

Message Set Standard

6.0 *Concept of Operations*

This standard identifies message sets that satisfy the external data flow requirements between a Traffic Management Center and other public transportation management centers and systems. The data flows represent a data exchange between a Traffic Management (Subsystem) and

1. Another Traffic Management Subsystem
2. Information Service Provider (Advanced Traveler Information Subsystem)
3. Emergency Management Subsystem
4. Transit Management Subsystem
5. Toll Administration Subsystem
6. Emission Management Subsystem

The message sets are organized into six groups. The six groups are Roadway-Network; Network-State; Network-Events; Traffic-Request; Traffic-Device-Status; and Traffic-Control. The following sections provide a concept of operations for these message groups.

6.1 **Roadway-Network Message Operation**

The Roadway-Network messages are designed to communicate the physical features and characteristics of the surface streets, arterial, limited access freeways, toll roads and connectors within a metropolitan/regional transportation roadway network. These messages provide a way for a regional traffic management organization to organize and define the roadways of a region, into one or more networks of connected links and nodes. This message group is organized into two message sets.

The messages will normally be transmitted on an infrequent but regular update interval, potentially on a weekly or monthly basis. For particular networks, with high levels of maintenance and construction activity, a need to update physical network characteristics on a daily basis would be appropriate. Each transportation system shall receive the messages of the group by subscription. The determination of how these sets will be transmitted, in a specific instance, is handled by the AP-DATEX-ASN Protocol Standard (reference 2.2.7).

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6.1.1 Roadway-Network-Description Set Operation

The roadway-network-description set transfers a complete description of the physical characteristics of each link and node that is part of the network. The network-connectivity of the links and nodes is provided in this set. This set is transmitted only at those times when a complete update of link and node characteristics for an existing roadway network is required. The message set is also used to communicate the link and node characteristics of a new roadway network, i.e., a roadway network incorporating major construction and redesign.

The structure that comprises the Network set consists of four messages:

1. Network-Identity
2. Link-Identify
3. Node-Description
4. Link-Description

The Network-Identify message in addition to the network name, identification number, and agency jurisdiction, provides network sizing data, i.e., number of links and nodes in the network. It also contains the sequence of link identification and node identification numbers.

The network-identifier and network-name are used across a number of message groups in order to uniquely identify the totality of roadway links and intersection nodes on which information is provided.

The organization-name uniquely identifies the jurisdiction(s) controlling traffic operations of the network. The link-set-size and link-set-list elements specify the number of and identification of the links in the network. The node-set-size and node-set-list elements provide corresponding information for the network nodes.

The Link-Identity message provides the data elements that uniquely identify each link that is part of the previously identified network. The number of Link-Identity messages transmitted as part of this message set is equal to the size of the link set. The identifier of the link is taken from the list of numbers in the link set. The link-jurisdiction, link-ownership and link-road-number elements further identify the link in terms of where it is located, which organization owns the link and what is the commonly designated road numbers.

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The link-data-stored element identifies the specific traffic data elements that are being collected and are currently available for that specific link. The final identifier for the link is the link-type. This data element identifies the link as a freeway, arterial surface street, toll road, tunnel, etc.

The separate Link-Description message provides the complete set of physical characteristics (including locations) that describes each specific link in the roadway network. The location of the link is defined through the location of its end points (the nodes of the network). The LRMS profile (reference 2.2.9) used to locate the beginning node and end node of each link is the latitude-longitude profile. When coupled with link-begin-node-id and link-end-node-id, the node-latitude and node-longitude data elements uniquely locate the end points of the link. Included within the message are data elements for link characteristics including: length; capacity; speed-limit, truck-speed-limit; lanes-minimum-number; right-shoulder-width; left-shoulder-width. Also included is a set of vehicle restrictions. The vehicle restrictions are: axle-count; height; width; length; weight.

Finally, for those links whose downstream node is an intersection, a set of data elements that describe intersection lane characteristics are included. These data elements are:

- Left-turn-pocket-lane-number
- Left-turn-pocket-length
- Right-turn-pocket-lane-number
- Right-turn-pocket-length
- Oversaturated-threshold

The Node-Description message is the final message of this set. This message contains identity data elements including: identifier, node-name, node-jurisdiction and node-ownership. These elements identify the node in terms of where it is located, which organization owns the link and what is its commonly designated name. Node location is further defined by the latitude and longitude data element that indicates the total number of links going into and out of the node. The type of node (node-type) data element has a valid value list that includes: freeway interchange; arterial with secondary cross street and arterial with crossing arterial. For these node types that are essentially intersections; a set of data elements that describe intersection characteristics are included. The data elements are:

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- Intersection-Identifier
- Intersection-Control Type
- Intersection-Number of Approaches

These intersection data elements connect the node description message of the roadway-network group with the surface-street-device-status and surface-street-control message sets. These are important relationships to connect networks-topology with network control.

6.1.2 **Roadway-Network-Update Set Operation**

The roadway-network-update set is used to update the physical characteristics of a single link; a single node or both a link and node. This set can be used to add or delete a link or a node to/from the current network. This message set is sent to other centers, on an infrequent but event driven update interval. The transmission occurs at the time a physical change, made to a network roadway or intersection is entered into the TMS database. When sending an update message, only the link or node characteristics that changed are sent in the message. In ASN.1 syntax this means the individual data elements are optional elements in the update message.

The structures that comprise the Network Update set consist of three messages:

1. Network-Update
2. Link-Update
3. Node-Update

The Network-Update message is always part of the update message transmission. This message identifies the network (network-identifier and network-name).

