



AZTech™ Transportation and Public Safety Center-to-Center

Dynamic Message Sign (DMS) and Traffic Management System (TMS) Functional Requirements

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January 3, 2006
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1. Definition of Terms

- **Center ID**

Each center will have an ID consisting of alphanumeric characters that uniquely identifies it from all other centers. The assignment and management of IDs will be handled by a central authority such as MCDOT. Each center will have to know its own ID as well as the ID of the center it wishes to communicate with.

- **Center-to-Center (C2C)**

The center-to-center (C2C) system provides a means for centers to communicate with other centers using a standard protocol for sending and receiving messages. The messages sent between centers allow centers to request inventory information, take control of a component, or query the status of a component at another center.

- **Control Message**

For DMS, a control message specifies a message to be displayed on a DMS at a given time. Remote centers may request using a control message that either a pre-defined or a custom text message be displayed on the local center's DMS.

For TMS, a control message indicates a timing plan to run, a ramp metering rate to set, and/or a special function to set.

- **Interchange**

An interchange is the junction of a freeway and cross street, and is typically comprised of one or two intersections, as described below.

- **Intersection**

In this document, an intersection can be a conventional traffic intersection made up of two or more cross streets, or can be a ramp meter location. Typically, an intersection is counted for each traffic signal or ramp meter controller present.

- **Inventory Message**

For DMS, an inventory message contains a list of pre-defined messages supported by a center, a list of each DMS and its location and operational attributes, and a list of environmental sensors that are co-located with each DMS. Inventory messages are designed to provide top-level information about a center's components. Once this information is received, a remote center can use the information to either command control of a component or query the status of a component.



For TMS, an inventory message contains a list of intersections, overlaps, and special functions that are maintained by the center. Inventory messages are designed to provide top-level information about a center's components. Once this information is received, a remote center can use the information to either command control of the component or query the status of the component.

- **Local Center**

In this document, the local center is the center that is receiving requests from another center. The requests can be inventory, control, or status messages.

- **Message Number**

Each pre-defined message that is available for display on a DMS will have a number linked to the message that is used to identify that message. The number will be unique to the center – no two pre-defined messages at a center will have the same number.

- **Priority**

The priority assigned to a message to be displayed on a DMS, based on a six level priority hierarchy where Priority 0 is the highest and 5 is the lowest. The details of the type of messages to assigned to each priority level of the message priority hierarchy should be included as part of a regional DMS policy.

- **Remote Center**

In this document, the remote center is the center that is sending requests to another center. The requests can be inventory, control, or status messages.

- **Request Message**

For DMS, a message issued by a remote center requesting inventory information, control of a DMS, or the status of a DMS or environmental sensor.

For TMS, a message issued by a remote center requesting inventory information, intersection detail, timing plan detail, control of an intersection, or the status of an intersection.

- **Response Message**

A message issued by a local center in response to a received request. The response contains the requested information for an inventory or status request or acknowledgement for a control message.

- **Sensor**

An environmental sensor station that is co-located with a DMS. Sensors provide information such as wind speed, air temperature, precipitation, solar radiance, and roadway visibility.



- **Status Message**

For DMS, a status message allows a remote center to query the status of either a specific DMS or environmental sensor. Current operational attributes are sent to the requesting center in response to a status message being sent. For DMS, the current message being displayed will be returned in the response. For environmental sensors, the current readings for the sensor are returned.

For TMS, a status message allows a remote center to query a specific intersection. Current operational attributes are sent to the requesting center in response to a status message being sent. For intersections, the current time, values for each special function, values for each detector, and operational attributes for each ramp meter are returned in the response.

- **Subscription ID**

A unique number assigned by a local center in response to receiving a subscription request. This number allows the remote center to cancel the subscription at any time.

- **Subscription Message**

A message sent by a remote center requesting that the local center send inventory updates during some specified time period. Subscriptions can also be used to request that a local center archive its status information at some specified frequency and send that status information at a given time of day.

- **Timing Plan ID**

A unique number generated by the local center. This number is linked to a specific timing plan that is available through the C2C system to remote centers.

- **Traffic Management System (TMS)**

Traffic Management System (TMS) includes traffic signal systems, as well as other related systems which are often controlled through the traffic signal system. Other TMS infrastructure includes ramp meters and detectors.

- **Unique Request Identifier**

A unique number generated by the remote center when it sends a request to a local center. The same number generated in the request is populated in the response message to aid the remote center in linking responses to sent request messages.



2. Introduction

The functional requirements contained within this document describe what the C2C stakeholders and champions wish to see in a C2C protocol. Once the functional requirements are approved, they will be made available to the National Standards representatives for development into a protocol specification. The specification itself will conform to NTCIP 2306, National Transportation Communications for ITS Protocol, Application Profile for XML Message Encoding and Transport in ITS Center to Center Communications (NTCIP C2C XML). During specification development, the National Standards representatives will map the functional requirements for each message to messages in data dictionaries from existing national and regional standards. The data dictionaries that will be referenced include (but are not limited to):

1. STANDARDS FOR TRAFFIC MANAGEMENT CENTER TO CENTER COMMUNICATIONS, Volume I: Concept of Operations and Requirements
2. Guide to the IEEE 1512™ Family of Standards
3. NTCIP 1203 - NTCIP Object Definitions for Dynamic Message Signs (DMS)
4. NTCIP 1204 - NTCIP Environmental Sensor Station Interface Standard
5. NTCIP 1207 - NTCIP Object Definitions for Ramp Meter Control (RMC)
6. NTCIP 1209 - NTCIP Object Definitions for Transportation Sensor Systems (TSS)
7. NTCIP 1210 - NTCIP Objects for Signal System Masters

The final deliverable from the National Standards representatives will be XML schemas, data dictionaries, and electronic data files. These deliverables will be used by the software vendors to develop their respective interface modules to conform to the C2C protocol.

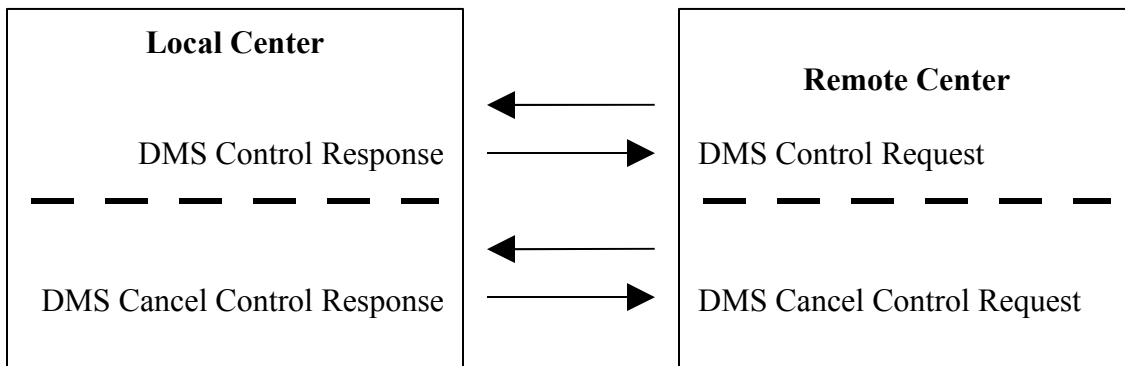
3. Dynamic Message Signs (DMS)

The Center-to-Center (C2C) System will support inter-agency DMS operations. Each agency will have the ability to request DMS messages to be displayed on signs operated by other agencies based on defined operational protocols and local center authorization. Additionally, each agency will be able to request DMS inventory information, status of each DMS, and environmental sensor data from other agencies.

Each agency will modify their existing software interface or develop a C2C interface module that will send and receive messages across the C2C network to accomplish the DMS operations. Remote centers will be able to send request messages and have them received by the local center. In turn, the local center will be able to send response messages and have them received by remote centers. The functional requirements for these messages follow:

3.1. Provide DMS Control to Remote Agencies

DMS control capability is provided to authorized remote agencies. The requirements to support this function are as follows:



3.1.1. Send DMS Control Request

- The ID of the receiving center
- The ID of the sending center
- The device ID of the DMS
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the request
- The message number for the pre-defined message that is to be displayed, or
- The specific message to be displayed
- The message page flash time
- The priority of the message being requested
- The start time for the message



- The start date for the message
- The expiration time for the message
- The expiration date for the message
- Additional information/comments

3.1.2.Receive DMS Control Request

The local center shall be capable of accepting and processing valid DMS control requests to display a pre-defined or new text message from one or more authorized remote centers.

