ESS) are used to monitor a wide range of environmental conditions, such as weather (e.g., wind, temperature, precipitation), pavement conditions, visibility, and air/water quality. ESSs are used to determine current conditions and the data is also combined with modeling algorithms for predicting future conditions such as fog or roadway icing.

In the transportation community, these devices are frequently used to:

- improve roadway maintenance
- provide weather information
- provide pavement conditions, such as icing and flooding that may reduce roadway capacity
- improve traffic operations

C2C ESS data is widely distributed to traveler information systems, emergency management systems, and remote Traffic Management Centers to inform them of conditions affecting roadway travel.

In order to provide the above functions, information exchange between centers must support the following user needs:

3.4.6.1 The Need for ESS Inventory Sharing

Inventory information is exchanged between centers so that ESSs that are being operated by a center can become known to other centers. The inventory information that is published includes data items such as location and device attributes.

3.4.6.2 The Need for ESS Status Sharing

Status information is provided for each device that a center is publishing to other centers. Status information includes the operational status of an ESS device as well as the current environmental data of the device.

3.4.7 Provide Lane Closure Gate Control

An External Center may need to open or close traffic gates. These gates are typically used to allow or deny access to facilities that may periodically close due to road/weather conditions, conflicting operations (e.g., reversible flow or draw-bridge), or other reasons.

In order to provide the above status and control functions, information exchange between centers must support the following user needs:

3.4.7.1 The Need for Gate Inventory Sharing

Inventory information is exchanged between centers so that gates that are being operated by a center can become known to other centers. The inventory information that is published includes data items about those gate controllers that exist and the information supported by the owning system.

3.4.7.2 The Need for Gate Status Sharing

Gate status sharing provides a TMC operator with information about the current status and operation of the gates in the inventory. Status information is provided for each gate that a center is publishing to other centers. Status information includes the status of the (e.g., open or closed).

3.4.7.3 Capability to Remotely Control Gates

An External Center may request a specific gate be open or close. This kind of control is important to allow or limit traffic flow on specific links based on congestion and/or accidents on the roadways or on adjoining roads.

3.4.8 Provide Highway Advisory Radio Control

The Highway Advisory Radio (HAR) is an important information dissemination device between an operator in the TMC and the travelers. Its use is often coupled with the use of messages on message signs to get more travelers to tune into the message.

HARs may be used by the operators of centers and/or external centers:

- to reach travelers at the major decision points in their trips before they add to the backup.

- to give notice of future construction and upcoming special events. center operator may need

The HAR can go by other acronyms and is not a highway-only information device. HAR are used to play messages to travelers via their AM/FM radios. Low powered FM radios may also be used to play the messages.

The advice given can include any form of traveler information but most often includes event information. While the majority of HAR are low power there is at least one instance of doing this function with a fully powered FM radio station.

There is no approved NTCIP object set, although a draft object set existed (circa 1998) at one time. The lack of an NTCIP Center-to-Field standard for HAR leads to the exclusion of shared HAR control functions from these operational requirements.

In order to provide the above status and control functions, information exchange between centers must support the following user needs:

3.4.8.1 The Need for HAR Inventory Sharing

Inventory information is exchanged between centers so that HARs that are being operated by a center can become known to other centers. The inventory information that is published includes data items such as location and attributes of the device.

3.4.8.2 The Need for HAR Status Sharing

HAR status sharing provides a TMC operator with information about the condition and current usage of the HAR devices in the inventory. Status information is provided for each device that a center is publishing to other centers. Status information includes the operational status of a HAR as well as the text of the message being broadcast.

3.4.8.3 Provide Remote HAR Control

The Traffic Management Center may allow the distant operators from other authorized traffic management systems to control a specific HAR device. This capability will allow an external center to send a request to play a message on a HAR that is controlled by the TMC.

3.4.9 Provide Lane Control

An External Center may need to close a lane, change the direction of a lane, or open a lane in order to properly manage traffic conditions.

Some uses of this type of control would be to enhance egress from a special event, to handle additional congestion from a nearby accident, or to close traffic to protect construction crews. These controls change the direction of a lane.

In order to provide the above status and control functions, information exchange between centers must support the following user needs:

3.4.9.1 The Need for Controllable Lanes Inventory Sharing

Inventory information is exchanged between centers so that controllable lanes that are being operated by a center can become known to other centers. The inventory information that is published includes data items about those lane controllers that exist and the information supported by the owning system.

3.4.9.2 The Need for Controllable Lanes Status Sharing

Lane control status sharing provides a TMC operator with information about the current status and operation of the controllable lanes in the inventory. Status information is provided for each lane controller that a center is publishing to other centers. Status information includes the operational status of the lane as well as direction of the traffic.

3.4.9.3 Provide Remote Lane Control

The Traffic Management Center may allow the distant operators from other authorized traffic management systems to control lane signals. This may include changing the direction of traffic on a reversible lane, opening or closing a lane in order to manage the prevailing traffic conditions.

3.4.10 Provide Ramp Meter Status and Control

Center-to-Center Ramp Control operations are primarily a coordination and management function between Traffic Management Center operators. This may include monitoring ramp meter operation within the network of interest and/or altering metering rates at ramps during an incident or event to alleviate congestion and move traffic efficiently.

When a center elects to participate in a C2C environment, it must publish inventory information about the ramp meters that it will allow other centers to access for status and for the control of metering rates. Ramp meter status sharing provides a remote center with information about the condition and current usage of the ramp meters in the inventory.

If another center determines that it needs to control an individual ramp the center will send a ramp control request. When the request is received the system will act upon the request with any of the following:

- A human in the loop to manually process the request
- A computer that automatically approves/denies the request
- Some combination of a human and computer to process the request.

The C2C messages are not prescriptive in how a center acts upon a request to control a ramp. The C2C messages only address the transmission of the request and the resulting response that must be sent back to the requesting center.

Once a request has been accepted and acted upon, the subject request for a ramp control can be terminated utilizing several different approaches:

- Command “Expired”: The command requested for the ramp control has timed out.
- Request is canceled by requesting center: the center that requested external ramp control cancels the request.
- Request is canceled by the owning center: ramp meter owner can cancel the request or can allow another request to replace the exiting ones. When this happens the owning center sends a message to the remote center to inform them that the request has been canceled.

In order to provide the above status and control functions, information exchange between centers must support the following user needs:

3.4.10.1 The Need for Ramp Meter Inventory Sharing

Inventory information is exchanged between centers so that ramp controllers that are being operated by a center can become known to other centers. The inventory information that is published includes data items about those ramp controllers that exist and the information supported by the owning system.

3.4.10.2 The Need for Ramp Meter Status Sharing

Ramp control status sharing provides a TMC operator with information about the current status and operation of the ramp controllers in the inventory. Status information is provided for each ramp controller that a center is publishing to other centers. Status information includes the operational status as well as the metering rate of the ramp controller.

3.4.10.3 Capability to Control Ramp Meter

An External Center may need to request the device be turned on/off and/or set the device to a specific metering rate. This kind of control is important to allow daily plans for ramp meters to be modified based on congestion and/or accidents on the roadways or on adjoining roads.

3.4.11 Provide Traffic Signal Control

Center-to-Center Signal Control operations are primarily a coordination and management function between Traffic Management Center operators. There are two areas of services related to traffic signals: services related to individual intersections and those related to a group of intersections working in a coordinated fashion, known as a Section. In both areas, the user may need to:

- monitor signal system operation within the network of interest
- alter signal timing plans along alternate routes during an incident or event to alleviate congestion and move traffic efficiently

When a center elects to participate in a C2C environment, it must publish inventory information about the signals that it will allow other centers to access for status and for the control of signal timing. Potential uses that other centers may have for the inventory and status information include locating signals on a map, monitoring intersection controller operation, checking traffic conditions at the desired locations, or checking for the problems associated with the traffic and equipment.

If another center determines that it needs to control an individual signal and/or a group of signals, the center will send a signal control request. When the request is received the system will act upon the request with any of the following:

- A human in the loop to manually process the request
- A computer that automatically approves/denies the request
- Some combination of a human and computer to process the request.

The C2C messages are not prescriptive in how a center acts upon a request to control a signal. The C2C messages only address the transmission of the request and the resulting response that must be sent back to the requesting center.

Once a request has been accepted and acted upon, the subject request for signal control can be terminated utilizing several different approaches:

- Command “Expired”: The command requested for the signal controller has timed out.
- Request is canceled by requesting center: the center that requested external signal control cancels the request.
- Request is canceled by the owning center: Signal system owner can cancel the request or can allow another request to replace the exiting ones. When this happens the owning center sends a message to the remote center to inform them that the request has been canceled.

In order to provide the above status and control functions, information exchange between centers must support the following user needs:

3.4.11.1 The Need for Signal System Inventory Sharing

Inventory information is exchanged between centers so that signals that are being operated by a center can become known to other centers. The inventory information that is published includes data items about those traffic signal controllers that exist, traffic signal sections and any other information supported by the owning system.

3.4.11.2 The Need for Intersection Status Sharing

Signal control status sharing provides a TMC operator with information about the current status and operation of the signals in the inventory. This provides capability to monitor intersection controller operation, check traffic conditions at the desired locations, or check for the problems associated with the traffic and equipment.

Status information is provided for each signal controller that a center is publishing to other centers. Status information includes the operational status of a signal as well as the control mode and timing parameters of the signal.

3.4.11.3 The Need for Section Status Sharing

Similar to 3.4.7.2, some centers may need to monitor the status of a section. A section is any user defined group of any number of intersections in any physical arrangement working in a coordinated fashion,

Status information is provided for each section that a center is publishing to other centers. Status information includes the operational status of all signals within the section as well as the section timing plan information.

3.4.11.4 Capability to Control Intersection Signals

External Centers may need to control a TMC’s traffic signals as a part of everyday system operations, executing mitigation plans for construction and special event congestion, and reacting to traffic incidents. The user may request another center to grant control of individual intersections or a section that they control. Furthermore, some External Centers may need to be able to dynamically assign or reassign specific intersections to new or existing groups.

Likewise, some agencies may wish to allow an External Center (e.g., perhaps because they are a part of the same Agency) to assume full control over traffic signal operations, including changing control modes and timing parameters such as split, offset, and cycle. Note that if

multiple requests are received at the owning center, and the current control mode is “free”, then “change timing plan” command has no meaning and the control mode command will have the highest priority. Also specail functions will be treated as a plan. The inventory should include the plan number, if any.

3.4.11.5 Capability to Control Sections

An External Center may also request another center to grant control of a section that they control. As described in 3.4.11.4, this may work in conjunction with dynamic sectioning to dynamically assign or reassign specific intersections to new or existing groups. It should be noted that an intersection can only be associated with a single section at any given time.

4.0 Requirements

4.1 Introduction

This chapter provides the detailed requirements of the operations discussed in the previous chapters of this document. The requirements also describe how these operations are provided to external center subsystems through a communications interface.

It should be noted that before performing any of these operations, the requesting center must log into the owning system and be properly authenticated based on requirements discussed below in Security Data.

4.2 Required and Optional Data

The requirements tables in this section include both “Required” and “Optional” data. This also has been addressed in message sets (see Volume II), where a separate column labeled “Optional/Required” is used to indicate whether or not data needs to be placed in this field when the message is exchanged between two centers.

The optional data has been included in the definition of the messages of this standard in order to support exchange of the complete set of data applicable to the specific operations. However, optional implies that the field does not have to be supplied. This could be due to the fact that the data does not exist or will not be needed by the requesting external centers. Therefore, these items should be determined and agreed upon between the participants in the C2C environment before the system is procured.

4.3 Features

4.3.1 Security Data

There are three operational requirements areas for the security information for Center-to-Center (C2C). The requirements statements for each of these functional areas are as follows:

Table 1. Security Data Functional Requirements

4.3.1.1 – Support User Login The Traffic Management Center shall support the security login of users. The requirements to support this function are as follows:
4.3.1.1.1 Establish User Identity The Center shall log users into the operating system in a manner that establishes the identity of the person at the operator console.
4.3.1.1.2 Provide Secondary Login The Traffic Management Center may have a secondary login for the application software to establish either a unique identity, an operational role, or user name identity.
4.3.1.2 – Support Authentication This section provides functional requirements for a TMC to support the security authentication

of a distant operator for the purpose of granting a security token to use a protected service. The requirements to support this function are as follows:

4.3.1.2.1 Send Authentication Interrogation Information

The TMC shall support sending the authentication interrogation information needed to establish the identity of a person requesting a security token for a protected service.

4.3.1.2.2 Contents of Authentication Interrogation Information

The Authentication Interrogation request shall include the following information:

- Name of the organization doing the interrogation
- Unique ID of the organization doing the interrogation
- Name of the requesting organization
- Unique ID of the requesting organization
- User name and password of the requesting operator

4.3.1.2.3 Send Authentication Interrogation Response

The TMC shall send an authentication interrogation response as needed to gain access to protected services.

4.3.1.2.4 Contents of Authentication Interrogation Response

The Authentication Interrogation response shall include the following information:

- Name of the organization doing the interrogation
- Unique ID of the organization doing the interrogation
- Name of the organization being interrogated
- Unique ID of the organization being interrogated
- User name of the operator in the targeted organization
- The content of the interrogation

4.3.1.3 – Support Security Tokens

This section provides the functional requirements for a TMC to support security tokens for providing and using protected services with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:

4.3.1.3.1 Send the Security Token Request Information

The TMC shall send the security token request information as needed.

4.3.1.3.2 Contents of Security Token Request

The Security Token Request information shall include the following:

- Name of the organization
- Unique ID of the organization.
- User name of the requesting organization
- The organization ID of the requesting organization
- Contact Information (name, phone number, pager, email address) for the Agency

- The specific ID (as in a device ID) if requesting a device specific token. Assumed to be for all devices if not sent.
- The time interval the token will be valid for. The granted duration may actually be shorter, subject to the security policy for the protected service.
- Number of times the token can be used.
- The date and time of the request

The following optional information may also be sent if it exists for the Security Tokens:

- The name of the protected resource. Assumed to be all provided services not sent (Example: “DMS Control”).

4.3.1.3.3 Process Security Token Request

The Traffic Management Center shall process the security token request information as needed.

4.3.1.3.4 Provide Response to Security Token Request

The TMC shall send the granted or rejected security token request information as needed.

4.3.1.3.5 Contents of Response Information

The response information shall include the following:

- Name of the organization
- Unique ID of the organization.
- Name of the person in the granting organization who did approve the authentication.
- The organization ID of the requesting organization
- A unique sequence number generated by the requesting center that uniquely identifies the control request within the requesting center
- Was the authentication successful? (Y or N)
- Contact Information (name, phone number, pager, email address) for the Agency
- If the authentication was rejected this text tells why.
- The time interval for the validity of the token. The duration may be shorter than requested.
- Number of times the token can be used. Number may be fewer than requested.
- If the authentication was OK this is the token that was granted

The following optional information may also be sent if it exists for the Security Token:

- The name of the protected resource. Assumed to be all provided services not sent. (Example: “DMS Control”)

4.3.1.3.6 Process Security Token Request

The Traffic Management Center shall process the granted or rejected security token request information as needed.

4.3.2 Administrative Information Sharing

This section of Operational Requirements covers the topic of the agencies, organizations, and people that own, operate, and maintain the systems in the center-to-center (C2C) network. The C2C network is more than just wires and the voltage levels on them. It is part of the relationship between the organizations on the network. The administrative data establishes a context for C2C relationships to exist.

There are three functional requirements areas for the administrative data for Center-to-Center (C2C). The requirements statements for each of these functional areas of support are as follows:

Table 2. Administrative Functional Requirements

4.3.2.1 Provide Agency Information Sharing The Center shall support the sharing of Agency information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this functions are as follows:
4.3.2.1.1 Update Agency Information The Traffic Management Center shall send changes to the Agency information to all subscribing ECs, after the Agency information is updated.
4.3.2.1.2 Contents of Agency Information Agency information shall include the following: • The unique ID of the agency The following optional information shall also be sent if it exists for the agency: • tte unique name of the agency • a brief description of the agency's role • the location of the agency • the function of the agency • the contact Information (name, phone number, pager, email address) for the agency • the date and time of the last change to this information
4.3.2.1.3 Send Agency Information Upon Request The Center shall send Agency information to an authorized requesting EC after the request is received from the EC.
4.3.2.1.4 Center to Receive and Process Agency Information The Center shall receive and process Agency information, both partial sets from automated updates and full sets from specific requests, when it is received from authorized EC's
4.3.2.2 Provide Organization Information Sharing This section provides the functional requirements for a Center to support sharing of Organization information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this functions are as follows:
4.3.2.2.1 Update Organization Information The Center shall send changes to the Organization information to all subscribing ECs after they are submitted to the database.
4.3.2.2.2 Contents of Organization Information Organization information shall include the following: • unique ID of the organization by agreement within the C2C environment

The following optional information may also be sent if it exists for the Agency:

- the unique name of the organization
- the location of the organization
- the function of the organization
- the center ID and name that is part of this organization
- the default contact information (name, phone number, pager, email address)
- the date and time of the last change to this information

4.3.2.2.3 Send Organization Information Upon Request
The Center shall send Organization information to an authorized requesting ECs after the request is received from the EC.

4.3.2.2.4 Center to Receive and Process Organization Information
The Center shall receive and process Organization information, both partial sets from automated updates and full sets from specific requests, when it is received from authorized EC's

4.3.2.3 – Provide Contact Information Sharing
The Center shall support the sharing of Contact information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:

4.3.2.3.1 Update Contact Information
The Center shall send changes to the *Contact* information to all subscribing ECs after they are submitted to the database.

4.3.2.3.2 Contents of Contact Information
Contact information shall include the following:

- the Unique contact ID as assigned by the Organization

The following optional information may also be sent if it exists for the Agency:

- the unique name of the person or point of contact as assigned at the agency level
- the job or role the contact fulfills at the organization, company, or agency
- the unique ID of the organization
- the name of the organization that the contact belongs to
- the Internet Email Address of the person - This can provide a unique identity for each person.
- the mailing address of the contact
- The delivery address of the contact
- The work phone number of the contact
- The cellular or mobile phone number of the contact
- The second phone number of the contact
- The fax number of the contact.
- The pager number of the contact.

• The radio contact information • Any other contact information • the date and time of the last change to this information
4.3.2.3.3 Send Contact Information Upon Request The Traffic Management Center shall send *Contact* information to an authorized requesting EC after the request is received from the EC.
4.3.2.3.4 Center to Receive and Process Contact Information The Traffic Management Center shall receive and process *Contact* information, both partial sets from automated updates and full sets from specific requests, when it is received from authorized EC's

4.3.3 Events Information Sharing

In a C2C environment, there is a need to share event information regarding travel, interruptions to travel, or projected interruptions to travel, in order to coordinate information for dissemination to centers or to the public.

Organizations that operate transportation facilities within the same region find it important to share information about events. Events can impact the local operations of neighboring agencies that may require coordination. Events can give insight into weather and traffic problems heading across a region. In addition, information sharing between centers is important for providing seamless information to travelers.

Information exchange *between* regions is now also important due to greater ITS integration and widespread 511 deployments. Inter-regional exchanges share many of the same requirements as regional exchanges. There is a continuum of requirements, up from local incident management, through traffic operations and regional maintenance operations, up to travel information at local, state, multi-state and national levels.

4.3.3.1 Purpose

The purpose of sharing event information is to allow centers to react operationally to event information that has been exchanged between centers, to coordinate with other centers as necessary, or to provide relevant information to the public.

4.3.3.2 Defining Events

Adopting common terminology is an important first step toward regional and national information exchange. The following general terms describe an event:

Current Event. A current event is defined broadly, to include any set of travel circumstances an agency may wish to report. This includes incidents, descriptions of road and traffic conditions, weather conditions, current construction, and current special events, whether expected or unexpected.

Planned Event. A planned event is a construction event or special event that is projected to occur and may include timeline schedule elements.

Recurrent Events. Events are not limited to unusual disruptions to normal travel conditions. They can also include recurrent circumstances that may occur often, e.g. peak hour congestion.

Timeline Schedules. Agencies need to exchange *timeline schedules* that describe planned construction activities such as lane closures covering multiple time periods. Also, timeline schedules may describe recurrent congestion that happens at consistent times each week. Finally, model predictions may be exchanged using timeline schedules, forecasting road conditions at intervals into the future.

Action Log. A current event or planned event can include an action log to depict changes to the event from its creation to its termination. The log can include changes to details of an event or operator entered, free text information. This historical view can be used to analyze response times or associate ITS devices to the event.

Related Events. Related events are handled separately in some centers' systems, that may be treated as concurrent elements of a single event in others. Deciding whether two events should be seen as related is a matter for operator judgment within the framework of a center's operating practices.

Concurrent Event Elements. Concurrent event elements are distinct components of complex events that may co-exist and overlap in time. Although each element may have its own duration, description and location, they are treated operationally as component parts of a single event.

Example: A lane closure within a roadwork construction project may cause delays. Some agencies would treat the delays as a separate event, distinct from the roadwork. Other agencies and drivers would see them as concurrent elements of the same event. The delays may also be associated with an incident during heavy snow in the roadwork zone, where some lanes are closed. The incident, the snow, the delay, the lane closures and the roadwork can be treated as elements of a single, compound event, or as many separate events.

Split and Merged Events. Circumstances initially reported as separate events may turn out to be parts of a larger, single event. Conversely, events initially reported as one event may need to be split into separate events later. Therefore, events shall be split or merged when necessary, while maintaining effective histories of what really happened.

4.3.3.3 Event Distribution

A shared method of event distribution is required across all centers in order to ensure the highest level of detail and promptness of event information. The following concepts outline this method:

Full Reporting Full reporting includes distribution of all details currently known about an event, including all the timeline schedule elements and action log elements (where distributed). Full reporting is normally used for an event recap (in response to a request) or when an event is first distributed.

Partial Reporting Partial reporting includes details for events that have been updated. Partial reporting is normally used to provide schedule changes, action log elements, and minimal changes to event details.

Event Management. Once an event has been received, it shall be able to be edited or updated and using any of these approaches:

- *Event "times out":* the event shall specify an expected duration or end time for the event, after which – if not updated – it shall be considered to have ended.
- *Report "times out":* the event shall specify a period of time within which the report is valid. Weather forecasts use this approach.

- *Termination by sender:* the center that created the event can distribute an update to indicate that the event has ended, or that the event is canceled.
- *Updating by sender:* the responsible center can update the event to show that conditions have changed, or have returned to normal.

Management of the event report information is primarily the responsibility of the sending center. Recipients of the information shall not make substantive changes. However, subject to agreements between centers, they may be allowed to transform, edit or simplify information to suit their specific requirements, while maintaining the essential meaning. The exchange agreement shall also determine whether (and to whom) a center may pass on the event information, in either its original or simplified form.

4.3.3.4 Event Information Exchange and Requests

Centers that exchange event information are required to provide the most recent event details for an event. Upon request, a center is also required to provide a response that includes the most recent event details for the events that are requested.

Event Requests. Usually, event exchanges are established through face-to-face negotiations and agreements before exchanges begin. In this case, agreements may establish information selection criteria, specifying the kinds of information to be sent, for which locations, and in what level of detail.

Once exchanges begin, the responsible center normally initiates an information exchange, without receiving a specific request. The sender is usually in the best position to judge the importance of a particular event, or may choose to send the information for operational reasons.

Advanced Requests. Optionally, advanced request procedures shall be provided for use between centers that so agree supporting requests for information selection criteria to be adjusted in real time. The exchange agreement shall indicate whether real-time requests for adjustments in selection criteria will be supported in any given exchanges.

Request Procedures. When a remote center determines a need to request event information for another center, the remote center can send a request, either manually, by means of a status exchange or using an advanced request (where supported). When the request is received the system will act upon the request with any of the following:

- A human in the loop to manually process the request
- A computer that automatically meets the request
- Some combination of a human and computer to process the request.

These requirements are not prescriptive over how a center acts upon a request to send or resend information. The requirements only address the transmission of the request and the response that shall be sent back to the requesting center.

4.3.3.5 Event Locations

When a center elects to participate in event exchanges, it shall publish information detailing all locations where events may be reported throughout its coverage area. Receiving centers shall use location information, to help assess the event's impacts on that center's operational area.

Considering that centers will have varying levels of geographic information, there are minimum requirements of providing a location, which shall include either a jurisdiction, a facility or a landmark that is recognizable by other centers. For example, correct route identification is necessary if an event occurs on an interstate highway.

Additional information can optionally be provided. The following shall be exchanged if available:

- Linear Reference (Point along a route usually measured in miles, from its beginning point, or from the state line and generally starting from the westernmost or southernmost point of the route)

Geographic Location – this standard references the GeoLocation data frame from the LRMS standard, which includes longitude, latitude, and horizontal datum.

The following concepts apply in describing the location of an event:

Landmark Locations. A landmark location shall describe a location that would not be identified as a single point on a route, such as a public facility, bridge or tunnel. If available, the geographic coordinates of the landmark shall be provided.

Area Locations. Area locations may be named jurisdictions, such as Lancaster County, or may be a general reference like 'the Seacoast'.

Locations on Routes. A location on a route shall be described using the route designator or name, a primary location (point) on the route, and optionally a secondary location (point) on the route. Where applicable, the primary location shall be the location of the event and the secondary location shall indicate the point at which the effects of an event begins (e.g. extent of the backup of traffic). Where available, the geographic coordinates of the primary and/or secondary location shall be provided.

4.3.3.6 Event Functional Requirements

Functional requirements for exchanging events and requests between centers are as follows:

Table 3. Event Functional Requirements

4.3.3.6.1 – Provide Event Information Sharing: : This section provides functional requirements to support the sharing of current event information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.3.6.1.1 Update Event Information The Center shall send changes to the Event Information to all subscribing ECs after the Event Information is updated.
4.3.3.6.1.2 Contents of the Event Information This information shall include the following: • the unique identifier for the event

- the agency name or identifier
- event class (always current)
- event status (e.g. new, update, clear/ended)
- type of event
- duration, expected period or expected end date and time of the event
- jurisdiction, facility, or landmark name
- timestamp
- current event description
- State FIPs code or State and County FIPs code
- update number

The following optional information may also be sent if it exists for the event:

- additional Location information including:
  - primary point or landmark name
  - secondary point or landmark name
  - jurisdictions where primary and secondary point or landmark is located
  - linear references of points or landmarks
  - geographic coordinates of points or landmarks (longitude, latitude)
  - direction
  - article (e.g. at, approaching, near)
  - alternate route
- weather condition
- roadway condition
- affected lane information
- agency contact information (name, phone number, pager, email address)
- reference to related events

4.3.3.6.1.3 Send Ended or Cancel Status
The Center shall send ended or cancel status for event information when the event's duration is exceeded, unless the event is set to be timed out. Otherwise, the system shall send an update with updated duration.

4.3.3.6.1.4 Receive Event Information
The Center shall receive event information.

4.3.3.6.1.5 Provide Event Action Log Information

4.3.3.6.1.6 Contents of the Event Action Log Information

The following optional action log information may be sent with a current event.

- event identifier (required, if action log element is sent)
- action log element identifier (required, if action log element is sent)

- time stamp (date and time required, if action log element is sent)
- timeline type (operator text, system update) (required, if action log element is sent)
- description of change (required, if action log element is sent)

4.3.3.6.1.7 Provide Event Information Recap
The center shall support the sharing of a recap of event information with the systems defined as being part of the C2C network. The requirements to support this function are as follows:

4.3.3.6.1.8 Request Event Information Upon Initialization
The External Center shall request a recap of event information upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure). The Center shall request updates since a specific date and time. Optionally, a Center can request all changes for an event or all action log elements for an event.

4.3.3.6.1.9 Send Event Information Upon Request
The system shall send event information when requested. The system shall send all details about the event(s) including action log elements that have been distributed. The system shall only provide the requested event information since the requested date and time.

4.3.3.6.2 – Share Planned Event Information: This section provides functional requirements to support the sharing of planned event information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:

4.3.3.6.2.1 Update Planned Event Information
The system shall send updates to planned event information when the planned event changes.

4.3.3.6.2.2 Contents of the Planned Event Information

This information shall include the following:

- the unique identifier for the planned event
- the agency name or identifier
- event class (always planned)
- event status (e.g. new, update, ended)
- type of event
- project/event lead or contact
- jurisdiction, facility, or landmark name
- timestamp
- projected begin date and end date for the planned event
- planned event description
- State FIPs code or State and County FIPs code
- update number

The following optional information may also be sent if it exists for the planned event:

- additional Location information including:
- primary point or landmark name
- secondary point or landmark name
- jurisdictions where primary and secondary point or landmark is located
- linear references of points or landmarks
- geographic coordinates of points or landmarks (longitude, latitude)
- direction
- article (e.g. at, approaching, near)
- contact phone numbers (fax, pager, email)
- reference Number (for Construction)
- expected attendance
- reference to related events

4.3.3.6.2.3 Send Ended or Cancel Status

The system shall send ended or cancel status for event information when the planned event's projected end date is exceeded. Otherwise, the system shall send an update with the projected completion date.

4.3.3.6.2.4 Receive Planned Event Information

The system shall receive planned event information.

4.3.3.6.2.5 Provide Planned Event Action Log Information

4.3.3.6.2.6 Contents of the Planned Event Action Log Information

The following optional action log information may be sent if action log elements are distributed:

- event identifier (required, if action log element is sent)
- action log element identifier (required, if action log element is sent)
- time stamp (date and time required, if action log element is sent)
- timeline type (operator text, system update) (required, if action log element is sent)
- description of change (required, if action log element is sent)

4.3.3.6.2.7 Provide Planned Event Timeline Schedule Information

4.3.3.6.2.8 Contents of the Planned Event Timeline Schedule Information
The following optional timeline schedule information may be sent if timeline schedules are distributed with the planned event

- event identifier (required, if timeline schedule element is sent)
- timeline schedule element identifier (required, if timeline schedule element is sent)
- schedule status (new, updated, deleted)
- start and end date and time
- days of week
- time of day
- expected delays
- alternate route
- affected lane information

4.3.3.6.2.9 Planned Event Recap
The center shall support the sharing of a recap of planned event information with other traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:

4.3.3.6.2.10 Request Recap of Planned Event Information Upon Initialization
The External Center shall request a recap of planned event information upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure). The Center shall request updates since a specific date and time.
Optionally, a Center can request all changes for an event, all timeline schedule elements for an event, or all action log elements for an event

4.3.3.6.2.11 Send Planned Event Information Upon Request
The system shall send planned event information when requested. The system shall send all details about the event including timeline schedule elements and action log elements. The system shall only provide the requested event information since the requested date and time.

4.3.3.6.3 – Provide Forecast Event Information Sharing: This section provides functional

requirements to support the sharing of forecast event information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:

4.3.3.6.3.1 Update Forecast Event Information
The system shall send updates to Forecast event information when the forecast event changes.

4.3.3.6.3.2 Contents of the Forecast Event Information

This information shall include the following:

- the unique identifier for the forecast event
- the agency name or identifier
- event class (always planned)
- event status (e.g. new, update, clear/ended)
- type of event
- jurisdiction, facility, or landmark name
- timestamp
- projected begin date/time and end date/time for the forecast event
- forecast event description
- State FIPs code or State and County FIPs code
- update number

The following optional information may also be sent if it exists for the forecast event:

- additional Location information including:
  - primary point or landmark name
  - secondary point or landmark name
  - jurisdictions where primary and secondary point or landmark is located
  - linear references of points or landmarks
  - geographic coordinates of points or landmarks (longitude, latitude)
  - direction
  - article (e.g. at, approaching, near)
- agency contact information (name, phone number, pager, email address)
- reference to related events

4.3.3.6.3.3 Send Ended or Cancel Status
The Center shall send Ended or cancel status for forecast event information when the event's duration is exceeded, unless the event is set to be timed out. Otherwise, the system shall send an update with projected completion.