3.1.3.Send DMS Control Response

The local center shall be capable of sending a response to the requesting center. The response to a DMS control request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The status of the request (implemented, queued, rejected)
- Additional information/comments

3.1.4.Receive DMS Control Response

The remote center shall be capable of receiving a response to a DMS control request.

3.1.5.Send DMS Cancel Control Request

The remote center shall be capable of sending a DMS cancel control request message if the center wishes to cancel a previous request to display a message. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The device ID of the DMS
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the request
- Additional information/comments

3.1.6.Receive DMS Cancel Control Request

The local center shall be capable of accepting and processing valid DMS cancel control requests to terminate a message previously requested. The local center shall display any unexpired messages based on priority.



3.1.7. Send DMS Cancel Control Response

The local center shall be capable of sending a response to the requesting center to a DMS cancel control request. The response to a DMS cancel control request shall include the following:

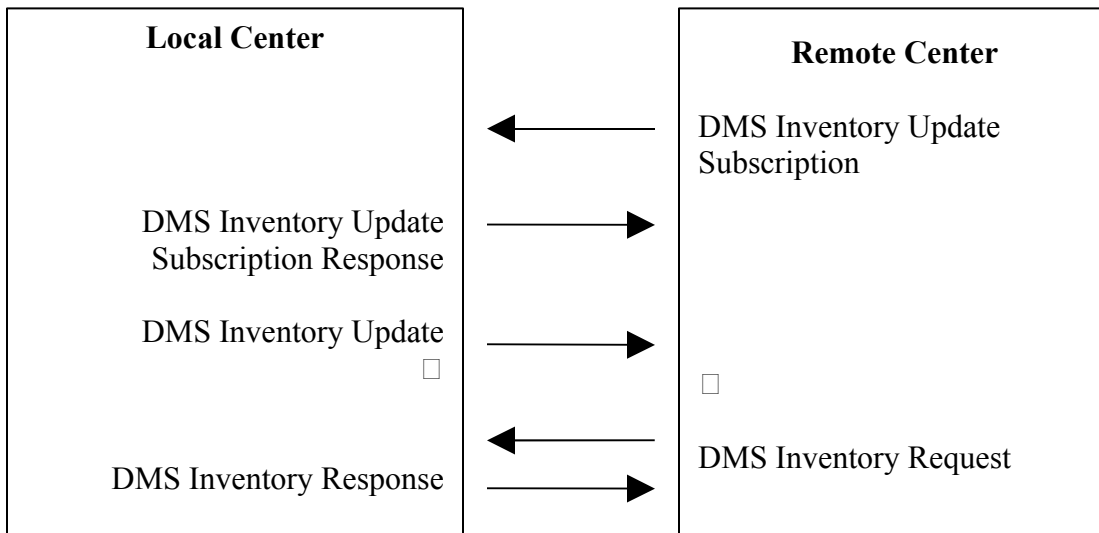
- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the cancellation request
- The status of the request (implemented, queued, rejected)
- Additional information/comments

3.1.8. Receive DMS Cancel Control Response

The remote center shall be capable of receiving a response to a DMS cancel control request.

3.2. Provide DMS Inventory Information

DMS inventory information is provided to authorized remote agencies. The requirements to support this function are as follows:



3.2.1. Send DMS Inventory Update Subscription

The remote center shall be capable of sending a DMS inventory update subscription message to each center from which it wants to receive inventory update messages. The subscription shall include the following:

- The ID of the receiving center
- The ID of the sending center



- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the subscription
- The start time of the subscription service
- The start date of the subscription service or ‘ongoing’ if subscribing to daily service
- The end time of the subscription service
- The end date of the subscription service or ‘ongoing’ if subscribing to daily service
- Subscription to DMS enabled/disabled
- Subscription to pre-defined messages enabled/disabled
- Subscription to environmental sensors enabled/disabled

3.2.2.Receive DMS Inventory Update Subscription

The local center shall be capable of accepting and processing valid DMS inventory update subscriptions.

3.2.3.Send DMS Inventory Update Subscription Response

The local center shall be capable of sending a response to the requesting center. The response to a DMS inventory update subscription shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The subscription service ID

3.2.4.Receive DMS Inventory Update Subscription Response

The remote center shall be capable of receiving a response to a DMS inventory update subscription.

3.2.5.Send DMS Inventory Update

The local center shall be capable of sending a DMS inventory update message to all subscribing remote centers upon DMS, pre-defined messages, and environmental sensors being added, removed, or changed. Messages shall only be sent between the start and end times of the subscription service. The update message shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name making the update
- The contact information (name, phone number, pager, email address) for the owning center



(repeated for each pre-defined message)

- Type of update: addition, removal, change
- The message number for each pre-defined message that has been added, removed, or changed
- The message content for the corresponding message number

(repeated for each DMS)

- Type of update: addition, removal, change
- The device ID of each DMS that has been added, removed, or changed
- The location of the device (longitude and latitude)
- The road name the sign is on
- The direction of travel the sign faces
- The sign make and model
- The sign type (VMS, CMS, BOS) and technology (LED, flip-disk, fiber optic)
- The number of lines supported, if any
- The number of characters supported, if any
- The number of scroll pages supported, if any

(repeated for each sensor)

- Type of update: addition, removal, change
- The device ID of each environmental sensor that has been added, removed, or changed
- The location of the device (longitude and latitude)
- The elevation of the sensor
- The road name the sensor is on
- The sensor description/purpose

3.2.6.Receive DMS Inventory Update

The remote center shall be capable of receiving a DMS inventory update message.

3.2.7.Send DMS Inventory Request

The remote center shall be capable of sending a DMS inventory request message to other centers upon connecting to the C2C network. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the request

3.2.8.Receive DMS Inventory Request

The local center shall be capable of accepting and processing valid DMS inventory requests.



3.2.9. Send DMS Inventory Response

The local center shall be capable of sending a response to the requesting center. The response to a DMS inventory request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The contact information (name, phone number, pager, email address) for the owning center

(repeated for each pre-defined message)

- The message number for each pre-defined message
- The message content for the corresponding message number

(repeated for each DMS)

- The device ID of each DMS
- The location of the device (longitude and latitude)
- The road name the sign is on
- The direction of travel the sign faces
- The sign make and model
- The sign type (VMS, CMS, BOS) and technology (LED, flip-disk, fiber optic)
- The number of lines supported, if any
- The number of characters supported, if any
- The number of scroll pages supported, if any

(repeated for each sensor)

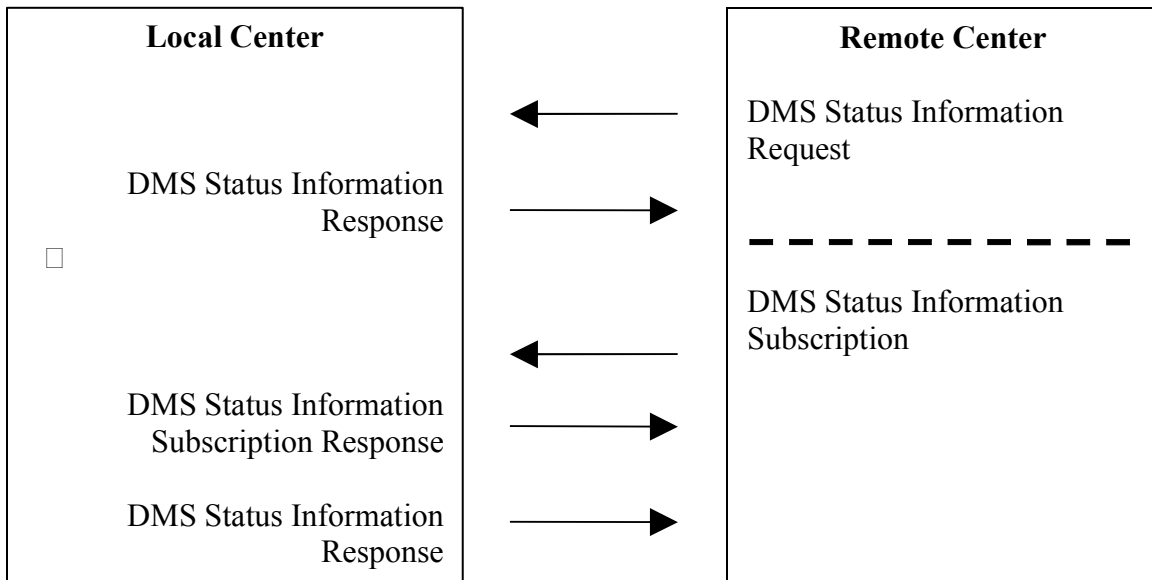
- The device ID of each environmental sensor
- The location of the device (longitude and latitude)
- The elevation of the sensor
- The road name the sensor is on
- The sensor description/purpose

3.2.10. Receive DMS Inventory Response

The remote center shall be capable of receiving a response to a DMS inventory request.