4.3.3.6.3.4 Receive Forecast Event Information
The Center shall receive forecast event information

4.3.3.6.3.5 Provide Forecast Event Action Log Information

4.3.3.6.3.6 Contents of the Forecast Event Action Log Information
The following optional action log information may be sent if action log elements are distributed:

- event identifier (required, if action log element is sent)
- action log element identifier (required, if action log element is sent)
- time stamp (date and time required, if action log element is sent)
- timeline type (operator text, system update) (required, if action log element is sent)
- description of change (required, if action log element is sent)

4.3.3.6.3.7 Provide Forecast Event Timeline Schedule Information

4.3.3.6.3.8 Contents of the Forecast Event Timeline Schedule Information
The following optional timeline schedule information may be sent if timeline schedules are distributed with the forecast event

- event identifier (required, if timeline schedule element is sent)
- timeline schedule element identifier (required, if timeline schedule element is sent)
- schedule status (new, updated, deleted)
- begin and end date and time
- days of week
- time of day
- expected delays
- alternate route
- affected lane information

4.3.3.6.3.9 Provide Forecast Event Recap
The center shall support the sharing of a recap of forecast event information with the systems defined as being part of the C2C network. The requirements to support this function are as follows:

4.3.3.6.3.10 Request a Recap of Forecast Event Information Upon Initialization
The External Center shall request a recap of forecast event information upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure). The system shall request updates since a specific date and time. Optionally, a system can request all changes for a forecast event, all timeline schedule elements for a forecast event, or all action log elements for a forecast event

4.3.3.6.3.11 Send Forecast Event Information Upon Request
The system shall send forecast event information when requested. The system shall send all details about the forecast event(s) including timeline schedule elements and action log elements. The system shall only provide the requested event information since the requested date and time.

4.3.4 Device Inventory, Status and Control

This section of the document is in response to the need to add mechanism to get the entire list of the devices for a device type. It provides requirements for generic device type inventory and

status messages. The messages developed based on this set of requirements will complement device-specific messages (e.g., CCTV inventory). These messages include:

Device-type inventory request - ability to request device inventory for the entire device type
Device-type inventory response – provide inventory for the entire device type
Device-type status request - ability to request device status for the entire device type
Device-type status response - provide status for the entire device type

The following requirements need to be considered for device inventory:

- It is not necessary to send the device inventory when a contact is updated - unless the contact ID changes.
- Only the updated inventory information needs to be updated
- The object ids should be unique within the TMC but concatinating with NTCIP 1104 naming convention (use as prefixes) in a regional environment. NTCIP 1104 naming convention uses the following: country id, state id, agency id, center id, entity kind, entity type, entity instance.

4.3.5 CCTV

This section of requirements covers the topic of Closed Circuit Television (CCTV) Control. The following types of messages are defined in this section for the exchange of CCTV Control requests:

- CCTV inventory information
- CCTV Status information
- Following device requests are supported:
  - Move CCTV (PTZ & Preset)
  - Set video attributes
- Responses to a request

The requirements that exist to exchange CCTV information and command/control requests between centers are as follows:

Table 4. CCTV Functional Requirements

4.3.4.1 – Provide CCTV Inventory Information The Traffic Management Center shall support the sharing of CCTV inventory information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.4.1.1 Update CCTV Inventory Information The TMC shall send changes to the CCTV inventory to all subscribing ECs after the inventory is updated.
4.3.4.1.2 Contents of the CCTV Inventory Information The inventory information shall include the following: • Unique identifier of the owning organization • Unique identifier of the device

- Location of the device (longitude and latitude)
- Indicate what remote centers may do with this CCTV (control type):
  - Status Only
  - Command Only
  - Status and Command
- Indicate types of requests supported:
  - presets
  - "jog" positioning (move relative to current position)
  - direction (i.e. N, S, E, W, NE, NW, SE, SW)
  - focus
  - zoom
  - wiper (turn on/off)
  - iris
  - Text Insertion capability
- Image capability: type of image supported (e.g. JPEG, TIFF, MPEG, etc.)

The following optional information may also be sent if it exists for the CCTV:

- Device Name as assigned by the owner organization
- Additional location information (route designator and linear reference)
- Text inserted at camera (for titling purposes)
- Uniform Resource Locator (URL) for where the current display of the CCTV can be found
- The unique ID of the roadway network to identify a center for which the CCTV control request is being made
- The unique link id on the network that the CCTV is on
- The unique node id on the network that the CCTV is on
- Contact Information (name, phone number, pager, email address) for the owner organization
- The date and time of the last change to this information. This date time stamp is for any changes to individual device inventory parameters.

4.3.4.1.3 Receive CCTV Inventory Information

The Traffic Management Center shall receive CCTV inventory messages.

4.3.4.1.4 Request CCTV Inventory Information Upon Initialization

The External Center may request CCTV inventory messages upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure).

4.3.4.1.5 Send CCTV Inventory Information Upon Request

The Traffic Management Center shall send CCTV information to an authorized requesting EC after the request is received from the EC.

4.3.4.2 Provide CCTV Status Information

The Traffic Management Center provides the sharing of CCTV status information with the systems defined as being part of the C2C communications environment. The requirements to

support this function are as follows:

4.3.4.2.1 Update CCTV Status
The TMC shall send CCTV status information to all subscribing ECs after the status is updated.

4.3.4.2.2 Contents of CCTV Status Information

The status information shall include the following:

- Unique identifier of the owning organization
- Unique identifier of the device
- The operational Status of the CCTV:
  - in service
  - locked, unavailable
  - out of service

The following optional information may also be sent if it exists for the CCTV:

- CCTV error
- CCTV image: this will be in the format specified in the CCTV inventory (e.g. JPEG, TIFF, MEPG, etc.)
- The name of the operator who is currently operating the CCTV
- Current position of the camera
- Current PTZ, focus or iris

4.3.4.2.3 Receive CCTV Status Information
The Center shall receive CCTV status messages.

4.3.4.2.4 Send CCTV Status Upon Request
The Traffic Management Center shall send CCTV status information to an authorized requesting EC after the request is received from the EC.

4.3.4.3 Support Remote Control Of CCTV Devices

The Traffic Management Center shall be capable of processing control requests received from other centers (these responses occur because of CCTV control requests commands previously issued). The requirements to support this function are as follows:

4.3.4.3.1 Receive CCTV Control Request
The Traffic Management Center shall receive CCTV control messages.

4.3.4.3.2 Send Response to CCTV Control Request
The TMC shall send a response to a CCTV control request.

4.3.4.3.3 Contents of the Response to CCTV Control Request
This information shall include the following:

- Unique identifier of the owning organization
- Unique identifier of the device
- A unique sequence number generated by the requesting center that uniquely identifies the control request within the requesting center
- Response to the request. Example responses include:
  - request performed

- unauthorized (user does not have proper permission)
- unknown device ID
- rejected: CCTV in use
- rejected: invalid request type (e.g. improper request made of the device)
- Request terminated

- the name of the operator acting on the request

The following optional information may also be sent if it exists for the CCTV:

- Time out on a control request for the CCTV

4.3.4.3.4 Receive CCTV Cancel Control

The Center shall receive a CCTV Cancel control message.

4.3.4.3.5 Send CCTV Cancel Control

The Traffic Management Center shall send a CCTV cancel control confirmation message.

4.3.4.4 Issue Control Requests to Remote CCTV Devices

A center shall be able to issue CCTV control requests to remote centers. The requirements to support this function are as follows:

4.3.4.4.1 Send a CCTV Control Request

The Center shall send a CCTV control request.

4.3.4.4.2 Contents of CCTV Control Request

This information shall include the following:

- Unique identifier of the owning organization
- Unique identifier of the device
- Security token to authenticate the operator and check for rights
- A unique sequence number generated by the requesting center that uniquely identifies the control request within the requesting center (this sequence number shall be returned to the requesting client in any response to the control request).
- Types of requests:
  - presets
  - “jog” positioning (move relative to current position)
  - direction (i.e. N, S, E, W, NE, NW, SE, SW)
  - focus
  - zoom
  - wiper (turn on/off)
  - manual iris
  - Text Insertion capability (i.e. titling)
  - Request a lock for the camera
  - Data to support control request

The following optional information may also be sent if it exists for the CCTV:

- Operator ID making the request
- The desired expiration time of the request

• Event ID: the event field shall not allow for multiple associations, only one event ID per request. • Response plan ID • The priority of this request
4.3.4.4.3 Receive CCTV Control Response The Center shall receive a response to a CCTV control request.

4.3.6 Video Switch Functional Requirements

This section of requirements covers the topic of Video Switching. The following types of messages are defined in this section for the exchange of Video Switch requests:

- Video Switch inventory information
- Video Switch Status information
- Following device requests are supported:
  - Make a video switch connection
- Responses to a request

The requirements that exist to exchange video switch information and command/control requests between centers are as follows:

Table 5. Video Switch Functional Requirements

Requirements
4.3.5.1 Provide Video Switch Inventory Information The Traffic Management Center shall support the sharing of Video Switch inventory information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.5.1.1 Update Video Switch Inventory Information The TMC shall send changes to the Video Switch inventory to all subscribing ECs after the inventory is updated.
4.3.5.1.2 Contents of the Video Switch Inventory Information This information shall include the following: • Unique identifier of the owning organization • Unique identifier of the device • Indicates what remote centers may do with this switch: - Status Only - Command Only • Status and Command • Types of requests supported: - switch one input to one output

Requirements
• Switch supports text insertion • Number of input video channels supported by the switch • Input Channel number • Description of input channel • Number of video output definitions to follow • Output Channel number • Description of output channel The following **optional** information may also be sent if it exists for the Video Switch: • Device Name as assigned by the owner organization
4.3.5.1.3 Receive Video Switch Inventory Information The Center shall receive video switch inventory messages.
4.3.5.1.4 Request Video Switch Inventory Information Upon Initialization The Center shall request video switch inventory messages upon system initialization.
4.3.5.1.5 Send Video Switch Information Upon Request The Traffic Management Center shall send Video Switch information to an authorized requesting EC after the request is received from the EC.
4.3.5.2 Provide Video Switch Status Information The Traffic Management Center shall provide the sharing of Video Switch status information with the systems defined as being part of the C2C communications environment. The requirements to support this function are as follows:
4.3.5.2.1 Update Video Switch Status The Traffic Management Center shall send *Video Switch* status information to all subscribing ECs after the status is updated.
4.3.5.2.2 Contents of Video Switch Status Information This information shall include the following: • Unique identifier of the owning organization • Unique identifier of the device • Number of video output to follow • Input Channel number • Output Channel number The following **optional** information may also be sent if it exists for the video switch: • Device Name as assigned by the owner organization • Text Inserted by the switch
4.3.5.2.3. Receive Video Switch Status Information The Center shall receive video switch status messages.
4.3.5.2.4 Send Video Switch Status Information Upon Request

Requirements
The Traffic Management Center shall send Video Switch status information to an authorized requesting EC after the request is received from the EC.
4.3.5.3 Issue Control Requests to Remote Video Switch Devices A center shall be able to issue Video Switch control requests to remote centers. The requirements to support this function are as follows:
4.3.5.3.1. Receive Video Switch Control Request The Center shall receive video switch control requests.
4.3.5.3.2 Contents of Video Switch Control Request This information shall include the following: • Unique identifier of the owning organization • Unique identifier of the device • Security token to authenticate the operator and check for rights • the unique request identifier • Number of input channel (could request multiple input channels) • Number of output channel The following **optional** information may also be sent if it exists for the video switch: • Operator ID making the request • Text to be inserted • Priority of the control request • Request a lock for the connection • The time that the lock is requested for
4.3.5.3.3 Send Response to Control Requests The Traffic Management Center shall send a response to a video switch control request.
4.3.5.3.4 Receive a Video Switch Cancel Control Message The Center shall receive a video switch cancel control message.
4.3.5.3.5 Send a *Video Switch Cancel Control Confirmation Message* The Center shall send a video switch cancel control confirmation message.
4.3.5.4 Support Remote Control of Video Switch Devices The Traffic Management Center shall be capable of processing responses received from other centers (these responses occur because of Video Switch control requests commands previously issued). The requirements to support this function are as follows:
4.3.5.4.1 Send a Video Switch Control Message The Center shall send a video switch control message.
4.3.5.4.2 Contents of the Video Switch Control Message This information shall include the following: • Unique identifier of the owning organization

Requirements
• Unique identifier of the device • A unique sequence number generated by the requesting center that uniquely identifies the control request within the requesting center • Response to the request. Example responses include: - request performed - unauthorized - unknown input channel - unknown output channel - rejected: no available ports • Request terminated
4.3.5.4.3 Receive a Response to Video Switch Control Request The Center shall receive a response to a video switch control request.
4.3.5.4.4 Send a Video Switch Cancel Control Message The Center shall send a video switch cancel control message.
4.3.5.4.5 Receive a Video Switch Cancel Control Confirmation Message The Center shall receive a video switch cancel control confirmation message.
4.3.5.5 Set Video Attributes The Traffic Management Center shall be capable of issuing a request to set the video attributes of a video channel. The requirements to support this function are as follows:
4.3.5.5.1 Send a Set Video Attributes Message The Center shall send a set video attributes message.
4.3.5.5.2 Contents of Video Attributes The Video Attributes information shall include the following: • Unique identifier of the device • Security token to authenticate the operator and check for rights • A unique sequence number generated by the requesting center that uniquely identifies the control request within the requesting center • Video channel identifier • Video attributes parameters: - Frames per second - Resolution (specified in pixels in “height x width” format) - Video format (e.g. MJPEG, MPEG-3, MPEG-4, etc.)
4.3.5.5.3 *Receive a Response to the Set Video Attributes Request* The Center shall receive a response to the set video attributes request. This information shall include the following: • Unique identifier of the owning organization • Unique identifier of the device • The unique sequence number • Response to the request. Example responses include:

Requirements
- request performed - unauthorized - unknown video channel - cannot support requested video parameters

4.3.7 Dynamic Message Signs

The following are needed to support the exchange of Dynamic Message Signs (DMS) status and to provide DMS control to remote centers:

- DMS inventory information
- DMS status information
- DMS control requests:
  - Display message request
  - Cancel message request
  - Provide message library contents
- Responses to a DMS request

The requirements that exist to exchange DMS information and command/control requests between centers are as follows:

Table 6. DMS Functional Requirements

4.3.6.1 Provide DMS Inventory Information The Traffic Management Center shall support the sharing of DMS inventory information with other authorized traffic management systems defined as being part of the center-to-center network. The requirements to support this function are as follows:
4.3.6.1.1 *Update DMS Inventory Information* The Traffic Management Center shall send changes to the DMS inventory to all subscribing ECs after the inventory is updated.
4.3.6.1.2 Contents of the DMS Inventory Information The inventory information shall contain the following information: • the unique identifier for the sign • the organization and center information • the sign type (e.g., VMS, CMS, BOS, portable VMS, etc.) • type of beacons, if any • location of the device (longitude and latitude) The following optional information may also be sent if it exists for the device: • the unique device name for the selected sign • the road name the sign is on • additional location information (route designator and linear reference)

- the direction of travel the sign faces
- the sign technology (e.g., LED, flip-disk, fiber optic, etc.)
- the sign height and width in pixels
- the URL where the contents of the DMS can be found
- contact information (name, phone number, pager, email address) for the owning center
- the date and time of the last message library was updated

4.3.6.1.3 Receive DMS Inventory Information
The Traffic Management Center shall receive DMS inventory information.

4.3.6.1.4 Request DMS Inventory Upon Initialization
The External Center may request DMS inventory information from other Traffic Management Centers it wishes to communicate with upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure).

4.3.6.1.5 *Send DMS Information Upon Request*
The Traffic Management Center shall send DMS information to an authorized requesting EC after the request is received from the EC.

4.3.6.1.6 Send Updates Since a Specific Date and Time
The Traffic Management Center shall only provide the requested information to the requesting Traffic Management Center with a list of devices or to provide updates since a data and time.

4.3.6.2 – Provide DMS Status Information
The Traffic Management Center shall provide the sharing of DMS status information with other authorized traffic management systems defined as being part of the Center-to-Center communications environment. The requirements to support this function are as follows:

4.3.6.2.1 *Update DMS Status Information*
The Traffic Management Center shall send changes to the DMS status to all subscribing ECs after the status is updated.

4.3.6.2.2 Contents of the DMS Status Information
The DMS Status Information shall contain the following:

- The name of the organization which put the message on the sign
- the unique device ID
- the operational status of the device (e.g., on, off, failed)
- current status of the device beacon (e.g., on, off, inoperative)
- the message currently being displayed on the sign
- the operator and center name for the current use of the sign

The following optional information may also be sent if it exists for the device:

- the state of the beacon, if any
- the message priority of the currently displayed message
- the expiration time of the message of the currently displayed message
- the associated event ID, if any
- the time at which the last successful communications occurred with the sign

4.3.6.2.3 – Receive DMS Status
The Traffic Management Center shall receive the DMS status.

4.3.6.2.4 – Send DMS Status Upon Request
The Traffic Management Center shall send DMS status information to an authorized requesting EC after the request is received from the EC.

4.3.6.3 Provide DMS Control Sharing
The Traffic Management Center provides DMS control capability to the authorized remote centers defined as being part of the C2C communications environment. The requirements to support this function are as follows:

4.3.6.3.1 Receive DMS Control Requests
The Traffic Management Center shall accept and process valid DMS control requests to display an existing or new text message from one or more authorized remote centers. Display of new text messages is only applicable for VMS type signs.

4.3.6.3.2 Send Responses to DMS Control Requests
The Traffic Management Center shall send a response (to the requesting center) to a DMS control request.

4.3.6.3.3 Contents of DMS Control Response
This response to a DMS control response shall include the unique device name of the DMS and all of the following information:

- the unique request identifier
- the operator and center name in the request
- the status of the request (implemented, queued, rejected)
- the name of the operator acting on the request

4.3.6.3.4 Receive DMS Cancel Control
The Traffic Management Center shall receive a DMS cancel control notification.

4.3.6.3.5 Send DMS Cancel Control
The Traffic Management Center shall send a DMS cancel control response.

4.3.6.3.6 Contents of DMS Cancel Control Response
This shall include the following information:

- the unique request identifier
- the operator and center name in the request
- the unique device ID
- the status of the request (implemented, queued, rejected)
- the name of the operator acting on the cancellation request

4.3.6.4 Request DMS Control

4.3.6.4.1 Send Control Requests
The External Center shall send a DMS control request message to a Traffic Management Center that controls a sign that a message is to be posted onto.

4.3.6.4.2 Contents of the Control Request
This request shall include the following information:

- the unique device ID of the DMS

• the security token (password, user ID) • the unique request identifier assigned by the requesting center • the operator and center name making the request • the message being requested • the priority of the message being requested • the expiration time for the message The following optional information may also be sent if it exists for the device: • the beacon status • the message number being requested • the event ID that current request is associated with (if any)
4.3.6.4.3 Receive Responses to DMS Control Requests The External Center shall receive a response to a DMS control request.
4.3.6.4.4 Send DMS Cancel Control The External Center shall send a DMS cancel control request (only sent for messages that the centers has requested to be displayed) if the Center wishes to explicitly cancel a previous request.
4.3.6.4.5 Contents of DMS Cancel Control Request This request shall include the following information: • unique device ID of the DMS • the Security Token (password, user ID) • the unique request identifier assigned by the requesting center • the operator and center name making the request
4.3.6.4.6 Receive Responses to DMS Cancel Control The External Center shall receive a response to a DMS cancel control request.

4.3.8 Environment Sensors

This section of Operational Requirements covers the topic of Environment Sensor Stations (ESS) and has been called road weather information systems (RWIS) as well. The following are needed to support the exchange of ESS inventory and status information between centers:

- ESS inventory information
- ESS Status information
- Responses to a ESS request

There are two areas of operational practices supporting ESS operations for Center-to-Center (C2C). The requirements statements for each of these functional areas of support are as follows:

Table 7. ESS Functional Requirements

Requirements
4.3.7.1 Provide ESS Inventory Information The Traffic Management Center shall support the sharing of ESS inventory information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.7.1.1 Update ESS Inventory Information The Traffic Management Center shall send changes to the ESS Inventory information to all subscribing ECs after the inventory is updated.
4.3.7.1.2 Contents of the ESS Inventory This information shall include the following: • the organization and center information • the unique device ID of the DMS • the date and time of the last change to the information The following optional information may also be sent if it exists for the device: • the device name as assigned by the owner organization • location of the device (latitude/longitude, route designator and linear reference) • the road name associated with the device • The unique ID of the network the station is associated with • ESS type (e.g., automatic, staffed, unknown) • ESS category (e.g., other, permanent, transportable, mobile) • Station elevation • contact information (name, phone number, pager, email address) for the owning center
4.3.7.1.3 Send ESS Inventory Information Upon Request The Traffic Management Center shall send ESS inventory information to an authorized requesting EC after the request is received from the EC.
4.3.7.1.4 Center to Receive and Process ESS Inventory Information The Traffic Management Center shall receive and process ESS inventory information when it is received from other authorized ECs in the defined C2C network.
4.3.7.2 Provide ESS Status Information The Traffic Management Center shall provide the sharing of ESS information with other authorized traffic management systems defined as being part of the C2C communications environment. This includes providing the status to C2C systems for the defined list of connected ESSs as well as accepting the status of ESS devices connected to other authorized traffic management systems in the defined C2C environment. The requirements to support this function are as follows:

Requirements
4.3.7.2.1 Update ESS Status Information The Traffic Management Center shall send changes to the ESS Status information to all subscribing ECs after the status is updated.
4.3.7.2.2 Contents of the ESS Status Information This information shall include the following information: • the unique ESS device ID • the operational status of ESS • the operator and center name for the current user of the device The following optional information may also be sent if it exists for the device: • the unique device name • indications of wind speed, direction, and gusting • indications of air temperature • indications of precipitation • indications of solar radiance • indications of roadway visibility from fog, smoke, dust etc • indications of pavement conditions • indications of the types of roadway treatments applied (sand, salt, chemical, etc.)
4.3.7.2.3 Send ESS Status Information Upon Request The Traffic Management Center shall send ESS Status information to an authorized requesting EC after the request is received from the EC.
4.3.7.2.4 Center to Receive and Process ESS Status Information The Traffic Management Center shall receive and process ESS Status information when it is received from other authorized ECs in the defined C2C network.

4.3.9 Lane Closure Gate Control

The following are needed to support the exchange of gate status and to provide gate control to remote centers:

- Gate inventory information
- Gate status information
- Gate control requests
- Responses to a gate control request

The requirements that exist to exchange gate information and command/control requests between centers are as follows:

Table 8. Lane Closure Gate Functional Requirements

Requirements
4.3.8.1 Provide Lane Closure Gate Inventory Information

Requirements
The Traffic Management Center shall support the sharing of Gate Controller inventory information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.8.1.1 Update Gate Inventory Information The Traffic Management Center shall send changes to the Gate Inventory information to all subscribing ECs after the inventory is updated.
4.3.8.1.2 Contents of the Gate Inventory Information This information shall include the following information: • the organization and center information • device ID of the gate controller • the location of the gate (latitude/longitude) The following optional information may also be sent if it exists for the device: • device name as assigned by the owner organization • The road name it is used for • Additional location information (route designator and linear reference) • number of lanes controlled by the gate • contact Information (name, phone number, pager, email address) for the owner organization • the date and time of the last update.
4.3.8.1.3 Send Gate Inventory Information Upon Request The Traffic Management Center shall send Gate Inventory information to an authorized requesting EC after the request is received from the EC.
4.3.8.1.4 Center to Receive and Process Gate Inventory Information The Center shall receive and process Gate inventory information when it is received from other authorized ECs in the defined C2C network.
4.3.8.1.5 Send Gate Inventory Information Upon System Initialization The Traffic Management Center shall send Gate Inventory information to an authorized requesting EC upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure).
4.3.8.2 Provide Lane Closure Gate Status Information The Traffic Management Center shall provide the sharing of gate status information with other authorized traffic management systems defined as being part of the C2C communications environment. This includes providing the status to C2C systems for the defined list of gates as well as accepting the status of gate control devices connected to other systems in the defined C2C environment. The requirements to support this function are as follows:
4.3.8.2.1 Update Gate Status Information The Traffic Management Center shall send changes to the Gate Status information to all subscribing ECs after the status is updated.
4.3.8.2.2 Contents of the Gate Status Information This information shall include the following information: • the unique device ID • the operational status of the device (e.g., on, off)

Requirements
• the current state of the gate (e.g., open, closed) • the operator or center name for the current use of the gate The following optional information shall also be sent if it exists for the device: • the unique name of the gate • the associated event ID (if any)
4.3.8.2.3. Send Gate Status Information Upon Request The Traffic Management Center shall send Gate Status information to an authorized requesting EC after the request is received from the EC.
4.3.8.2.4 Center to Receive and Process Gate Status Information The Center shall receive and process Gate Status information when it is received from other authorized ECs.
4.3.8.3 Provide Remote Lane Closure Gate Control This section defines the functional requirements for a TMC to support remote control of a lane closure gate by distant operators in the defined C2C communications environment. The subsections below describe the requirements to support this function:
4.3.8.3.1 Receive and Process Gate Control Requests The Traffic Management Center shall receive and process gate control requests when it is received from other authorized traffic management systems in the defined C2C network.
4.3.8.3.2 Contents of the Gate Control Request This request shall include the following information: • the unique device ID of the gate controller • the Security Token (password, user ID) • the unique request identifier • the operator and center IDs in the request • the gate control action that the request is associated with (e.g., open or close) • the expiration time of the command requested for the gate control The following optional information may also be sent if it exists for the device: • the associated event ID (if any) • the priority of this request
4.3.8.3.3 Send Responses to Gate Control Requests The Traffic Management Center shall send a response to each gate control request from other authorized traffic management systems in the defined C2C network.
4.3.8.3.4 Contents of the Gate Control Response This response shall include the following information: • the unique device ID of the lane closure gate • the unique request identifier • the operator and center IDs in the request

Requirements
• the status of the request (e.g., accepted, rejected, requested changes completed, request canceled) The following optional information may also be sent if it exists for the device: • the gate usage name (e.g., the name of the response plan or control scenario) • the operator name who changed the status of the gate
4.3.8.3.5 Send Gate Cancel Control Request The External Center shall send a Gate cancel control request if the Center wishes to explicitly cancel a previous request.
4.3.8.3.6 Contents of Gate Cancel Control Request This request shall include the following information: • unique device ID of the lane closure gate • the Security Token (password, user ID) • the unique request identifier assigned by the requesting center • the operator and center name making the request the date and time of the request
4.3.8.3.7 Receive Responses to Gate Cancel Control The External Center shall receive a response to a Gate cancel control request.

4.3.10 Highway Advisory Radio

There are two areas of operational practices supporting Highway Advisory Radio (HAR) for Center-to-Center (C2C). These are:

- HAR inventory information
- HAR Status information

The requirements statements for each of these two functional areas of support are as follows:

Table 9. HAR Functional Requirements

4.3.9.1 Provide HAR Inventory Information The Traffic Management Center shall support the sharing of HAR inventory information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.9.1.1 Update HAR Inventory Information The Traffic Management Center shall send changes to the HAR Inventory information to all subscribing ECs after the inventory is updated.
4.3.9.1.2 Contents of the HAR Inventory Information This information shall include the following information: • the unique device ID • the organization and center information • Associated Beacons (Yes or No) • current status of the device beacon (e.g., on, off, inoperative)

- the date and time of the last change to the information

The following **optional** information may also be sent if it exists for the device:

- Device Name as assigned by the owner organization
- Text Description of pertinent capabilities including frequency, range, or other information.
- The location of the physical device (latitude/longitude, route designator and linear reference)
- The unique ID of the network to identify the primary coverage of the HAR
- Contact Information (name, phone number, pager, email address) for the owner organization

4.3.9.1.3 *Send HAR Inventory Information Upon Request*

The Traffic Management Center shall send HAR Inventory information to an authorized requesting EC after the request is received from the EC.

4.3.9.1.4 Request HAR Inventory Information Upon Initialization

The External Center may request HAR inventory information after system initialization (i.e. when the system connects to other centers through the C2C infrastructure).

4.3.9.1.5 Center to Receive and Process HAR Inventory Information

The Center shall receive and process HAR inventory information when it is received from other authorized ECs in the defined C2C network.

4.3.9.2 Provide HAR Status Sharing

The Traffic Management Center shall provide the sharing of HAR status information with other authorized traffic management systems defined as being part of the C2C communications environment. This includes providing the status to C2C systems for the defined list of HAR as well as accepting the status of HAR devices connected to other systems in the defined C2C environment. The requirements to support this function are as follows:

4.3.9.2.1 *Update HAR Status Information*

The Traffic Management Center shall send changes to the HAR Status information to all subscribing ECs after the status is updated.

4.3.9.2.2 Contents of HAR Status Information

This information shall include the following information:

- the unique device ID
- the operational status of the device
- the operator and center names for the current users of the device
- The text of the current messages being announced on the device

The following **optional** information may also be sent if it exists for the device:

- the unique name of the device
- Status of beacons (on/off)
- the associated event IDs
- the organizations owning the events that the current usage is associated with

4.3.9.2.3. Send HAR Status Information Upon Request

The Traffic Management Center shall send HAR Status information to an authorized requesting EC after the request is received from the EC.
4.3.9.2.4 *Receive and Process HAR Status Information* The Traffic Management Center shall receive and process HAR Status information when it is received from other authorized ECs.
4.3.9.3 Provide HAR Control Sharing The Traffic Management Center shall provide local operator control of a HAR device by distant operators in the defined C2C communications environment. The requirements to support this function are as follows:
4.3.9.3.1 Receive HAR Control Requests The Traffic Management Center shall receive and process HAR control requests.
4.3.9.3.2 Contents of the Control Request This request shall include the following information: • the Security Token (password, user ID) • the unique request identifier assigned by the requesting center • the operator and center name making the request • the unique device ID of the HAR • the message being requested • the priority of the message being requested • the expiration time for the message The following optional information may also be sent if it exists for the device: • the event ID that current request is associated with (if any)
4.3.9.3.3 Send Responses to HAR Control Requests The Traffic Management Center shall send a response (to the requesting center) to a HAR control request.
4.3.9.3.4 Contents of the HAR Control Response This response to a HAR control response shall include the following information: • the unique device ID of the HAR • the unique request identifier • the operator and center IDs in the request • the status of the request (implemented, queued, rejected) • the name of the operator acting on the request
4.3.9.3.5 Receive HAR Cancel Control Request The Traffic Management Center shall receive a HAR cancel control notification.
4.3.9.3.6 Send HAR Cancel Control Request The External Center shall send a HAR cancel control request (only sent for the messages that the EC has requested to be played) if the Center wishes to explicitly cancel a previous request.
4.3.9.4.7 Contents of HAR Cancel Control Request This request shall include the following information:

• the Security Token (password, user ID) • the unique request identifier assigned by the requesting center • the operator and center name making the request the date and time of the request • the unique device ID of the HAR

4.3.11 Lane Control Signals

The following are needed to support the exchange of lane control signal status and to provide late control to remote centers:

- Lane control signal inventory information
- Lane control signal status information
- Lane control requests
- Responses to a lane control request

The requirements that exist to exchange lane control signal information and command/control requests between centers are as follows:

Table 10. Lane Control Signal Functional Rquirements

4.3.10.1. Provide Lane Control Signal Inventory Information The Traffic Management Center shall support the sharing of lane control signal inventory information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.10*.1.1 Update Lane Control Inventory Information* The Traffic Management Center shall send changes to the Lane Control Signal Inventory information to all subscribing ECs after the inventory is updated.
4.3.10.1.2 Contents of Lane Control Inventory This information shall include the following information: • the organization and center information • device ID of the lane signal controller • the unique id of the roadway • the unique id of the lane being controlled • the date and time of the last change to the information The following optional information may also be sent if it exists for the device: • device name as assigned by the owner organization • The road name it is used for or the facility name it is in • number of lanes controlled by the signal • contact Information (name, phone number, pager, email address) for the owner organization
4.3.10.1.3 Center to Receive and Process Lane Control Inventory Information The Traffic Management Center shall receive and process Lane Control inventory information when it is received from other authorized ECs in the defined C2C network.

4.3.10.1.4 Request Lane Control Inventory Information Upon Initialization
The External Center may request Lane Control Signal inventory information upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure).