3.3. Provide DMS Status Information

DMS status information is provided to authorized remote agencies. The requirements to support this function are as follows:



3.3.1. Send DMS Status Information Request

The remote center shall be capable of sending a DMS status information request message to the local center that controls a sign that is being queried. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The device ID of the DMS
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the request

3.3.2. Receive DMS Status Information Request

The local center shall be capable of accepting and processing valid DMS status information requests.

3.3.3. Send DMS Status Information Response

The local center shall be capable of sending a response to the requesting center. The response to a DMS status information request shall include the following:

- The ID of the receiving center
- The ID of the sending center



- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The operational status of the device (on, off, failed)
- The message currently being displayed on the sign
- The name of the agency which put the message on the sign
- The priority of the message currently being displayed on the sign
- The start time of the message currently being displayed on the sign
- The start date of the message currently being displayed on the sign
- The expiration time of the message currently being displayed on the sign
- The expiration date of the message currently being displayed on the sign

3.3.4.Receive DMS Status Information Response

The remote center shall be capable of receiving a response to a DMS status information request.

3.3.5.Send DMS Status Information Subscription

The remote center shall be capable of sending a DMS status information subscription message to each center from which it wants to receive status update messages. The subscription shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the subscription
- The start time of the subscription service
- The start date of the subscription service or ‘ongoing’ if subscribing to daily service
- The end time of the subscription service
- The end date of the subscription service or ‘ongoing’ if subscribing to daily service

3.3.6.Receive DMS Status Information Subscription

The local center shall be capable of accepting and processing valid DMS status information subscriptions.

3.3.7.Send DMS Status Information Subscription Response

The local center shall be capable of sending a response to the requesting center. The response to a DMS status information subscription shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request



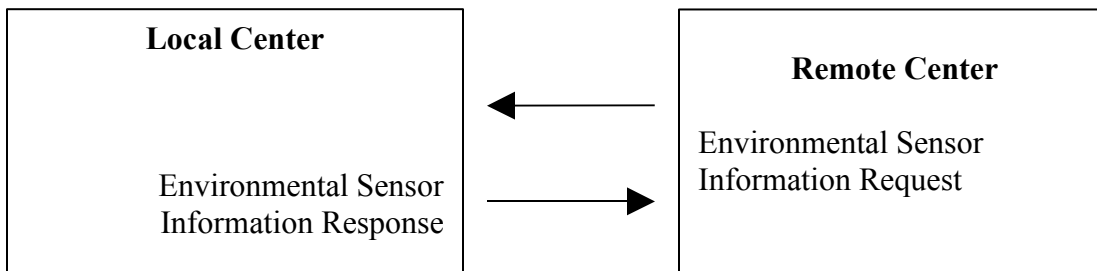
- The name of the operator at the local center acting on the request
- The subscription service ID

3.3.8. Receive DMS Status Information Subscription Response

The remote center shall be capable of receiving a response to a DMS status information subscription.

3.4. Provide Environmental Sensor Information

Environmental sensor information is provided to authorized remote agencies. The requirements to support this function are as follows:



3.4.1. Send Environmental Sensor Information Request

The remote center shall be capable of sending an environmental sensor information request message to the local center that controls a sensor that is being queried. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The device ID of the environmental sensor
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the request

3.4.2. Receive Environmental Sensor Information Request

The local center shall be capable of accepting and processing valid environmental sensor information requests.

3.4.3. Send Environmental Sensor Information Response

The local center shall be capable of sending a response to the requesting center. The response to an environmental sensor information request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier



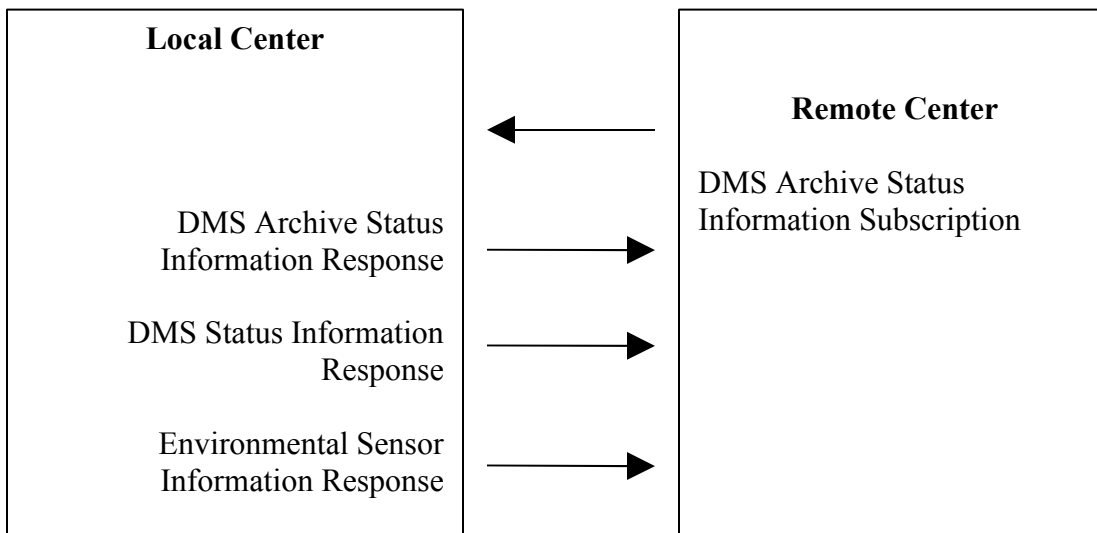
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The operational status of the device (on, off, failed)
- The indications of wind speed, direction, and gusting
- The indications of air temperature
- The indications of precipitation
- The indications of solar radiance
- The indications of roadway visibility from fog, smoke, dust, etc

3.4.4. Receive Environmental Sensor Information Response

The remote center shall be capable of receiving a response to an environmental sensor information request.

3.5. Archive Status Information Subscription

DMS status information can be archived by local centers at the request of a remote center. The requirements to support this function are as follows:



3.5.1. Send DMS Archive Status Information Subscription

The remote center shall be capable of sending a DMS archive status information subscription message to each center from which it wants to receive status updates. The subscription shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the subscription



- The start time of the archival period
- The start date of the archival period or ‘ongoing’ if subscribing to daily archival
- The end time of the archival period
- The end date of the archival period or ‘ongoing’ if subscribing to daily archival
- Archival frequency (how often status information should be archived)
- The send time (when the archived data should be sent to the requesting center)
- The send date (when the archived data should be sent to the requesting center) or ‘ongoing’ if subscribing to daily archival
- Subscription to DMS status information enabled/disabled
- Subscription to environmental status information enabled/disabled

3.5.2. Receive DMS Archive Status Information Subscription

The local center shall be capable of accepting and processing valid DMS archive status information subscriptions.

3.5.3. Send DMS Archive Status Information Response

The local center shall be capable of sending a response to the requesting center. The response to a DMS archive status information subscription shall include the following:

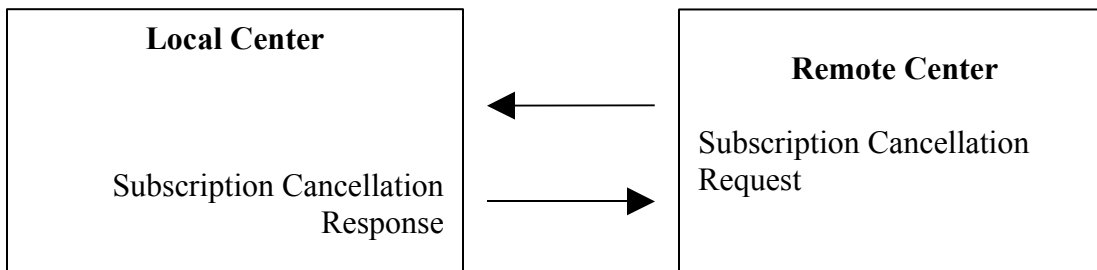
- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The subscription service ID

3.5.4. Receive DMS Archive Status Information Response

The remote center shall be capable of receiving a response to a DMS archive status information subscription.

3.6. Provide Subscription Cancellation

Remote agencies may cancel subscription services with the local center. The requirements to support this function are as follows:





3.6.1. Send Subscription Cancellation Request

The remote center shall be capable of sending a subscription cancellation request message to the local center when it wishes to cancel a subscription service previously started. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The subscription service ID
- The security attribute (user name and password)
- The operator and agency name making the request

3.6.2. Receive Subscription Cancellation Request

The local center shall be capable of accepting and processing valid subscription cancellation requests.