4.3.10.1.5 *Send Lane Control Inventory Information Upon Request*
The Traffic Management Center shall send Lane Control Inventory information to an authorized requesting EC after the request is received from the EC.

4.3.10.2 Provide Lane Control Signal Status Information
The Traffic Management Center shall provide the sharing of lane control signal status information with other authorized traffic management systems defined as being part of the C2C communications environment. This includes providing the status to C2C systems for the defined list of controlled lanes as well as accepting the status of lane control devices connected to other systems in the defined C2C environment. The requirements to support this function are as follows:

4.3.10.2.1 Update Lane Control Status Information
The Traffic Management Center shall send changes to the Lane Control Status information to all subscribing ECs after the status is updated.

4.3.10.2.2 Contents of the Lane Control Status Information
This information shall include the following information:

- device ID of the lane signal controller
- the operational status of the device (e.g., on, off)
- the current state of the lane (e.g., open, closed)
- the direction of travel
- the operator or center IDs for the current use of the lane

The following optional information may also be sent if it exists for the device:

- the unique name of the lane control signal

4.3.10.2.3 Receive and Process Lane Control Status Information
The Traffic Management Center shall receive and process Lane Control Status information when it is received from other authorized ECs.

4.3.10.2.4 *Send Lane Control Status Information Upon Request*
The Traffic Management Center shall send Lane Control Status information to an authorized requesting EC after the request is received from the EC.

4.3.10.3 Provide Remote Lane Control
The Traffic Management Center shall provide local operator control of lane signals by distant operators from other authorized traffic management systems in the defined C2C communications environment. The requirements to support this function are as follows:

4.3.10.3.1 Receive and Process Lane Control Requests
The Traffic Management Center shall receive and process Lane Control Requests from other authorized traffic management systems in the defined C2C network.

4.3.10.3.2 Contents of the Lane Control Request
This request shall include the unique device ID of the lane signal controller and all of the

following information:

- the unique request identifier
- the operator and center IDs in the request
- the unique device ID
- the lane control action that the request is associated with (e.g., open or close)
- the expiration time of the command requested for the gate control

The following optional information may also be sent if it exists for the device:

- the associated event ID (if any)
- the priority of this request

4.3.10.3.3 Send Responses to Lane Control Requests
The Traffic Management Center shall send a response to each lane control request from other authorized traffic management systems in the defined C2C network.

4.3.10.3.4 Contents of the Lane Control Response
This response shall include the following information:

- the unique request identifier
- the operator and center name in the request
- device ID of the lane signal controller
- the status of the request (e.g., accepted, rejected, requested changes completed, request canceled)
- the name of the owning operator acting on the request

The following optional information may also be sent if it exists for the device:

- the event ID that current request is associated with
- the operator name who changed the status of the lane

4.3.10.3.5 Receive Lane Control Cancel Notification
The TMC shall receive a Lane Control Cancel notification.

4.3.10.3.6 Send Lane Control Cancel Request
The External Center shall send a Lane Cancel Control request if the Center wishes to explicitly cancel a previous request.

4.3.10.3.7 Contents of the Lane Control Cancel Request
This request shall include the following information:

- the unique device ID of the lane control signal
- the Security Token (password, user ID)
- the unique request identifier assigned by the requesting center
- the operator and center name making the request the date and time of the request

4.3.12 Ramp Meter

The following are needed to support the exchange of ramp meter status and to provide ramp control to remote centers:

- Ramp Meter inventory information
- Ramp Meter status information
- Ramp control requests
- Responses to a ramp Control request

The requirements that exist to exchange ramp meter information and command/control requests between centers are as follows:

Table 11. Ramp Meter Functional Requirements

4.3.11.1 Provide Ramp Meter Inventory Information The Traffic Management Center shall support the sharing of ramp meter inventory information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.11.1.1 Update Ramp Meter Inventory Information The Traffic Management Center shall send changes to the Ramp Meter Inventory information to all subscribing ECs after the inventory is updated the inventory is updated.
4.3.11.1.2 Contents of the Ramp Meter Inventory Information This information shall include the following information: • the organization and center information • the unique device ID of the ramp controller • the location of the ramp meter (latitude/longitude) • the unique name of the road the ramp leads to • direction of travel being metered • the date and time of the last change to the information The following optional information may also be sent if it exists for the device: • the ramp name • additional location information (route designator and linear reference) • table of plan IDs for pre-stored plans • number of lanes controlled by the ramp meter • ramp lane type (e.g., general traffic, HOV lane, bus lane, right turn bypass, other) • make and model of the controller • name of the firmware installed in the controller • release version for the firmware installed in the controller • The URL for the maintenance information for this device

- contact information (name, phone number, pager, email address) for the owning center

4.3.11.1.3 Center to Receive and Process Ramp Meter Inventory Information
The Traffic Management Center shall receive and process Ramp Meter inventory information when it is received from other authorized ECs in the defined C2C network.

4.3.11.1.4 Request Inventory Information Upon Initialization
The External Center may request Ramp Meter inventory information upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure). The Center shall request updates since a specific date and time.

4.3.11.1.5 Send Ramp Meter Inventory Information Upon Request
The Traffic Management Center shall send Ramp Meter inventory information when requested. If a list of devices is provided in the request the system shall only send updates for those devices. The Traffic Management Center shall only provide the requested information for a list of devices or to provide updates since a data and time.

4.3.11.2 Provide Ramp Meter Status Information

The Traffic Management Center shall provide the sharing of ramp meter status information with other authorized traffic management systems defined as being part of the C2C communications environment. This includes providing the status to C2C systems for the defined list of connected ramp meters as well as accepting the status of ramp meter devices connected to other systems in the defined C2C environment. The requirements to support this function are as follows:

4.3.11.2.1 Update Ramp Meter Status Information
The Traffic Management Center shall send changes to the Ramp Meter Status information to all subscribing ECs after the status is updated.

4.3.11.2.2 Contents of the Ramp Meter Status Information
This information shall include the following information:

- the unique device ID of the ramp controller
- ramp meter status (e.g., off, green, yellow, flashing)
- the current state of the ramp (e.g., open, closed)
- the operator and center name for the current use of the signal
- the last update to this information

The following optional information may also be sent if it exists for the device:

- the unique ramp name
- the current ramp meter control type (e.g., pre-timed, demand-capacity, occupancy, gap acceptance merge, area-wide)
- ramp metering type (e.g., one-a-time, two-at-a-time, platoon metering)
- the operator name who changed the control type and/or metering rate

4.3.11.2.3 Receive Ramp Meter Status
The Center shall receive the Ramp Meter Status.

4.3.11.2.4 Send Ramp Meter Status Information Upon Request

The Traffic Management Center shall send Ramp Meter Status information to an authorized requesting EC after the request is received from the EC.
4.3.11.3 Provide Remote Ramp Meter Control The Traffic Management Center shall provide local operator control of ramp meters by distant operators from other authorized traffic management systems in the defined C2C communications environment. The requirements to support this function are as follows:
4.3.11.3.1 Receive and Process Ramp Control Requests The Traffic Management Center shall receive and process Ramp control requests from other authorized traffic management systems in the defined C2C network.
4.3.11.3.2 Contents of the Ramp Meter Control Request This request shall include the following information: • the Security Token (password, user ID) • the unique request identifier • the operator and center IDs in the request • the unique device ID of the ramp controller • the plan ID that the request is associated with • the expiration time of the command requested for the signal control The following optional information may also be sent if it exists for the device: • the ramp meter control type that the request is associated with • the ramp usage name (e.g., the name of the response plan or control scenario) • the priority of this request
4.3.11.3.3 Send Response to Ramp Control Request The Traffic Management Center shall send a response to each Ramp control request from other authorized traffic management systems in the defined C2C network.
4.3.11.3.4 Contents of the Response to Ramp Control Request This response shall include the unique device ID of the ramp meters and all of the following information: • the unique ramp meter identifier • the unique request identifier • the operator and center IDs in the request • the status of the request (e.g., accepted, rejected, requested changes completed, request canceled) • the name of the owning operator acting on the request The following optional information shall also be sent if it exists for the device: • the ramp usage name (e.g., the name of the response plan or control scenario) • The operator name who changed the control type and/or metering rate
4.3.11.3.5 Receive Ramp Meter Control Cancel Notification

The TMC shall receive a Ramp Meter Control Cancel notification.
4.3.11.3.6 Send Ramp Meter Control Cancel Request The External Center shall send a Ramp Meter Cancel Control request if the Center wishes to explicitly cancel a previous request.
4.3.11.3.7 Contents of the Ramp Meter Control Cancel Request This request shall include the following information: • The unique device ID of the ramp meter controller • the Security Token (password, user ID) • the unique request identifier assigned by the requesting center • the operator and center name making the request the date and time of the request

4.3.13 Traffic Signal Controllers

The following are needed to support the exchange of traffic signal status and to provide signal control to remote centers:

- Signal inventory information:
  - Intersection
  - Section
- Signal status information
- Signal control requests:
  - Intersection:
    Change timing plan
    Change special function outputs
    Change control mode
  - Section :
    Change control mode
    Change timing plan
- Responses to a Signal Control request

In order to discover the section ID's, the DeviceTypeInventoryRequest message described in 4.3.4 above will be used. Coding a device type “9” will return a list of devices of that type, namely, Sections.

The requirements that exist to exchange signal control information and command/control requests between centers are as follows:

Table 12. Signal Control Functional Requirements

4.3.12.1 Provide Signal System Inventory Information The Traffic Management Center shall support the sharing of Signal Control inventory

information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function for intersections and sections are as follows:

4.3.12.1.1 Update Signal System Inventory Information
The Traffic Management Center shall send changes to the Signal Control Inventory information to all subscribing ECs after the inventory is updated.

4.3.12.1.2 Contents of the Signal Control Inventory Information
This shall include the following information:

- the organization and center information
- the unique device ID
- the intersection information that the controller is on
- the date and time of the last change to the information

The following optional information shall be sent if it exists for the device:

- the unique name of the road network and node the signal is associated with
- location information (longitude and latitude, route designator and linear reference)
- text description of the intersection
- the controller types provided
- make and model of the signal controller
- name of the firmware installed in the signal controller
- release version for the firmware installed in the controller
- Identification of the master controller for this signal controller
- contact information (name, phone number, pager, email address) for the owning center
- A list of timing patterns used by the intersection containing this controller

4.3.12.1.3. Receive Signal Control Inventory Information
The Center shall receive Signal Control inventory information.

4.3.12.1.4 Request Signal Control Inventory Information upon system initialization
The External Center shall request SC inventory information upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure). The Center shall request updates since a specific date and time.

4.3.12.1.5 *Send Signal Control Inventory Information Upon Request*
The Traffic Management Center shall send Signal Control inventory information when requested. If a list of devices is provided in the request the system shall only send updates for those devices. The Traffic Management Center shall only provide the requested information for a list of devices or to provide updates since a data and time.
The Traffic Management Center shall send SC inventory information when requested for an individual device.

4.3.12.2 Provide Intersection Status Information The Traffic Management Center shall provide the sharing of Signal Control status information with other authorized traffic management systems defined as being part of the C2C communications environment. This includes providing the status to C2C systems for the defined list of connected Signal Controllers as well as accepting the status of Signal Control devices connected to other systems in the defined C2C environment. The requirements to support this function are as follows:
4.3.12.2.1 *Update Signal Control Status Information* The Traffic Management Center shall send changes to the Signal Control Status information to all subscribing ECs after the status is updated.
4.3.12.2.2 Contents of the Signal Control Status Information This information shall include the following information: • the unique device ID of the signal controller • the communication status of the device (e.g., on, off, failed) • the current mode of operation (e.g., Time-Base Coordination (TBC), free, manual, flash, preempt, TRSP, adaptive) • the operator and center name for the current user of the signal The following optional information shall also be sent if it exists for the device: • the unique intersection name • ID of the section of which the intersection is currently a member. • the current timing plan • The last change to the timing plan • The operator name who changed the control mode and/or timing plan, if not Time-Of-Day (TOD) • Name of the currently active preemption for the intersection • Time difference between the controller's clock and owning center's clock
4.3.12.2.3 Receive Signal Control Status The Center shall receive the Signal Control status.
4.3.12.2.4 Send Signal Control Status Information Upon Request The Traffic Management Center shall send Signal Control Status information to an authorized requesting EC after the request is received from the EC.
4.3.12.3 Provide Section Status Information The Traffic Management Center shall provide the sharing of Section status information with the systems defined as being part of the C2C communications environment. The requirements to support this function are as follows:
4.3.12.3.1 Update Section Signal Status Information The Traffic Management Center shall send changes to the Section Signal Status information to all subscribing ECs after the status is updated.
4.3.12.3.2 Contents of the Section Status Information

This information shall include the following information:

- the unique section ID
- The list of intersections included in the section
- the current mode of operation
- the current timing plan information of the section
- the operator and center name for the current user of the signal

The following optional information may also be sent if it exists for the device:

- the current timing plan name
- date and time of the last changes to the timing plan

4.3.12.3.3 Receive Section Status
The Center shall receive the section status.

4.3.12.3.4 Send Section Status Upon Request
The Traffic Management Center shall send Section Status information to an authorized requesting EC after the request is received from the EC.

4.3.12.4 Provide Remote Signal Control

This section defines the functional requirements for an authorized external center to remotely control intersections owned by the TMC.

4.3.12.4.1 Receive and Process Signal Control Requests
The Traffic Management Center shall receive and process Signal Control requests from other authorized traffic management systems in the defined C2C network. This shall include requests for changing control mode and requests for changing timing plans.

4.3.12.4.2 Contents of the Signal Control Mode Change Request
This request shall include the following information:

- the Security Token (password, user ID)
- the unique request identifier
- the operator and center IDs in the request
- the unique device ID of the signal controller
- the intersection control mode that the request is associated with
- the expiration time of the command requested for the signal control

The following optional information may also be sent if it exists for the device:

- the priority of this request
- the event ID that current request is associated with (if any)

4.3.12.4.3 Contents of the Signal Control Timing Plan Change Request
This request shall include the following information:

- the Security Token (password, user ID)

- the unique request identifier
- the operator and center IDs in the request
- the unique device ID of the signal controller
- The timing plan ID that the request is associated with
- The expiration time of the command requested for the signal control

The following optional information may also be sent if it exists for the device:

- the priority of this request
- the event ID that current request is associated with (if any)

4.3.12.4.4 Send Responses to Signal Control Request
The Traffic Management Center shall send a response to each request for signal control from other traffic management systems in the defined C2C network.

4.3.12.4.5 Contents of the Response to Signal Control Request
This response shall include the following information:

- the unique request identifier
- the operator and center name in the request
- the unique device ID of the signal controller
- the status of the request (e.g., accepted, rejected, requested changes completed, request canceled)

The following optional information may also be sent if it exists for the device:

- the unique section ID
- the current timing pattern ID
- the current control mode
- The operator name who changed the control mode and/or timing plan (if not TOD)

4.3.12.4.5 Receive Cancel Signal Control Notification
The TMC shall receive a signal Cancel Control Notification.

4.3.12.4.6 Send Cancel Signal Control Request
The External Center shall send a signal cancel control request if the Center wishes to explicitly cancel a previous request.

4.3.12.4.7 Contents of the Cancel Signal Control Request
This shall include the following information:

- The unique device ID of the signal controller
- the Security Token (password, user ID)
- the unique request identifier assigned by the requesting center
- the operator and center name making the request the date and time of the request

4.3.12.5 Provide Remote Section Control

The Traffic Management Center shall provide distant operators from other authorized traffic management systems control of all the signals within the requested sections in the defined C2C communications environment that provide such control. This shall include requests for changing section control mode and requests for changing section timing plans.

4.3.12.5.1 Receive and Process Section Control Requests

The Traffic Management Center shall receive and process Section control requests from other authorized traffic management systems in the defined C2C network.

4.3.12.5.2 Contents of the Section Control Mode Change Request

This request shall include the following information:

- the Security Token (password, user ID)
- the unique request identifier
- the operator and center IDs in the request
- the unique section ID
- The section control mode that the request is associated with
- The expiration time of the command requested for the section control

The following optional information may also be sent if it exists for the device:

- the priority of this request
- the event ID that current request is associated with (if any)
- the section name

4.3.12.5.3 Contents of the Section Timing Plan Change Request

This request shall include the following information:

- the Security Token (password, user ID)
- the unique request identifier
- the operator and center IDs in the request
- the unique section ID
- The section timing plan ID that the request is associated with
- The expiration time of the command requested for the section control

The following optional information may also be sent if it exists for the device:

- the priority of this request
- the event ID that current request is associated with (if any)
- the section name

4.3.12.5.4 Send Responses to Section Control Requests

The Traffic Management Center shall send a response to each section control request from other authorized traffic management systems in the defined C2C network.

4.3.12.5.5 Contents of the Section Control Response

This response shall include the following information: • The unique ID of the section • the unique request identifier assigned by the requesting center • the status of the request (e.g., accepted, rejected, requested changes completed, request canceled) • the owning operator that acted upon the request The following optional information may also be sent if it exists for the device: • The operator name who changed the control mode and/or timing plan (if not TOD) • the event ID that current request is associated with (if any) • Response plan ID that current request is associated with (if any)
4.3.12.5.5 Receive Cancel Section Control Notification The TMC shall receive a section cancel control notification.
4.3.12.5.6 Send Cancel Section Control Request The External Center shall send a section cancel control request if the Center wishes to explicitly cancel a previous request.
4.3.12.5.7 Contents of the Cancel Section Control Request This shall include the following information: • the unique request identifier • the operator and center name in the request • the unique section ID • the name of the operator acting on the cancellation request • the reason the request was cancelled

4.3.14 Traffic Network and Traffic Data

This section of Operational Requirements covers the topic of Traffic Network and Traffic Data. This includes requirements for sharing GIS based traffic network inventory, location attributes including linear reference and geographic coordinates, to support the location of detector inventories as well as the location of events, between operational centers. Traffic data includes the dissemination or sharing of detector based link status that can be received from multiple field sources including probes, radar and loops. The traffic data can be attributed to the underlying link node based traffic network.

The following are needed to support the exchange of traffic network and traffic data as well as operational status of links and nodes between centers:

- Traffic network inventory information
- Traffic detector inventory information

- Links and Nodes location attributres and status information based on a GIS
- Traffic detectors status

The required and optional information for traffic network (link and node) inventory sharing and status are as follows:

Table 13. Traffic Network Data Functional Requirements

4.3.13.1 Provide Traffic Network Inventory Information The Traffic Management Center shall support sharing of network inventory composed of a predefined list of nodes and links based on a GIS, with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.13.1.1 Update Traffic Network Inventory Information The Traffic Management Center shall send changes to the Traffic Network Inventory information to all subscribing ECs after the inventory is updated.
4.3.13.1.2 Contents of the Traffic Network Inventory Information This information shall include the following information: • the organization and center information • the unique ID of the traffic network • list of all link IDs in the network • list of all node IDs in the network The following optional information may also be sent if it exists for the traffic network: • name of the traffic data network • number of sections in the network • number of links in the network • number of nodes in the network • contact information (name, phone number, pager, email address) for the owning center • the date and time of the last change to the information
4.3.13.1.3 Update Node Inventory Information The Traffic Management Center shall send changes to the Node Inventory information to all subscribing ECs after they are submitted to the database.

4.3.13.1.4 Contents of the Node Inventory Information

The following information are required for node inventory sharing:

- unique identifier of the organization that owns or operates the node
- unique ID of the traffic network
- unique node ID in the traffic network
- location of the node

The following optional information may also be sent if it exists for the node:

- node name as assigned by the owning organization
- node type
- number of links that are associated with the node
- the date and time of the last change to this information

4.3.13.1.5 Update Link Inventory Information

The Traffic Management Center shall send changes to the Link Inventory information to all subscribing ECs after they are submitted to the database.

4.3.13.1.6 Contents of the Link Inventory Information

The following information are required for link inventory sharing:

- unique identifier of the owning organization
- unique ID of the traffic network
- unique identifier of the link
- link type
- link location (begin and end Node)
- link begin and end node Identifiers

The following optional information may also be sent if it exists for the link:

- link name as assigned by the owning organization
- other names by which the link is known
- link law enforcement agency
- link owner
- road surface condition
- shoulder widths
- median type
- link designator
- link Linear reference of begin and end node
- length of the link

- link capacity
- posted speed limits
- the date and time of the last change

4.3.13.1.7 Receive and Process Traffic Network Inventory Information

The Traffic Management Center shall receive and process Traffic Network inventory information when it is received from other authorized traffic management systems in the defined C2C network.

4.3.13.1.8 Request Traffic Network Inventory Information Upon Initialization

The External Center shall request traffic network inventory information upon system initialization (i.e. when the system connects to other centers through the C2C infrastructure). The Center shall request updates since a specific date and time.

4.3.13.1.9 Send Traffic Network Inventory Information Upon Request

The Traffic Management Center shall send traffic network inventory information when requested. If a list of links and/or nodes is provided in the request The Traffic Management Center shall only send updates for those links and nodes. The Traffic Management Center shall only provide the requested information for a list of links and nodes or to provide updates since a data and time.

4.3.13.2 Provide NODE Status Information

The Traffic Management Center shall support sharing of node status information with other authorized traffic management systems defined as being part of the C2C communications environment.

4.3.13.2.1 Update Node Status Information

The Traffic Management Center shall send changes to the Node Status information to all subscribing ECs after the status is updated.

4.3.13.2.2 Contents of the Node Status Information

This information shall include the following information:

- unique node ID in the traffic network
- the unique ID of the traffic network
- organization that owns or operates the node
- status of the node (open, restricted, closed)
- the operator and center name for the current use of the node
- The date and time of the last change to this information

The following optional information may also be sent if it exists for the node:

- the unique node name

4.3.13.2.3 Receive Node Status

The Center shall receive the Node status.

4.3.13.2.4 Send Node Status Information Upon Request

The Traffic Management Center shall send Node Status information to an authorized

requesting EC after the request is received from the EC.

4.3.13.3 Provide LINK Status Information

The Traffic Management Center shall support sharing of link status information with other authorized traffic management systems defined as being part of the C2C network.

4.3.13.3.1 Update Link Status Information
The Traffic Management Center shall send changes to the Link Status information to all subscribing ECs after the status is updated.

4.3.13.3.2 Contents of the Link Status Information
The following information are required for link status sharing:

- unique link Identifier in the traffic network
- the unique ID of the traffic network
- organization that owns or operates the link
- status of the link (open, restricted, closed)
- the operator and center name for the current use of the link
- the date and time of the last change to this information

The following optional information may also be sent if it exists for the link:

- the unique link name (roadway name)
- current direction of travel on the link
- current number of lanes open or available
- priority given for certain condition (e.g. evacuation)
- restriction of access to roadway (e.g., height, number of axles, weight)
- roadway surface condition (e.g., wet, slick, icing)
- flag representing saturation of the link
- description of measure of traffic flow on the link

4.3.13.3.3 Send Link Status Information Upon Request
The Traffic Management Center shall send Link Status information to an authorized requesting EC after the request is received from the EC.

4.3.13.3.4 Receive Link Status
The Center shall receive link status changes from other authorized traffic management systems in the C2C network.

4.3.13.4 Provide LINK Data Sharing

The Traffic Management Center shall support sharing of link data with other authorized traffic management systems defined as being part of the C2C network.

4.3.13.4.1 Update Link Data
The Traffic Management Center shall send changes to the link data to all subscribing ECs on a periodic basis or when it is updated.

4.3.13.4.2 Contents of the Link Data
The following information are required for link data sharing:

- unique link ID in the traffic network
- the unique ID of the traffic network

• organization that owns or operates the link The following optional information shall also be sent if it exists for the link: • type of data stored for the link • source of data (e.g., loop, radar, etc…) • data type that is currently available (e.g., predicted, historical, actual) • link lane number • average link delay • Average alternate route delay • Link headway • Link existing capacity • average travel time • Link travel time increase • link volume • link average speed • Link estimated vehicle speed • link density • link average occupancy • the date and time of the last change to this information
4.3.13.4.3 Send Link Data Upon Request The Traffic Management Center shall send Link Data to an authorized requesting EC after the request is received from the EC.

4.3.15 Traffic Detector Functional Requirements

The required and optional information for Traffic Detector inventory sharing and status are as follows:

Table 14. Traffic Detector Functional Requirements

Requirements
4.3.14.1 Provide Traffic Detector Inventory Information The Traffic Management Center shall support sharing of detector inventory with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.14.1.1 Update Traffic Detector Inventory Information The Traffic Management Center shall send changes to the Traffic Detector Inventory information to all subscribing ECs after the inventory is updated.
4.3.14.1.2 Contents of the Detector Inventory Information The following information are required for traffic data inventory sharing: • organization that owns or operates the detector • unique detector ID for each detector

The following optional information may also be sent if it exists for the detector:

- unique ID of the traffic network
- station ID for each individual detector
- name that identifies each detector (e.g., NB RT Reston Pkway/Sunrise St)
- location of each detector (latitude/longitude, route designator and linear reference)
- link associated with each detector
- direction detector is reporting on
- detector type
- lanes that detector is reporting on
- the date and time of the last change to this information

4.3.14.1.3 Send Traffic Detector Inventory Information Upon Request

The Traffic Management Center shall send Detector Inventory information to an authorized requesting EC after the request is received from the EC.

4.3.14.1.4 Receive Detector Inventory Information

The Center shall receive detector inventory changes from other authorized traffic management systems in the C2C network.

4.3.14.2 Provide Traffic Detector Status Information

The Traffic Management Center shall support sharing of detector status information with other authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:

4.3.14.2.1 Update Detector Status Information

The Traffic Management Center shall send changes to the Traffic Detector Status to all subscribing ECs after the status is updated.

4.3.14.2.2 Contents of the Detector Status Information

The following information are required for detector status sharing:

- unique ID of the traffic network
- unique detector ID
- organization that owns or operates the device
- organization ID requesting the status
- status of the detector (operational, off-line, failed)

The following optional information may also be sent if it exists for the detector:

- name that identifies the detector
- type of detector
- station or individual detector
- lanes that detector is reporting on
- the date and time of the last change to this information

4.3.14.2.3 Send Traffic Detector Status Information Upon Request

The Traffic Management Center shall send Detector Status information to an authorized requesting EC after the request is received from the EC.

4.3.14.3 Provide Traffic Detector Data

The Traffic Management Center shall support sharing of detector data with other

authorized traffic management systems defined as being part of the C2C network. The requirements to support this function are as follows:
4.3.14.3.1 Receive Detector Data Requests The TMC shall receive and process detector data requests.
4.3.14.3.2 Contents of the Detector Data The following information are required for detector status sharing: • unique detector ID • data collection date • period of accumulation • organization that owns or operates the device The following optional information may also be sent if it exists for the detector: • name that identifies the detector • average speed during period of accumulation • average occupancy during period of accumulation • vehicle count during period of accumulation • Detector occupancy • Vehicle queue length
4.3.14.3.3 Send Traffic Detector Data Upon Request The Traffic Management Center shall send Detector data to an authorized requesting EC after the request is received from the EC.

5.0 Traceability to the National ITS Architecture

5.1 Introduction

The Traceability to National Architecture Matrix provides the linkage between MS-ETMCC requirements and the architecture flows between Traffic Management subsystem (TMS), other subsystems and system terminators. The architecture flows in the National Architecture Matrix are based on version 4.0 of the National ITS Architecture. The content of the matrix is based on inputs provided by the National ITS Architecture Team and NTCIP C2C Working Group.

5.2 Definitions

The following terms and definitions have been employed throughout the subject matrix:

Source Name: The full name of the source subsystem or terminator.

Destination Name: The full name of the destination subsystem or terminator.

Architecture Flow: The name of the information flowing directionally from the Source to the Destination.

General Conops Area Reference: The MSETMCC Conops paragraph numbers at a high level that could be used in the ConOps (see NTCIP 1203 DMS v2.20 paragraph 2.8) reference.

Specific Conops Reference: The lower level MSETMCC ConOps paragraph numbers that relate to the architecture flow.

Requirements: The MSETMCC Requirements paragraph numbers that relate to the architecture flow.

Recommended Action: This is the recommendation provided by the Architecture Team. The actions identify whether the flow is:

- Included – included in the MSETMCC scope.
- Out of Scope - clearly another standard is including this flow or should be including that.
- Future - this is not in MSETMCC current scope but may be included in the future.

5.3 Summary

A total of 76 architecture flows have been identified by extracting the Center-to-Center flows between TMS and other subsystems. Based on the recommended actions listed above, 32 flows are included in this ConOps and Requirements document, 31 flows are subject to future work and 13 flows are considered out of scope.

Traceability to the National ITS Architecture
Data Flows between Traffic Management and other subsystems.

Source Name	*Src Class*	*Destination Name*	*Dest. Class*	*Architecture Flow*	*General Conops Area Reference*	*Specific Conops Reference*	*Requirements*	*Recommended Action*
Archived Data Management Subsystem	Center	Traffic Management	Center	archive requests	3.3	3.3.1.2, 3.3.2.4, 3.3.3.4	4.3.3.6.2, 4.3.3.6.3	Included
Archived Data Management Subsystem	Center	Traffic Management	Center	archive status				Future
Emergency Management	Center	Traffic Management	Center	road network probe information				Future
Emergency Management	Center	Traffic Management	Center	resource request				Future
Emergency Management	Center	Traffic Management	Center	remote surveillance control	3.4	3.4.3	4.3.4.3, 4.3.4.4	Included
Emergency Management	Center	Traffic Management	Center	incident response status	3.3	3.3.1	4.3.3.6	Included. Suggest coordination with IEEE P1512
Emergency Management	Center	Traffic Management	Center	emergency traffic control request				Future
Emergency Management	Center	Traffic Management	Center	incident information	3.3	3.3.1	4.3.3.6	Include. Suggest coordination with IEEE P1512
Emissions Management	Center	Traffic Management	Center	wide-area statistical pollution information				Future
Information Service Provider	Center	Traffic Management	Center	request for road network conditions	3.3	3.3.4	4.3.13	Included
Information Service Provider	Center	Traffic Management	Center	logged special vehicle route				Out of Scope. SAE ATIS
Information Service Provider	Center	Traffic Management	Center	fare and price information				Out of Scope. SAE ATIS
Information Service Provider	Center	Traffic Management	Center	road network probe information				Future
Maintenance and Construction Management	Center	Traffic Management	Center	current asset restrictions				Future, not included because the use of restrictions in the conops is similar but more limited than what is used in MCMS
Maintenance and Construction	Center	Traffic Management	Center	road weather information	3.3	3.3.1, 3.3.3	4.3.3.6.1	Included

Source Name	Src Class	Destination Name	Dest. Class	Architecture Flow	General Conops Area Reference	Specific Conops Reference	Requirements	Recommended Action
Management								
Maintenance and Construction Management	Center	Traffic Management	Center	work zone information				Future
Maintenance and Construction Management	Center	Traffic Management	Center	roadway maintenance status				Future
Maintenance and Construction Management	Center	Traffic Management	Center	maint and constr resource response				Future
Maintenance and Construction Management	Center	Traffic Management	Center	incident information	3.3	3.3.1	4.3.3.6	Included. Suggest coordination with IEEE P1512
Maintenance and Construction Management	Center	Traffic Management	Center	equipment maintenance status				Future
Maintenance and Construction Management	Center	Traffic Management	Center	maint and constr work plans				Future
Toll Administration	Center	Traffic Management	Center	probe data	3.3.5		4.3.13	Included.
Toll Administration	Center	Traffic Management	Center	toll demand management response				Future
Traffic Management	Center	Archived Data Management Subsystem	Center	traffic archive data	3.3	3.3..1.2, 3.3.2.4, 3.3.3.4	4.3.3.6.2, 4.3.3.6.3	Included. TMC includes archiving of data
Traffic Management	Center	Emergency Management	Center	emergency traffic control response				Future
Traffic Management	Center	Emergency Management	Center	incident information	3.3	3.3.1	4.3.3.6	Included. Suggest coordination with IEEE P1512
Traffic Management	Center	Emergency Management	Center	incident information request	3.3	3.3.1	4.3.3.6	Included. Suggest coordination with IEEE P1512
Traffic Management	Center	Emergency Management	Center	resource deployment status				Future
Traffic Management	Center	Emergency Management	Center	road network conditions	3.3	3.3.4	4.3.13	Include.
Traffic Management	Center	Emissions Management	Center	pollution state data request				Future
Traffic	Center	Information Service	Center	request fare and				Future