3.6.3. Send Subscription Cancellation Response

The local center shall be capable of sending a response to the requesting center. The response to a subscription cancellation shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The subscription service ID
- The operator and agency name in the request
- The name of the operator at the local center acting on the cancellation request
- The status of the request (implemented, queued, rejected)
- Additional information/comments

3.6.4. Receive Subscription Cancellation Response

The remote center shall be capable of receiving a response to a subscription cancellation request.



4. Traffic Management Systems (TMS)

The Center-to-Center (C2C) System will support inter-agency TMS operations. Each agency will have the ability to request inventory information for all intersections in a TMS, information for a specific intersection, and details of a timing plan for a specific intersection. Additionally, each agency will be able to control an intersection and query its status based on defined operational protocols and local center authorization.

Each agency will modify their existing software interface or develop a C2C interface module that will send and receive messages across the C2C network to accomplish the TMS operations. Remote centers will be able to send request messages and have them received by the local center. In turn, the local center will be able to send response messages and have them received by remote centers.

It should be noted that the messages have been generally divided into types for information gathering, control, and status. The information gathering messages can collect information about the system in three steps, in order to minimize the amount of irrelevant information that must be transmitted to a remote center interested only in a very specific area. The three message types are as follows:

1. **Inventory** – This includes only a listing of intersections on the subject system, along with location and key identifying information for each.
2. **Intersection Information** – This includes details about one specific intersection, such as detector IDs and locations, overlaps, special functions, and a listing of descriptions for the available timing plans.
3. **Timing Plan Details** – This includes details about a specific timing plan at a specific intersection, such as cycle length, offset, and phase descriptions.

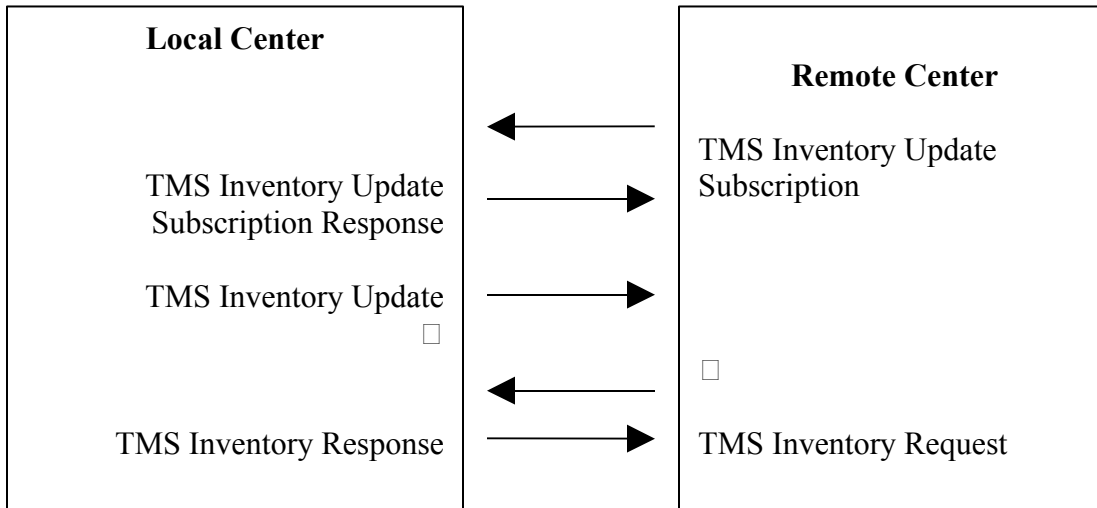
Since each information gathering message type provides more detailed information about a narrower target list, remote centers can focus on only the information that is relevant to their operations, but, if desired, can still request a wide range of information by sending multiple request messages.

Control and status messages, by their nature, are directed at specific intersections, and so the layered approach is not necessary in those cases.

The functional requirements for all TMS messages follow:

4.1. Provide TMS Inventory to Remote Agencies

TMS inventory capability is provided to authorized remote agencies. The requirements to support this function are as follows:



4.1.1. Send TMS Inventory Update Subscription

The remote center shall be capable of sending a TMS inventory update subscription message to each center from which it wants to receive inventory update messages. Note that an inventory update is a listing of those inventory items (intersections) which are added, removed, or changed. A base condition of all existing intersections on a system would be obtained as a one-time request, rather than a subscription, using the “TMS Inventory Request” message, described in Section 4.1.7.

The subscription shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the subscription
- The start time of the subscription service
- The start date of the subscription service or ‘ongoing’ if subscribing to daily service
- The end time of the subscription service
- The end date of the subscription service or ‘ongoing’ if subscribing to daily service
- Subscription to intersections enabled/disabled
- Subscription to overlaps enabled/disabled
- Subscription to special functions enabled/disabled

4.1.2. Receive TMS Inventory Update Subscription

The local center shall be capable of accepting and processing valid TMS inventory update subscriptions.

4.1.3. Send TMS Inventory Update Subscription Response



The local center shall be capable of sending a response to the requesting center. The response to a TMS inventory update subscription shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The subscription service ID

4.1.4.Receive TMS Inventory Update Subscription Response

The remote center shall be capable of receiving a response to a TMS inventory update subscription.

4.1.5.Send TMS Inventory Update

The local center shall be capable of sending a TMS inventory update message to all subscribing remote centers upon intersections being added, removed, or changed. The update message shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name making the update
- The contact information (name, phone number, pager, email address) for the owning center

(repeated for each intersection)

- Type of update: addition, removal, or change
- The ID for each intersection that has been added, removed, or changed
- The intersection description (name of each street at the intersection)
- The ID of the section that the intersection is part of, if any
- The ID of the zone that the intersection is part of, if any
- The location of the intersection (longitude and latitude)

(repeated for each overlap)

- Type of update: addition, removal, or change
- The number for each overlap that has been added, removed, or changed
- The overlap description

(repeated for each special function)

- Type of update: addition, removal, or change
- The number for each special function (usually 1 through 8)
- The definition of each special function



4.1.6.Receive TMS Inventory Update

The remote center shall be capable of receiving a TMS inventory update message.

4.1.7.Send TMS Inventory Request

The remote center shall be capable of sending a TMS inventory request message to other centers upon connecting to the C2C network. The request shall include the following information:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The security attribute (user name and password)
- The operator and agency name making the request

4.1.8.Receive TMS Inventory Request

The local center shall be capable of accepting and processing valid TMS inventory requests.

4.1.9.Send TMS Inventory Response

The local center shall be capable of sending a response to the requesting center. The response to a TMS inventory request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The contact information (name, phone number, pager, email address) for the owning center

(repeated for each intersection)

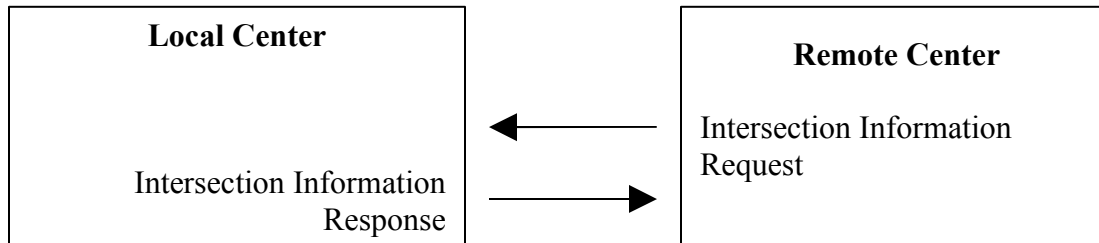
- The ID for each intersection
- The intersection description (name of each street at the intersection)
- The ID of the section that the intersection is a part of, if any
- The ID of the zone that the intersection is a part of, if any
- The location of the intersection (longitude and latitude)

4.1.10.Receive TMS Inventory Response

The remote center shall receive responses to TMS inventory requests.

4.2. Provide Intersection Information to Remote Agencies

Intersection information capability is provided to authorized remote agencies. The requirements to support this function are as follows:



4.2.1. Send Intersection Information Request

The remote center shall be capable of sending an intersection information request message to other centers when it wishes to request detailed information for that intersection. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The ID of the intersection
- The unique request identifier
- The security attribute (user name and password)
- The operator and agency name making the request

4.2.2. Receive Intersection Information Request

The local center shall be capable of accepting and processing valid intersection information requests.