Source Name	Src Class	Destination Name	Dest. Class	Architecture Flow	General Conops Area Reference	Specific Conops Reference	Requirements	Recommended Action
Management		Provider		price information				
Traffic Management	Center	Information Service Provider	Center	road network conditions	3.3	3.3.4	4.3.13	Included
Traffic Management	Center	Maintenance and Construction Management	Center	field equipment status	3.3	3.4.1-11	4.3.4.2, 4.3.5.2, 4.3.6.2, 4.3.7.2, 4.3.8.2, 4.3.9.2, 4.3.10.2, 4.3.11.2, 4.3.12.2, 4.3.12.3, 4.3.13.2, 4.3.13.3, 4.3.14.2	Included
Traffic Management	Center	Maintenance and Construction Management	Center	incident information	3.3	3.3.1	4.3.3.6	Included. Suggest coordination with IEEE P1512
Traffic Management	Center	Maintenance and Construction Management	Center	maint and constr resource request				Future
Traffic Management	Center	Maintenance and Construction Management	Center	road network conditions	3.3	3.3.4	4.3.13	Included
Traffic Management	Center	Maintenance and Construction Management	Center	work plan feedback				Future
Traffic Management	Center	Toll Administration	Center	toll demand management request				Future
Traffic Management	Center	Transit Management	Center	request transit information				Out of Scope. TCIP
Traffic Management	Center	Transit Management	Center	transit demand management request				Out of Scope. TCIP
Traffic Management	Center	Transit Management	Center	traffic control priority status				Future
Traffic Management	Center	Transit Management	Center	road network conditions	3.3	3.3.4	4.3.13	Included
Traffic Management	Center	Event Promoters	Center	event confirmation				Future
Traffic Management	Center	Map Update Provider	Center	map update request				Future
Traffic	Center	Media	Center	road network	3.3	3.3.4	4.3.13	Included

Source Name	Src Class	Destination Name	Dest. Class	Architecture Flow	General Conops Area Reference	Specific Conops Reference	Requirements	Recommended Action
Management				conditions				
Traffic Management	Center	Other TM	Center	traffic control coordination	3.4	3.4.1-11	4.3.4.3-4, 4.3.5.3-5, 4.3.6.3-5, 4.3.8.3, 3.3.9.3, 4.3.10.3, 4.3.11.3, 4.3.12.4-5	Included.
Traffic Management	Center	Other TM	Center	traffic information coordination	3.3	3.3.1-5, 3.4.1-3.4.11	4.3.4.1-2, 4.3.5.1-2, 4.3.6.1-2, 4.3.7.1-2, 4.3.8.1-2, 4.3.9.1-2, 4.3.10.1-2, 4.3.11.1-2, 4.3.12.1-2, 4.3.13.1-2, 4.3.14.1-2	Included
Traffic Management	Center	Weather Service	Center	environmental conditions data	3.3, 3.4	3.3.3.1, 3.4.6	4.3.3.6.1, 4.3.7.2	Included.
Traffic Management	Center	Enforcement Agency	Center	request for enforcement				Future
Traffic Management	Center	Enforcement Agency	Center	traffic violation notification				Future
Traffic Management	Center	DMV	Center	license request				Out of Scope. DMV would likely dictate this interface
Traffic Management	Center	Rail Operations	Center	hri advisories				Future
Traffic Management	Center	Surface Transportation Weather Service	Center	environmental conditions data	3.3, 3.4	3.3.3.1, 3.4.6	4.3.3.6.1, 4.3.7.2	Included.
Traffic Management	Center	Surface Transportation Weather Service	Center	transportation weather information request	3.3, 3.4	3.3.3.1, 3.4.6	4.3.3.6.1, 4.3.7.2	Included.
Transit Management	Center	Traffic Management	Center	transit system data				Out of Scope. TCIP
Transit Management	Center	Traffic Management	Center	transit demand management response				Out of Scope. TCIP
Transit Management	Center	Traffic Management	Center	request for road network conditions	3.3	3.3.4	4.3.13	Included.
Transit Management	Center	Traffic Management	Center	road network probe information				Future.
Transit	Center	Traffic Management	Center	traffic control priority				Future

Source Name	Src Class	Destination Name	Dest. Class	Architecture Flow	General Conops Area Reference	Specific Conops Reference	Requirements	Recommended Action
Management				request				
Event Promoters	Center	Traffic Management	Center	event plans	3.3	3.3.2	4.3.3.6.2	Included.
Map Update Provider	Center	Traffic Management	Center	map updates				Future
Media	Center	Traffic Management	Center	media information request	3.3	3.3.1	4.3.3	Included.
Media	Center	Traffic Management	Center	external reports	3.3	3.3.1	4.3.3	Included
Other TM	Center	Traffic Management	Center	traffic control coordination	3.4	3.4.1-11	4.3.4.3-4, 4.3.5.3-5, 4.3.6.3-5, 4.3.8.3, 3.3.9.3, 4.3.10.3, 4.3.11.3, 4.3.12.4-5	Included.
Other TM	Center	Traffic Management	Center	traffic information coordination	3.3	3.3.1-5, 3.4.1-3.4.11	4.3.4.1-2, 4.3.5.1-2, 4.3.6.1-2, 4.3.7.1-2, 4.3.8.1-2, 4.3.9.1-2, 4.3.10.1-2, 4.3.11.1-2, 4.3.12.1-2, 4.3.13.1-2, 4.3.14.1-2	Included
Weather Service	Center	Traffic Management	Center	environmental conditions data	3.3, 3.4	3.3.3.1, 3.4.6	4.3.3.6.1, 4.3.7.2	Included.
Weather Service	Center	Traffic Management	Center	weather information				Out of Scope. Accumulated forecasted and current weather data
DMV	Center	Traffic Management	Center	registration				Out of Scope. DMV would likely dictate this interface
Rail Operations	Center	Traffic Management	Center	railroad schedules				Future
Rail Operations	Center	Traffic Management	Center	railroad advisories				Future
Surface Transportation Weather Service	Center	Traffic Management	Center	environmental conditions data	3.3, 3.4	3.3.3.1, 3.4.6	4.3.3.6.1, 4.3.7.2	Included
Surface Transportation Weather Service	Center	Traffic Management	Center	transportation weather information	3.3, 3.4	3.3.3.1, 3.4.6	4.3.3.6.1, 4.3.7.2	Included.
Parking Management		Traffic Management		parking availability				Out of Scope. ATIS/TCIP
Parking Management		Traffic Management		parking demand management response				Out of Scope. ATIS/TCIP

Source Name	*Src Class*	*Destination Name*	*Dest. Class*	*Architecture Flow*	*General Conops Area Reference*	*Specific Conops Reference*	*Requirements*	*Recommended Action*
Traffic Management		Parking Management		parking instructions				Out of Scope. ATIS/TCIP
Traffic Management		Parking Management		parking demand management request				Out of Scope. ATIS/TCIP

6.0 Needs and Requirements Traceability Matrix

The Needs and Requirements Traceability Matrix provides a mapping between the User Needs and the Requirements. The table also provides two columns that are used by project specific implementations to assist in determining implementation specific details. One is for identifying whether item is project requirement or not (yes/no); universal requirements show only yes. The other is used as needed to identify specific decisions required for some items, or left blank, allowing filling in with unusual particulars.

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
2.5.1	Security Needs			Yes	
2.5.1.1	Providing User Login	4.3.1.1	Support User Login	Yes	
		4.3.1.1.1	Establish User Identity	Yes	
		4.3.1.1.2	Provide Secondary Login	No	
2.5.1.2	Supporting Authentication	4.3.1.2	Support Authentication	Yes	
		4.3.1.2.1	Send Authentication Interrogation Information	Yes	
		4.3.1.2.2	Contents of Authentication Interrogation Information	Yes	
		4.3.1.2.3	Send Authentication Interrogation Response	Yes	
		4.3.1.2.4	Contents of Authentication Interrogation Response	Yes/No	
2.5.1.3	Processing Security Token	4.3.1.3	Support Security Tokens	Yes	
		4.3.1.3.1	Send the Security Token Request Information	Yes	
		4.3.1.3.2	Contents of Security Token Request	Yes/No	
		4.3.1.3.3	Process Security Token Request	Yes	
		4.3.1.3.4	Provide Response to Security Token Request	Yes	
		4.3.1.3.5	Contents of Response Information	Yes/No	
		4.3.1.3.6	Process Security Token Request	Yes	
3.2.2	Provide information on Agencies, Centers, Systems, and Users			Yes/No	
3.2.2.1	The Need for Agency Information Sharing	4.3.2.1	Provide Agency Information Sharing	Yes / No	
		4.3.2.1.1	Update Agency Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.2.1.2	Contents of Agency Information	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.2.1.3	Send Agency Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.2.1.4	Center to Receive and Process Agency Information	Yes	
3.2.2.2	The Need for Organization Information Sharing	4.3.2.2	Provide Organization Information Sharing	Yes / No	
		4.3.2.2.1	Update Organization Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.2.2.2	Contents of Organization Information	Yes/No	
		4.3.2.2.3	Send Organization Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.2.2.4	Center to Receive and Process Organization Information	Yes	
3.2.2.3	The Need for Contact Information Sharing	4.3.2.3	Provide Contact Information Sharing	Yes / No	
		4.3.2.3.1	Update Contact Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.2.3.2	Contents of Contact Information	Yes/No	
		4.3.2.3.3	Send Contact Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.2.3.4	Center to Receive and Process Contact Information	Yes	
3.3.1	Share Current Event Information			Yes/No	
3.3.1.1	The Need for Current Event Information	4.3.3.6.1	Provide Event Information Sharing	Yes / No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.3.6.1.1	Update Event Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.3.6.1.2	Contents of Event Information	Yes/No	
		4.3.3.6.1.3	Send Ended or Cancel Status	Yes	
		4.3.3.6.1.4	Receive Event Information	Yes	
3.3.1.2	The Need for Event Action Log Information	4.3.3.6.1.5	Provide Event Action Log Information	Yes / No	
		4.3.3.6.1.6	Contents of Event Action Log Information	No	
3.3.1.3	The Need for Event Recap	4.3.3.6.1.7	Provide Event Information Recap	Yes / No	
		4.3.3.6.1.8	Request Recap Upon Initialization	Yes/No	
		4.3.3.6.1.9	Send Event Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.3.2	Share Planned Event Information			Yes/No	
3.3.2.1	The Need for Planned Event Information	4.3.3.6.2	Provide Planned Event Information Sharing	Yes / No	
		4.3.3.6.2.1	Update Planned Event Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.3.6.2.2	Contents of the Planned Event Information	Yes/No	
		4.3.3.6.2.3	Send Ended or Cancel Status	Yes	
		4.3.3.6.2.4	Receive Planned Event Information	Yes	
3.3.2.2	The Need for Planned Event Action Log Information	4.3.3.6.2.5	Provide Planned Event Action Log Information	No	
		4.3.3.6.2.6	Contents of Planned Event Action Log Information	No	
3.3.2.3	The Need for Planned Event Timeline Schedule Information	4.3.3.6.2.7	Provide Planned Event Timeline Schedule Information		

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.3.6.2.8	Contents of Planned Event Schedule Timeline Information	No	
3.3.2.4	The Need for Planned Event Recap	4.3.3.6.2.9	Provide Planned Event Recap	Yes / No	
		4.3.3.6.2.10	Request Recap of Planned Event Information Upon Initialization	Yes/No	
		4.3.3.6.2.11	Send Planned Event Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.3.3	Share Forecast Event Information			Yes/No	
3.3.3.1	Share Forecast Weather Events	4.3.3.6.3	Provide Forecast Event Information Sharing	Yes / No	
3.3.3.2	Share Forecast Road Conditions	4.3.3.6.3	Provide Forecast Event Information Sharing	Yes / No	
3.3.3.3	The Need for Forecast Event Information	4.3.3.6.3	Provide Forecast Event Information Sharing	Yes / No	
		4.3.3.6.3.1	Update Forecast Event Information	Yes/No	
		4.3.3.6.3.2	Contents of the Forecast Event Information	Yes	
		4.3.3.6.3.3	Send Ended or Cancel Status	Yes	
		4.3.3.6.3.4	Receive Forecast Event Information	Yes	
3.3.3.4	The Need for Forecast Event Action Log Information	4.3.3.6.3.5	Provide Forecast Event Action Log Information	No	
		4.3.3.6.3.6	Contents of Forecast Event Action Log Information	No	
3.3.3.5	The Need for Forecast Event Timeline Schedule Information	4.3.3.6.3.7	Provide Forecast Event Timeline Schedule Information		
		4.3.3.6.3.8	Contents of Forecast Event Timeline Information	No	
3.3.3.6	The Need for Forecast Event Recap	4.3.3.6.3.9	Provide Forecast Event Recap	Yes / No	
		4.3.3.6.3.10	Request Recap of Forecast Event Information Upon Initialization	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.3.6.3.11	Send Forecast Event Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.3.4	Provide Traffic Network Data			Yes / No	
3.3.4.1	The Need for Network Inventory Information	4.3.13.1	Provide Traffic Network Inventory Information	Yes / No	
		4.3.13.1.1	Update Traffic Network Inventory Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.13.1.2	Contents of the Traffic Network Inventory Information	Yes/No	
		4.3.13.1.7	Receive and Process Traffic Network Inventory Information	Yes	
		4.3.13.1.8	Request Traffic Network Inventory Information Upon Initialization	Yes/No	
		4.3.13.1.9	Send Traffic Network Inventory Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.3.4.2	The Need for Node Inventory Information			Yes/No	
		4.3.13.1.3	Update Node Inventory Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.13.1.4	Contents of the Node Inventory Information	Yes/No	
3.3.4.3	The Need for Link Inventory Information			Yes / No	
		4.3.13.1.5	Update Link Inventory Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.13.1.6	Contents of the Link Inventory Information	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
3.3.4.4	The Need for Node Status Information	4.3.13.2	Provide NODE Status Information	Yes / No	
		4.3.13.2.1	Update Node Status Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.13.2.2	Contents of the Node Status Information	Yes/No	
		4.3.13.2.3	Receive Node Status	Yes	
		4.3.13.2.4	Send Node Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.3.4.5	Link Status Request		Provide LINK Status Information	Yes / No	
		4.3.13.3.1	Update Link Status Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.13.3.2	Contents of the Link Status Information	Yes / No	
		4.3.13.3.3	Send Link Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.13.3.4	Receive Link Status	Yes	
3.3.3.6		4.3.13.4	Provide LINK Data Sharing		
		4.3.13.4.1	Update Link Data	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.13.4.2	Contents of the Link Data	Yes / No	
		4.3.13.4.3	Send Link Data Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.3.5	Provide Traffic Detector Data				

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
3.3.5.1	The Need for Detector Inventory Information	4.3.14.1	Provide Traffic Detector Inventory Information	Yes / No	
		4.3.14.1.1	Update Traffic Detector Inventory Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.14.1.2	Contents of the Detector Inventory Information	Yes/No	
		4.3.14.1.3	Send Traffic Detector Inventory Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.14.1.4	Receive Detector Inventory Information	Yes	
3.3.5.2	Detector Status Request	4.3.14.2	Provide Traffic Detector Status Information	Yes / No	
		4.3.14.2.1	Update Detector Status Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.14.2.2	Contents of the Detector Status Information	Yes/No	
		4.3.14.2.3	Send Traffic Detector Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.3.5.3	The Need for Detector Data Sharing		Provide Traffic Detector Data	Yes/No	
		4.3.14.3.1	Receive Detector Data Requests	Yes	
		4.3.14.3.2	Contents of the Detector Data	Yes/No	
		4.3.14.3.3	Send Traffic Detector Data Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.3	Control				