4.2.3. Send Intersection Information Response

The local center shall be capable of sending a response to the requesting center. The response to an intersection information request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The ID of the section that the intersection is a part of, if any
- The ID of the zone that the intersection is a part of, if any
- The location of the intersection (longitude and latitude)
- Time source used by the intersection (GPS, UTC)

(in the case of a ramp meter)



- The name of the nearest major cross street to the ramp meter
- The direction of travel the ramp meter controls
- The number of lanes controlled by the ramp meter

(repeated for each timing plan)

- The ID of each timing plan defined for the intersection
- The description of the timing plan

(repeated for each scheduled activity)

- The start time for each scheduled activity
- The stop time for each scheduled activity
- The ID of the timing plan for each scheduled activity

(repeated for each detector)

- The device ID of each detector at the intersection
- The location of the device (longitude and latitude)
- The lane the detector is monitoring
- The setback from stopbar
- The type of detector (speed, volume, occupancy)

(repeated for each overlap)

- The number for each overlap
- The overlap description

(repeated for each special function)

- The number for each special function (usually 1 through 8)
- The definition of each special function

(repeated for each controller log entry during the last 24 hours)

- The time and date for each controller log entry
- The controller log entry

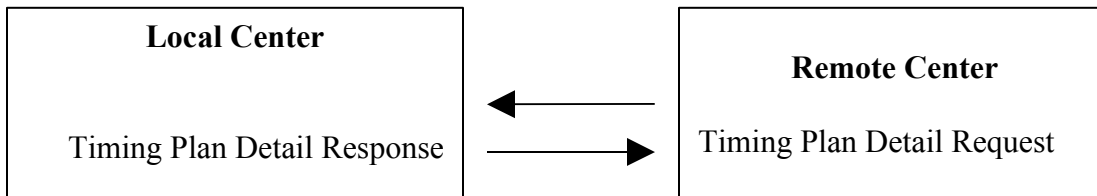
4.2.4.Receive Intersection Information Response

The remote center shall be capable of receiving responses to intersection information requests.



4.3. Provide Timing Plan Details to Remote Agencies

Timing plan detail capability is provided to authorized remote agencies. The requirements to support this function are as follows:



4.3.1. Send Timing Plan Detail Request

The remote center shall be capable of sending a timing plan detail request message to other centers when it wishes to request detailed information for that timing plan. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The ID of the intersection
- The ID of a timing plan defined for the intersection
- The unique request identifier
- The security attribute (user name and password)
- The operator and agency name making the request

4.3.2. Receive Timing Plan Detail Request

The local center shall be capable of accepting and processing valid timing plan detail requests.

4.3.3. Send Timing Plan Detail Response

The local center shall be capable of sending a response to the requesting center. The response to a timing plan detail request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The cycle length
- The offset
- The number of phases

(repeated for each phase)



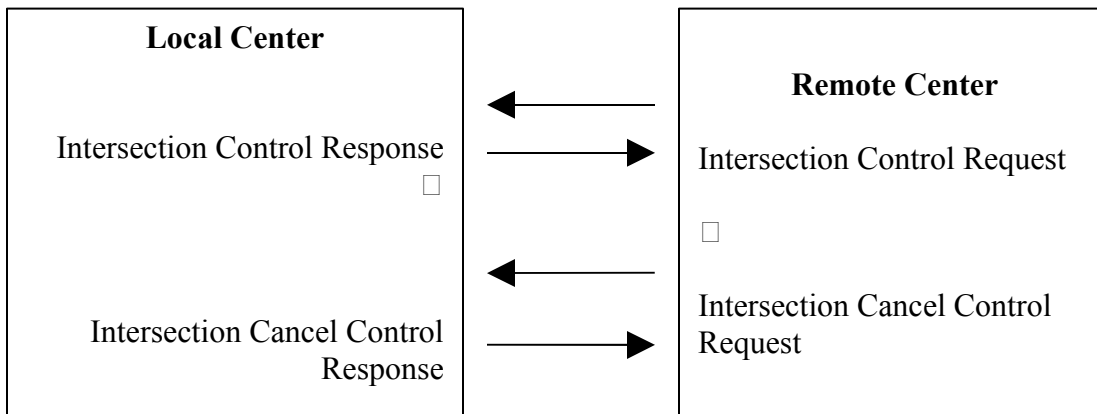
- The movement for each phase (NBT, NBL, NBR, etc)
- The split for each phase

4.3.4.Receive Timing Plan Detail Response

The remote center shall be capable of receiving responses to timing plan detail requests.

4.4.Provide Intersection Control to Remote Agencies

Intersection control capability is provided to authorized remote agencies. The requirements to support this function are as follows:



4.4.1.Send Intersection Control Request

The remote center shall be capable of sending an intersection control request message to the local center that owns the intersection to be controlled. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The ID of the intersection
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the request
- The start time for the control request
- The start date for the control request
- The expiration time for the control request
- The expiration date for the control request
- The timing plan number to run, if any

(in the case of a ramp meter)

- The new state of the ramp meter (on or off)
- The volume/rate to set for the ramp meter



(repeated for each special function, if any)

- The number of the special function to set
- The new value for the special function (on or off)

- Additional information/comments

4.4.2.Receive Intersection Control Request

The local center shall be capable of accepting and processing valid intersection control requests to control an intersection from authorized remote centers.

4.4.3.Send Intersection Control Response

The local center shall be capable of sending a response to the requesting center. The response to an intersection control request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The status of the request (implemented, queued, rejected)
- Additional information/comments

4.4.4.Receive Intersection Control Response

The remote center shall be capable of receiving a response to an intersection control request.

4.4.5.Send Intersection Cancel Control Request

The remote center shall be capable of sending an intersection cancel control request message if the center wishes to cancel a previous timing plan change. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The ID of the intersection
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the request
- Additional information/comments

4.4.6.Receive Intersection Cancel Control Request



The local center shall be capable of accepting and processing valid intersection cancel control requests to terminate a timing plan previously requested. The local center shall revert to the previously scheduled timing plan.

4.4.7. Send Intersection Cancel Control Response

The local center shall be capable of sending a response to the requesting center. The response to an intersection cancel control request shall include the following:

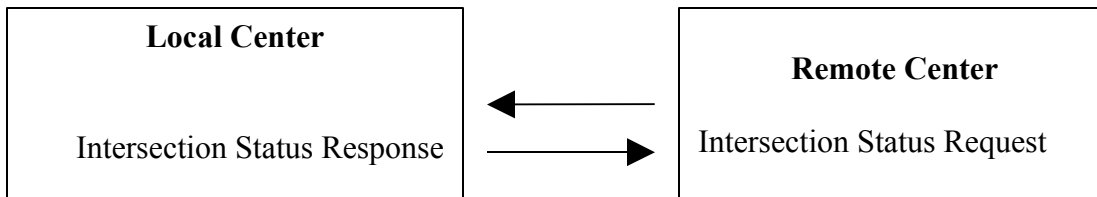
- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the cancellation request
- The status of the request (implemented, queued, rejected)
- Additional information/comments

4.4.8. Receive Intersection Cancel Control Response

The remote center shall be capable of receiving a response to an intersection cancel control request.

4.5. Provide Intersection Status to Remote Agencies

Intersection status is provided to authorized remote agencies. The requirements to support this function are as follows:



4.5.1. Send Intersection Status Request

The remote center shall be capable of sending an intersection status request message to the local center that controls an intersection that is being queried. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The ID of the intersection
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the request

4.5.2. Receive Intersection Status Request



The local center shall be capable of accepting and processing valid intersection status requests.

4.5.3. Send Intersection Status Response

The local center shall be capable of sending a response to an intersection status request. The response to an intersection status request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The operational status of the controller (on, off, free, flash)
- The ID of the timing plan that is running, if any
- The current time in the controller
- The current time at central
- The current Coordinated Universal Time (UTC)
- The battery backup status

(in the case of a ramp meter)

- The status of the ramp meter (on, off, fail)
- The volume/rate for the ramp meter

(repeated for each special function)

- The number of each special function
- The value for each special function

(repeated for each detector)

- The ID of each detector
- The value for each detector

4.5.4. Receive Intersection Status Response

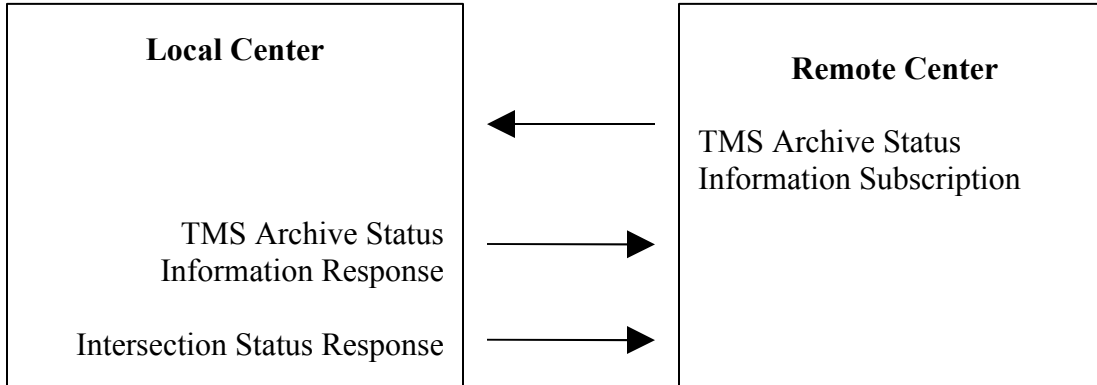
The remote center shall be capable of receiving a response to an intersection status request.

4.6. Archive Status Information Subscription

TMS status information can be archived by local centers at the request of a remote center. Any remote center can make such a request. However, it is envisioned that this function would be employed only by the Regional Archive Data Server (RADS), as other centers would not have a need to request archive status subscriptions of neighboring jurisdictions. The security attribute provides a means of limiting such subscriptions to the RADS user, if local center operators perceive this as a concern.



The requirements to support this function are as follows:



4.6.1. Send TMS Archive Status Information Subscription

The remote center shall be capable of sending a TMS archive status information subscription message to each center from which it wants to receive status updates. The subscription shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The unique request identifier assigned by the requesting center
- The security attribute (user name and password)
- The operator and agency name making the subscription
- The start time of the archival period
- The start date of the archival period or ‘ongoing’ if subscribing to daily archival
- The end time of the archival period
- The end date of the archival period or ‘ongoing’ if subscribing to daily archival
- Archival frequency (how often status information should be archived)
- The send time (when the archived data should be sent to the requesting center)
- The send date (when the archived data should be sent to the requesting center) or ‘ongoing’ if subscribing to daily archival

4.6.2. Receive TMS Archive Status Information Subscription

The local center shall be capable of accepting and processing valid TMS archive status information subscriptions.

4.6.3. Send TMS Archive Status Information Response

The local center shall be capable of sending a response to the requesting center. The response to a TMS archive status information subscription shall include the following:

- The ID of the receiving center
- The ID of the sending center



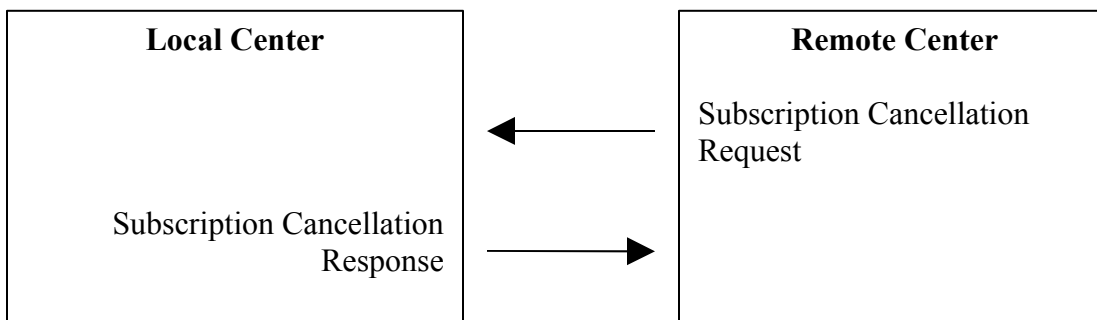
- The unique request identifier
- The operator and agency name in the request
- The name of the operator at the local center acting on the request
- The subscription service ID

4.6.4.Receive TMS Archive Status Information Response

The remote center shall be capable of receiving a response to a TMS archive status information subscription.

4.7.Provide Subscription Cancellation

Remote agencies may cancel subscription services with the local center. The requirements to support this function are as follows:



4.7.1.Send Subscription Cancellation Request

The remote center shall be capable of sending a subscription cancellation request message to the local center when it wishes to cancel a subscription service previously started. The request shall include the following:

- The ID of the receiving center
- The ID of the sending center
- The subscription service ID
- The security attribute (user name and password)
- The operator and agency name making the request

4.7.2.Receive Subscription Cancellation Request

The local center shall be capable of accepting and processing valid subscription cancellation requests.

4.7.3.Send Subscription Cancellation Response

The local center shall be capable of sending a response to the requesting center. The response to a subscription cancellation shall include the following:

- The ID of the receiving center
- The ID of the sending center



- The subscription service ID
- The operator and agency name in the request
- The name of the operator at the local center acting on the cancellation request
- The status of the request (implemented, queued, rejected)
- Additional information/comments

4.7.4. Receive Subscription Cancellation Response

The remote center shall be capable of receiving a response to a subscription cancellation request.



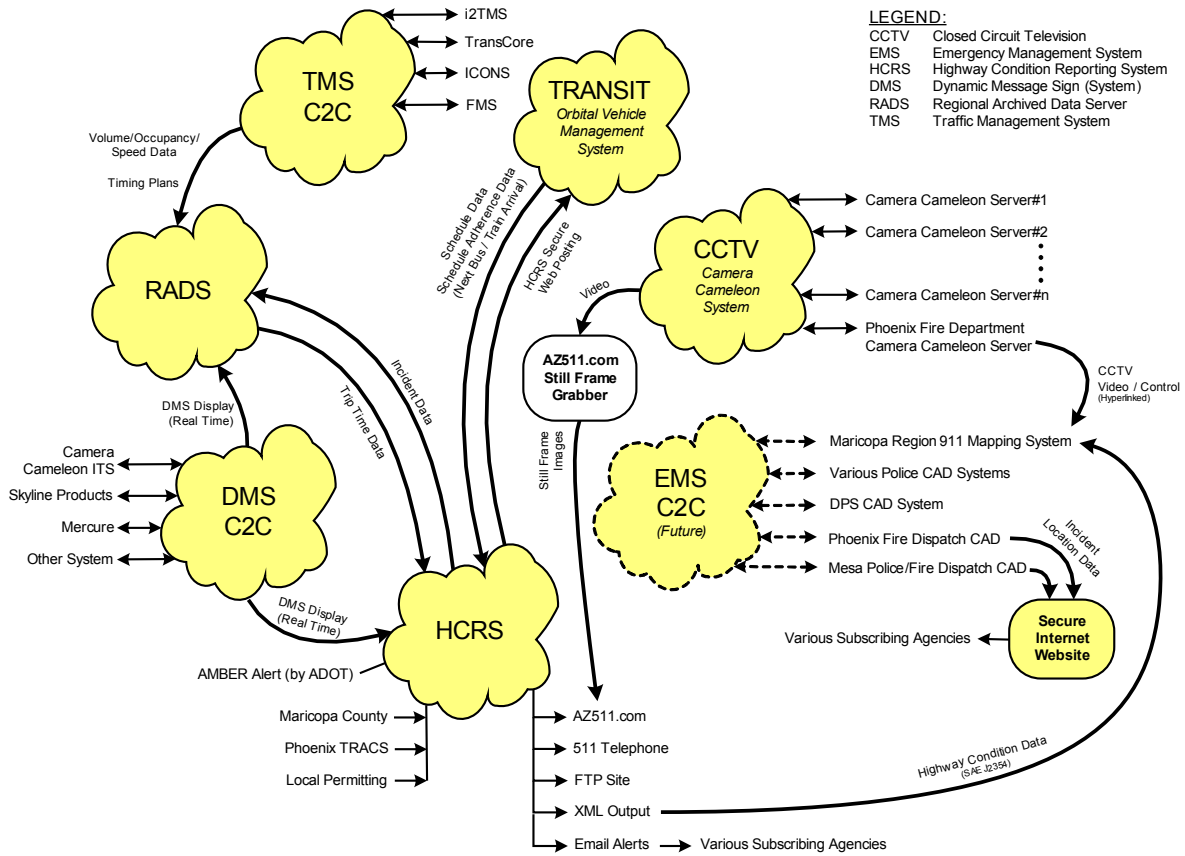
5. Interface Module / Software Background

5.1. System Architecture

The Center-to-Center (C2C) System will support inter-agency sharing of information and control of transportation and public safety systems. The C2C System consists of seven key components:

- DMS – Dynamic Message Signs
- CCTV – Closed Circuit Television
- TMS – Traffic Management Systems
- HCRS – Highway Condition Reporting System
- TRANSIT – Orbital Vehicle Management System
- RADS – Regional Archived Data Server
- EMS – Emergency Management System