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
3.4.3.1	The Need for CCTV Inventory Sharing	4.3.4.1	Provide CCTV Inventory Information	Yes / No	
		4.3.4.1.1	Update CCTV Inventory Information	Yes/No	Updates are transmitted within _____ seconds of being updated.
		4.3.4.1.2	Contents of the CCTV Inventory Information	Yes	
		4.3.4.1.3	Receive CCTV Inventory Information	Yes	
		4.3.4.1.4	Request CCTV Information Upon Initialization	Yes/No	
		4.3.4.1.5	Send CCTV Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.3.2	The Need for CCTV Status Sharing	4.3.4.2	Provide CCTV Status Information	Yes / No	
		4.3.4.2.1	Update CCTV Status	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.4.2.2	Contents of CCTV Status Information	Yes/No	
		4.3.4.2.3	Receive CCTV Status Information	Yes/No	
		4.3.4.2.4	Send CCTV Status Upon Request	Yes/No	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.3.3		4.3.4.3	Support Remote Control of CCTV Devices	Yes / No	
		4.3.4.3.1	Receive CCTV Control Request s	Yes/No	
		4.3.4.3.2	Send Response to CCTV Control Request	Yes/No	
		4.3.4.3.3	Contents of the Response to CCTV Control Request	Yes/No	
		4.3.4.3.4	Receive CCTV Cancel Control	Yes/No	
		4.3.4.3.5	Send CCTV Cancel Control	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
3.4.3.4	Processing CCTV Control Receipt		Issue Control Requests to Remote CCTV Devices	Yes / No	
		4.3.4.4.1	Send a CCTV Control Request	Yes/No	
		4.3.4.4.2	Contents of CCTV Control Request	Yes	
		4.3.4.4.3	Receive CCTV Control Response	Yes/No	
3.4.4	Control			Yes/No	
3.4.4.1	The Need for Video Switch Inventory Sharing		Provide Video Switch Inventory Information	Yes / No	
		4.3.5.1.1	Update Video Switch Inventory Information	Yes/No	Updates are transmitted within _____ seconds of being updated.
		4.3.5.1.2	Contents of the Video Switch Inventory Information	Yes	
		4.3.5.1.3	Receive Video Switch Inventory Information	Yes/No	
		4.3.5.1.4	Request Video Switch Inventory Information upon initialization	Yes/No	
		4.3.5.1.5	Send Video Switch Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.4.2	The Need for Video Switch Status Sharing		Provide Video Switch Status Information	Yes / No	
		4.3.5.2.1	Update Video Switch Status Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.5.2.2	Contents of the Video Switch Status Information	Yes/No	
		4.3.5.2.3	Receive Video Switch Status Information	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.5.2.4	Send Video Switch Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.4.3	Processing Video Switch Control Receipt	4.3.5.3	Support Remote Control of Video Switch Devices	Yes / No	
		4.3.5.3.1	Receive Video Switch Control Requests	Yes/No	
		4.3.5.3.2	Contents of the Video Switch Control Requests	Yes	
		4.3.5.3.3	Send Response to Control Requests	Yes/No	
		4.3.5.3.4	Receive a Video Switch Cancel Control Message	Yes/No	
		4.3.5.3.5	Send a Video Switch Cancel Control Confirmation Message	Yes/No	
3.4.4.4	Processing Video Switch Control Transmission	4.3.5.4	Issue Control Requests to Remote Video Switch Devices	Yes / No	
		4.3.5.4.1	Send a Video Switch Control Message	Yes/No	
		4.3.5.4.2	Contents of the Video Switch Control Message	Yes	
		4.3.5.4.3	Receive a Response to Video Switch Control Request	Yes/No	
		4.3.5.4.4	Send a Video Switch Cancel Control Message	Yes/No	
		4.3.5.4.5	Receive a Video Switch Cancel Control Confirmation Message	Yes/No	
3.4.4.5	Setting Video Switch Attributes		Set Video Attributes	Yes / No	
		4.3.5.5.1	Send a Set Video Attributes Message	Yes/No	
		4.3.5.5.2	Contents of Video Attributes	Yes/No	
		4.3.5.5.3	Receive a Response to the Set Video Attributes Request	Yes/No	
3.4.5	Provide DMS Status and Control			Yes	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
3.4.5.1	The Need for DMS Inventory Sharing	4.3.6.1	Provide DMS Inventory Information	Yes / No	
		4.3.6.1.1	Update DMS Inventory Information	Yes/No	Updates are transmitted within _____ seconds of being updated.
		4.3.6.1.2	Contents of the DMS Inventory Information	Yes	
		4.3.6.1.3	Receive DMS Inventory Information	Yes/No	
		4.3.6.1.4	Request DMS Inventory Upon Initialization	Yes/No	
		4.3.6.1.5	Send DMS Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.6.1.6	Send Updates Since a Specific Date/Time	Yes	
3.4.5.2	The Need for DMS Status Sharing	4.3.6.2	Provide DMS Status Information	Yes / No	
		4.3.6.2.1	Update DMS Status Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.6.2.2	Contents of the DMS Status Information	Yes	
		4.3.6.2.3	Receive DMS Status	Yes/No	
		4.3.6.2.4	Send DMS Status Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.5.3	DMS Control Request	4.3.6.4	Request DMS Control	Yes / No	
		4.3.6.4.1	Send Control Requests	Yes/No	
		4.3.6.4.2	Contents of the Control Request	Yes/No	
		4.3.6.4.3	Receive Responses to DMS Control Requests	Yes/No	
		4.3.6.4.4	Send DMS Cancel Control	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.6.4.5	Contents of DMS Cancel Control Request	Yes/No	
		4.3.6.4.6	Receive Responses to DMS Cancel Control	Yes/No	
3.4.5.4	Processing DMS Control Request	4.3.6.3	Provide DMS Control Sharing	Yes / No	
		4.3.6.3.1	Receive DMS Control Requests	Yes/No	
		4.3.6.3.2	Send Responses to DMS Control Requests	Yes/No	
		4.3.6.3.3	Contents of DMS Control Response	Yes	
		4.3.6.3.4	Receive DMS Cancel Control	Yes/No	
		4.3.6.3.5	Send DMS Cancel Control	Yes/No	
		4.3.6.3.6	Contents of DMS Cancel Control Response	Yes/No	
3.4.6	Provide Environmental Sensor Data			Yes/No	
3.4.6.1	The Need for ESS Inventory Sharing	4.3.7.1	Provide ESS Inventory Information	Yes/No	
		4.3.7.1.1	Update ESS Inventory Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.7.1.2	Contents of the ESS Inventory	Yes/No	
		4.3.7.1.3	Send ESS Inventory Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.7.1.4	Center to Receive and Process ESS Inventory Information	Yes	
3.4.6.2	The Need for ESS Status Sharing	4.3.7.2	Provide ESS Status Information	Yes/No	
		4.3.7.2.1	Update ESS Status Information	Yes/No	Updates are transmitted to all authorized ECs within _____ seconds of being updated.
		4.3.7.2.2	Contents of the ESS Status Information	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.7.2.3	Send ESS Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.7.2.4	Center to Receive and Process ESS Status Information	Yes	
3.4.7	Provide Lane Closure Gate Control			Yes	
3.4.7.1	The Need for Gate Inventory Sharing	4.3.8.1	Provide Lane Closure Gate Inventory Information	Yes/No	
		4.3.8.1.1	Update Gate Inventory Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.8.1.2	Contents of the Gate Inventory	Yes/No	
		4.3.8.1.3	Send Gate Inventory Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.8.1.4	Center to Receive and Process Gate Inventory Information	Yes/No	
		4.3.8.1.5	Send Gate Inventory Information Upon System Initialization	Yes/No	
3.4.7.2	The Need for Gate Status Sharing	4.3.8.2	Provide Lane Closure Gate Status Information	Yes/No	
		4.3.8.2.1	Update Gate Status Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.8.2.2	Contents of the Gate Status Information	Yes/No	
		4.3.8.2.3	Send Gate Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.8.2.4	Center to Receive and Process Gate Status Information	Yes	
3.4.7.3	Capability to Remotely Control Gates	4.3.8.3	Provide Remote Lane Closure Gate Control	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.8.3.1	Receive and Process Gate Control Requests	Yes/No	
		4.3.8.3.2	Contents of the Gate Control Request	Yes/No	
		4.3.8.3.3	Send Responses to Gate Control Requests	Yes	
		4.3.8.3.4	Contents of the Gate Control Response	Yes/No	
		4.3.8.3.5	Send Gate Cancel Control Request	Yes/No	
		4.3.8.3.6	Contents of Gate Cancel Control Request	Yes/No	
		4.3.8.3.7	Receive Responses to Gate Cancel Control	Yes/No	
3.4.8	Provide Highway Advisory Radio Control			Yes	
3.4.8.1	The Need for HAR Inventory Sharing	4.3.9.1	Provide HAR Inventory Information	Yes/No	
		4.3.9.1.1	Update HAR Inventory Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.9.1.2	Contents of the HAR Inventory Information	Yes/No	
		4.3.9.1.3	Send HAR Inventory Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.9.1.4	Request HAR Inventory Information Upon Initialization	Yes/No	Request shall be sent from the TMC within ____ seconds after the start of system initialization.
		4.3.9.1.5	Center to Receive and Process HAR Inventory Information	Yes	
3.4.8.2	The Need for HAR Status Sharing	4.3.9.2	Provide HAR Status Sharing	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.9.2.1	Update HAR Status Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.9.2.2	Contents of HAR Status Information	Yes/No	
		4.3.9.2.3	Send HAR Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.9.2.4	Receive and Process HAR Status Information	Yes	
3.4.8.3	Provide Remote HAR Control	4.3.9.3	Provide HAR Control Sharing	Yes/No	
		4.3.9.3.1	Receive HAR Control Requests	Yes/No	
		4.3.9.3.2	Contents of the HAR Control Request	Yes/No	
		4.3.9.3.3	Send Responses to HAR Control Requests	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.9.3.4	Contents of the HAR Control Response	Yes/No	
		4.3.9.3.5	Receive HAR Cancel Control Request	Yes	
		4.3.9.3.6	Send HAR Cancel Control Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
		4.3.9.3.7	Contents of HAR Cancel Control Request	Yes/No	
3.4.9	Provide Lane Control			Yes	
3.4.9.1	The Need for Controllable Lanes Inventory Sharing	4.3.10.1	Provide Lane Control Signal Inventory Information	Yes/No	
		4.3.10.1.1	Update Lane Control Inventory Information	Yes/No	Updates are transmitted within _____ seconds of being changed

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.10.1.2	Contents of the Lane Control Inventory	Yes/No	
		4.3.10.1.3	Center to Receive and Process Lane Control Inventory Information	Yes	
		4.3.10.1.4	Request Lane Control Inventory Information Upon Initialization	Yes/No	
		4.3.10.1.5	Send Lane Control Inventory Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.9.2	The Need for Controllable Lanes Status Sharing	4.3.10.2	Provide Lane Control Signal Status Information	Yes/No	
		4.3.10.2.1	Update Lane Control Status Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.10.2.2	Contents of the Lane Control Status Information	Yes/No	
		4.3.10.2.3	Receive and Process Lane Control Status Information	Yes/No	
		4.3.10.2.4	Send Lane Control Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.9.3	Provide Remote lane Control	4.3.10.3	Provide Remote Lane Control	Yes/No	
		4.3.10.3.1	Receive and Process Lane Control Requests	Yes/No	
		4.3.10.3.2	Contents of the Lane Control Request	Yes/No	
		4.3.10.3.3	Send Responses to Lane Control Requests	Yes/No	
		4.3.10.3.4	Contents of the Lane Control Response	Yes/No	
		4.3.10.3.5	Receive Lane Control Cancel Notification	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.10.3.6	Send Lane Control Cancel Request	Yes/No	
		4.3.10.3.7	Contents of the Lane Control Cancel Request	Yes/No	
3.4.10	Provide Ramp Meter Status and Control			Yes	
3.4.10.1	The Need for Ramp Meter Inventory Sharing	4.3.11.1	Provide Ramp Meter Inventory Information	Yes / No	
		4.3.11.1.1	Update Ramp Meter Inventory Information	Yes/No	Updates are transmitted within _____ seconds of being updated.
		4.3.11.1.2	Contents of the Ramp Meter Inventory	Yes/No	
		4.3.11.1.3	Center to Receive and Process Ramp Meter Inventory Information	Yes	
		4.3.11.1.4	Request Inventory Information Upon Initialization	Yes/No	
		4.3.11.1.5	Send Ramp Meter Inventory Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.10.2	The Need for Ramp Meter Status Sharing	4.3.11.2	Provide Ramp Meter Status Information	Yes / No	
		4.3.11.2.1	Update Ramp Meter Status Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.11.2.2	Contents of the Ramp Meter Status Information	Yes	
		4.3.11.2.3	Receive Ramp Meter Status	Yes	
		4.3.11.2.4	Send Ramp Meter Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.10.3	Capability to Control Ramp Meter	4.3.11.3	Provide Remote Ramp Meter Control	Yes / No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.11.3.1	Receive and Process Ramp Control Requests.	Yes/No	
		4.3.11.3.2	Contents of the Ramp Meter Control Request	Yes/No	
		4.3.11.3.3	Send Response to Ramp Control Request	Yes/No	
		4.3.11.3.4	Contents of the Response to Ramp Control Request	Yes/No	
		4.3.11.3.5	Receive Ramp Meter Cancel Control Notification	Yes/No	
		4.3.11.3.6	Send Ramp Meter Cancel Control Request	Yes/No	
		4.3.11.3.7	Contents of the Ramp Meter Cancel Control Request	Yes/No	
3.4.11				Yes	
3.4.11.1	The Need for Signal System Inventory Sharing	4.3.12.1	Provide Signal System Inventory Information	Yes / No	
		4.3.12.1.1	Update Signal System Inventory Information	Yes/No	Updates are transmitted within _____ seconds of being updated.
		4.3.12.1.2	Contents of the Signal Control Inventory Information	Yes	
		4.3.12.1.3	Receive Signal Control Inventory Information	Yes/No	
		4.3.12.1.4	Request Signal Control Inventory Information upon system initialization	Yes/No	
		4.3.12.1.5	Send Signal Control Inventory Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.11.2	The Need for Intersection Status Sharing	4.3.12.2	Provide Intersection Status Information	Yes / No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.12.2.1	Update Signal Control Status Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.12.2.2	Contents of the Signal Control Status Information	Yes	
		4.3.12.2.3	Receive Signal Control Status	Yes	
		4.3.12.2.4	Send Signal Control Status Information Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.11.3	The Need for Section Status Sharing	4.3.12.3	Provide Section Status Information	Yes / No	
		4.3.12.3.1	Update Section Signal Status Information	Yes/No	Updates are transmitted within _____ seconds of being changed
		4.3.12.3.2	Contents of the Section Status Information	Yes/No	
		4.3.12.3.3	Receive Section Status	Yes	
		4.3.12.3.4	Send Section Status Upon Request	Yes	Information are transmitted to the requesting EC within _____ seconds of receiving the request.
3.4.11.4	Capability to Control Intersections	4.3.12.4	Provide Remote Signal Control	Yes / No	
		4.3.12.4.1	Receive and Process Signal Control Requests	Yes/No	
		4.3.12.4.2	Contents of the Signal Control Request	Yes/No	
		4.3.12.4.3	Send Responses to Signal Control Request	Yes/No	
		4.3.12.4.4	Contents of the Response to Signal Control Request	Yes/No	
		4.3.12.4.5	Receive Cancel Signal Control Notification	Yes/No	
		4.3.12.4.6	Send Cancel Signal Control Request	Yes/No	

User Need ID	User Need	FR ID	Functional Requirement	Project Requirement?	Additional Project Requirements
		4.3.12.4.7	Contents of the Cancel Signal Control Request	Yes/No	
3.4.11.5	Capability to Control Sections	4.3.12.5	Provide Remote Section Control	Yes / No	
		4.3.12.5.1	Receive and Process Section Control Requests	Yes/No	
		4.3.12.5.2	Contents of the Section Control Request	Yes/No	
		4.3.12.5.3	Send Responses to Section Control Requests	Yes/No	
		4.3.12.5.4	Contents of the Section Control Response	Yes/No	
		4.3.12.5.5	Receive Cancel Section Control Notification	Yes/No	
		4.3.12.5.6	Send Cancel Section Control Request	Yes/No	
		4.3.12.5.7	Contents of the Cancel Section Control Request	Yes/No	