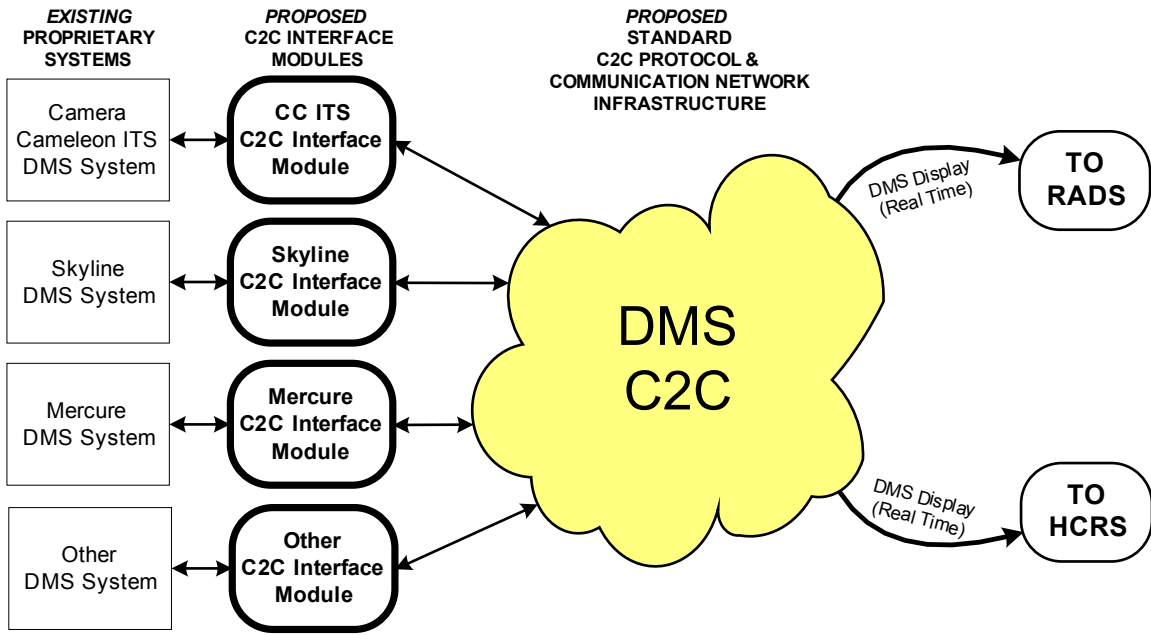
The following diagram shows each component in the C2C System and communication links between each component:



Each component in the C2C network includes the existing proprietary software systems that control the end system (DMS, intersection controller, ramp meter, detector, etc). In each component, the C2C “cloud” is a network that allows the systems to communicate with other systems using a standard C2C protocol. Software vendors will develop C2C interface modules to translate information and control from their systems into the standard C2C protocol.

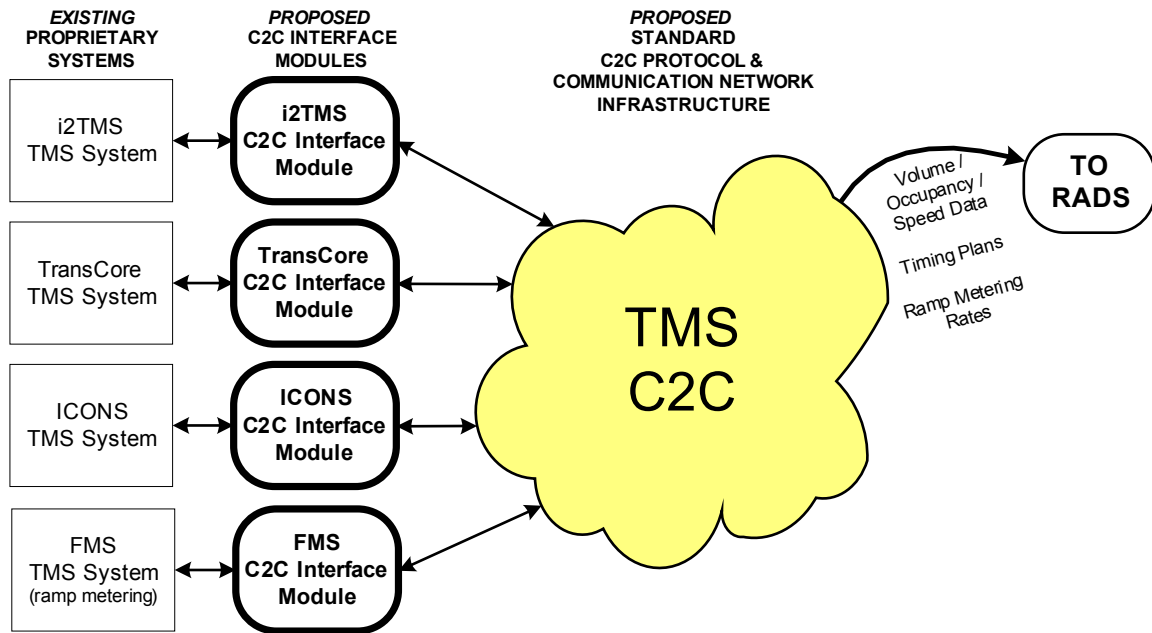
5.2.DMS Component

The DMS Component provides for the sharing of DMS information and posting of DMS messages using Camera Cameleon, Skyline, Mercure, and any other DMS system connected to the DMS C2C network that supports the DMS C2C protocol. DMS messages can be made available with the RADS and HCRS systems. The following diagram shows the DMS component with its proprietary systems, proposed C2C interface modules, C2C network, and links to RADS and HCRS:



5.3.TMS Component

The TMS Component provides for the sharing of traffic information and control of ramp meters, detectors, and intersection controllers using i2TMS, TransCore, ICONS, FMS, and any other TMS system connected to the TMS C2C network that supports the TMS C2C protocol. Detector data and timing plans will be shared with the RADS system. The following diagram shows the TMS component with its proprietary systems, proposed C2C interface modules, C2C network, and link to RADS:





6. Interface Module / Software Requirements

In support of creating the C2C System, each software vendor will be responsible for modifying their existing systems or creating new interface modules to provide the translation between their own system and the standard C2C protocol. The requirements for implementing the interface modules follow:

6.1.General

6.1.1.Logging

6.1.1.1.All C2C request messages that are sent or received shall be logged to a database or flat file at each center. The recommended database systems include MS Access, SQL Server, and Oracle. The recommend flat file format is comma-delimited (CSV). The log entries should contain the time and date of the request, the operator and agency name making the request, and all of the attributes making up the incoming or outgoing request. It is recommended that log files be kept for a minimum of 24 hours. The actual duration shall be determined by the software vendor for each center system based on the storage capacity and bandwidth they will have in their database system.

6.1.2.Maps

6.1.2.1.Existing maps shall be capable of being extended into neighboring jurisdictions to allow for TMS and DMS components from remote agencies to be displayed. The extent of mapping required for each system will be determined by each jurisdiction.

6.1.3.C2C Network

6.1.3.1.Every center shall have a unique ID that corresponds to a server name or IP address.
6.1.3.2.Every center shall maintain a list mapping all center IDs in the C2C network with their server names and/or IP addresses.

6.1.4.Security

6.1.4.1.Every user from a center should receive pre-authorization prior to sending and receiving messages with neighboring centers.
6.1.4.2.Pre-authorization includes registering unique user names and associated passwords with each remote center the local center wishes to communicate with.
6.1.4.3.The user names shall be in the format:
“center ID”.”first name”.”last name” -- user name assigned for a person
“center ID”.”facility name” -- user name assigned for a facility
Center IDs consist of numbers only. User names must contain alphanumeric characters only. No spaces are allowed.



6.1.4.4. Each user name shall have the following permission levels enabled or disabled by the authorizing center:

- Inventory – when enabled, the user will be able to request inventory information and subscribe to inventory updates
- Status – when enabled, the user will be able to query DMS and TMS components
- Control – when enabled, the user will be able to request control of DMS and TMS components

6.1.5. Requesting Messages

6.1.5.1. Every request message shall contain the unique ID of the sending center as well as the unique ID of the receiving center.

6.1.5.2. When sending request messages, every center shall generate a unique request ID and include this ID in the request message.

6.1.5.3. This request identifier shall be communicated back by responding centers so that it provides a means for matching responses to requests.

6.1.5.4. The unique request ID shall consist of the center ID followed by a unique sequence number generated by the requesting center.

6.1.5.5. Every request message should contain the operator's name (first and last) and agency name.

6.1.6. Responding to Messages

6.1.6.1. Responding to request messages may either be automatic by each center's interface module (software) or be done on a request-by-request basis by an operator at the responding center. After hours operations should provide for some level of automatic response to facilitate C2C communication.

6.1.6.2. Every response message shall contain the unique ID of the sending center as well as the unique ID of the receiving center.

6.1.6.3. Every response message shall include the unique request identifier, operator name, and agency name from the request message.

6.1.6.4. Every response message shall include the name of the operator at the responding center who is acting on the request. The name shall be the actual person or "automatic" if the response was done automatically via the interface module.

6.1.6.5. When responding to a request for status, the responding center shall ensure that the response data is current. If necessary, the responding center should query the DMS or TMS component to update its data prior to responding to a status request.

6.1.6.6. When sending out an inventory update message, the inventory update message should only contain information that was subscribed for by the requesting center.



6.1.7. Listening for Messages

- 6.1.7.1. Every center shall be capable of “listening” for requests or subscriptions sent by remote centers.
- 6.1.7.2. Every center shall be capable of “listening” for response messages after it issues request or subscription messages to one or more centers.

6.1.8. Connectivity

- 6.1.8.1. Every center shall be capable of posting "No Communication" messages on the interface module user interface to indicate any devices that are not active and/or responding.
- 6.1.8.2. Every time the interface module communicates with a DMS or TMS component, the device time should be updated if it is not in sync with the interface module and/or central system.

6.2. DMS

6.2.1. User Interface

- 6.2.1.1. Every center shall be capable of providing a way to specify and send a DMS control request.
- 6.2.1.2. Every center shall be capable of providing a way to specify and send a DMS cancel control request.
- 6.2.1.3. Every center shall be capable of providing a way to specify and send a DMS inventory update subscription.
- 6.2.1.4. Every center shall be capable of providing a way to specify and send a DMS inventory request.
- 6.2.1.5. Every center shall be capable of providing a way to specify and send a DMS status information request.
- 6.2.1.6. Every center shall be capable of providing a way to specify and send a DMS status information subscription.
- 6.2.1.7. Every center shall be capable of providing a way to specify and send an environmental sensor information request.
- 6.2.1.8. Every center shall be capable of providing a way to specify and send a DMS archive status information subscription request.
- 6.2.1.9. Every center shall be capable of providing a way to specify and send a DMS subscription cancellation request.
- 6.2.1.10. Every center shall be capable of providing a way for operators to view received messages and specify and send response messages.
- 6.2.1.11. Every center shall be capable of providing a way to log into the C2C network with a unique user name and password.

6.2.2. Inventory



- 6.2.2.1.Each center shall be capable of maintaining a list of IDs representing each DMS they control.
- 6.2.2.2.Each center shall be capable of maintaining a list of numbers for each pre-defined message used on their DMS systems.
- 6.2.2.3.Each center shall be capable of maintaining a list of IDs representing each environmental sensor they control.
- 6.2.2.4.While these IDs and numbers need not be unique among all centers, they should be unique within each center.

6.2.3.DMS Message Queue

- 6.2.3.1.Each center shall be capable of maintaining a list of messages queued for display on their DMS.
- 6.2.3.2.The priority of each message, start and expiration time and date, and name of the agency requesting the message should be kept in the list.
- 6.2.3.3.Messages should be displayed on the DMS based on priority and start and expiration time and date.

6.2.4.DMS Control Messages

- 6.2.4.1.A DMS control request message can contain either a pre-defined message (number) or a text message to be displayed on the other center's DMS.
- 6.2.4.2.Priorities in DMS control request messages range from 1 to 5 with 1 being the highest.
- 6.2.4.3.When a DMS control request message is received, the interface module or operator shall examine the request and send back a response message identifying if the request was implemented, queued for implementation, or rejected.
- 6.2.4.4.If a text message in a request is too long for the designated sign, the receiving center should simply reject the message and identify the reason in the additional comments field in the response.

6.2.5.DMS Cancel Control Messages

- 6.2.5.1.If a DMS message is cancelled or otherwise expires, the center shall be capable of displaying any unexpired messages it has queued based on priority.

6.2.6.DMS Inventory Messages

- 6.2.6.1. Every DMS center shall be capable of sending a DMS inventory update message to each subscribing center in the C2C network. The update message shall be sent when DMS, pre-defined messages, or environmental sensors are added, changed, or removed.
- 6.2.6.2. When a DMS center is connected to the C2C network, it shall be capable of sending a message to all remote centers requesting their inventory information.





6.3.TMS

6.3.1.User Interface

- 6.3.1.1. Every center shall be capable of providing a way to specify and send a TMS inventory update subscription.
- 6.3.1.2. Every center shall be capable of providing a way to specify and send a TMS inventory request.
- 6.3.1.3. Every center shall be capable of providing a way to specify and send an intersection information request.
- 6.3.1.4. Every center shall be capable of providing a way to specify and send a timing plan detail request.
- 6.3.1.5. Every center shall be capable of providing a way to specify and send an intersection control request.
- 6.3.1.6. Ideally, graphical user interface buttons should be provided to simplify setting a timing plan for a specific set of signals or intersections based on a predefined incident (e.g., freeway closure).
- 6.3.1.7. Every center shall be capable of providing a way to specify and send an intersection cancel control request.
- 6.3.1.8. Every center shall be capable of providing a way to specify and send an intersection status request.
- 6.3.1.9. Every center shall be capable of providing a way to specify and send a TMS archive status information subscription request.
- 6.3.1.10. Every center shall be capable of providing a way to specify and send a TMS subscription cancellation request.
- 6.3.1.11. Every center shall be capable of providing a way for operators to view received messages and specify and send response messages.
- 6.3.1.12. Every center shall be capable of providing a way to login to the C2C network with a unique user name and password.

6.3.2.Inventory

- 6.3.2.1. Each center shall be capable of maintaining a list of IDs for each intersection/ramp meter they control.
- 6.3.2.2. Each center shall be capable of maintaining a list of special functions for each intersection.
- 6.3.2.3. Each center shall be capable of maintaining a list of overlaps for each intersection.
- 6.3.2.4. Each center shall be capable of maintaining a list of timing plans defined for each intersection.
- 6.3.2.5. Each center shall be capable of maintaining a list of schedules for each intersection.
- 6.3.2.6. Each center shall be capable of maintaining a list of detectors for each intersection.



6.3.2.7. While these IDs and numbers need not be unique among all centers, they should be unique within each center.

6.3.3. TMS Inventory Messages

6.3.3.1. Every TMS center shall be capable of sending a TMS inventory update message to each subscribing center in the C2C network. The update message shall be sent when intersections are added, changed, or removed.

6.3.3.2. When a TMS center is connected to the C2C network, it should send a message to all remote centers requesting their inventory information.

6.3.4. Intersection Information Messages

6.3.4.1. When a TMS center wishes to have more detailed information for an intersection, it shall be capable of sending an intersection inventory request message to the specific center who owns the intersection.

6.3.5. Timing Plan Details Messages

6.3.5.1. When a TMS center wishes to have more detailed information for a timing plan, it shall be capable of sending a timing plan detail request message to the specific center who owns the intersection with the desired timing plan.

6.3.6. Intersection Control Messages

6.3.6.1. An intersection control request message can contain a timing plan to set (run), a ramp meter volume/rate to change, and/or a special function to set.

6.3.6.2. When an intersection control request message is received, the interface module or operator should examine the request and send back a response message identifying if the request was implemented, queued for implementation, or rejected.

6.3.7. Intersection Cancel Control Messages

6.3.7.1. If an intersection timing plan is cancelled via the intersection cancel control request being issued, the center be capable of reverting to the previous timing plan if it is still active or run the next timing plan per the schedule.

6.3.8. Detector Monitoring

6.3.8.1. The TMS interface module and underlying proprietary vendor software shall be capable of monitoring detectors. When thresholds are met or exceeded, the TMS interface module should be capable of issuing a DMS control request message to post a message on a DMS located at another center

6.4. RADS

6.4.1. DMS Information Gathering



6.4.1.1.The RADS system shall be capable of issuing a DMS status information request or DMS archive status information subscription request to each center in the C2C network whenever it needs to know what message is displayed on each DMS.

6.4.2.TMS Information Gathering

6.4.2.1.The RADS system shall be capable of issuing an intersection status request or TMS archive status information subscription request to each center in the C2C network whenever it needs updated detector data and timing plan information for each intersection.

6.4.2.2.The RADS system shall be capable of issuing a timing plan detail request to each center in the C2C network whenever it needs detailed information regarding timing plans being run for each intersection.

6.5.HCRS

6.5.1.DMS Information Gathering

6.5.1.1.The HCRS system shall be capable of issuing a DMS status information request to each center in the C2C network whenever it needs to know what message is displayed on each DMS.