After specifying the network, the message includes a section-identifier data element within which the link or node to be updated is located. Finally, the link-identifier and / or node-identifier data elements are included in this message. These elements communicate the specific link and / or node that is being updated. A single link and / or node is updated by a single Network-Update message.

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When a link identifier is part of the Network-Update message, the corresponding Link-Update message is transmitted in direct sequence.

If a link is being deleted, then the Link-Update message contains only the link-identifier as a single data element. If a link is being added, then the Link-Update message contains all data elements that are listed in the Link-Identity and Link-Description messages described in Section 6.1.1. If one or more of the link features is being modified, then the Link-Update message contains the link-identifier and only the modified features.

In a corresponding sequence, when a node identifier is part of the Network-Update message, the corresponding Node-Update message is transmitted in direct sequence.

If a node is being deleted, then the Node-Update message contains only the node-identifier as a single data element. If a node is being added, then the Node-Update message contains all data elements that are listed in the Node-Description message described in Section 6.1.1. If one or more of the node features are being modified, then the Node-Update message contains the node-identifier and only the modified features.

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6.2 **Network-State Message Operation**

The Network-State messages are a group that provides current and predicted traffic conditions for any set of roadway links and nodes in a specified network. Additionally, this group provides current conditions with respect to emissions, weather, priority routes and parking facilities. The group is divided into 5 sets:

1. Current-Network-State Set – describes the most recent current traffic conditions that are available for distribution. The collection time interval for the data and the type of data (e.g. actual, historical, etc.) is also provided.
2. Predicted-Network-State Set – describes future traffic conditions for a specified future time period starting at current clock time.
3. Roadway-Network-Environment Set – describes current roadway emission or weather conditions at specific network locations.
4. Current-Priority-Routes Set – describes current travel times for specified priority routes. Route categories are emergency, commercial vehicle and transit.
5. Current-Parking-State Set: describes current parking availability at a specific facility.

This group of messages will normally be transmitted to another transportation system on a regular synchronous update interval. Each receiving transportation system shall subscribe individually to each message set. The message sets shall be published at a regular update interval. Alternatively, either message set can be requested on a one-time only basis. The determination of how these sets will be transmitted, in a specific instance, is handled by the AP-DATEX-ASN Protocol Standard (reference 2.2.7).

6.2.1 **Current-Network-State Set Operation**

The current-network-state set communicates the current traffic operations and flow conditions for a specified set of links and/or nodes in a network. A total of five messages make up this set. The three messages defining link operating conditions are:

1. Link-Set: provides the list of links for which current conditions are being transmitted.

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2. Current-Link-Conditions: provides the operating conditions of the links specified in the link-set message.
3. Current-Link-State: provides the current traffic flow conditions for links specified in the link-set message.

The Link-Set message contains five data elements. The network-identifier element identifies the network for which the link conditions are provided. The network-link-set-size specifies the number of links for which operating and flow conditions are provided. The network-link-set-list identifies, by link-identifier, the set of links for which operating and flow conditions are provided in the following messages. Finally, data elements are included that establish the data time interval and end time for the collection interval.

The Current-Link-Conditions message includes a sequence of data elements that collectively describe operating conditions of a single link defined by its link-identifier. For each link included in the Link-Set message, a separate Current-Link-Conditions message will be transmitted. The link operating condition data elements included in this message are:

Link-num-lane-open
Link-priority-type
Link-restriction-class
Link-status
Link-surface-condition
Link-oversaturated-flag

These data elements are optional for inclusion in each instance of message transmission.

The Current-Link-State message includes the sequence of data elements that describes the traffic flow conditions on a single link identified by its link-identifier. The link-based traffic flow parameters included in this message are delay, travel-time, volume, speed, density, occupancy-percent and level-of-service. For each link included in the Link-Set message a separate Current-Link-State message will be transmitted. The data elements of this message are optional for inclusion in each instance of message transmission.

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In a corresponding structure, the two messages defining node operating conditions are:

1. Node-Set: provides the list of nodes for which current performance is provided.
2. Current-Node-Conditions: provides operating conditions of the nodes specified in the node-set message.

The Node-Set message contains three data elements. The network-identifier element identifies the network for which node conditions are provided. The network-node-set-size specifies the number of nodes for which operating and flow conditions are provided. The network-node-set-list identifies, by node-identifier, the set of nodes for which operating and flow conditions are provided in the following messages.

The Current-Node-Conditions message includes a single data element that describes the current operating status of the node (open; restriction; closed; event). For each node, listed in the Node-Set message, a separate Current-Node-Conditions message is transmitted. The data elements are mandatory for inclusion in each instance of message transmission.

This message set shall normally be transmitted to other center-based transportation systems on a regular periodic update interval. The receiving system would subscribe for the messages. Its subscription would specify the update frequency. Alternatively, again based on the subscription specification, the message set can be requested on a one-time only basis.

6.2.2 Predicted-Network-State Set Operation

The predicted-network-state set transfers predicted traffic operations and flow conditions for a selected set of links and nodes over a specified time interval. A total of five messages make up this set.

The three messages defining future link conditions are:

1. Link-Predict: provides the list of links for which predicted conditions are being transmitted along with the prediction time interval.

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2. Predicted-Link-Conditions: provides the predicted operating conditions for the links specified in the link-predict message.
3. Predicted-Link-State: provides the predicted traffic flow parameters of the links specified in the link-predict message.

The Link-Predict message in addition to containing the network-id, link-set-size and link-set-list data elements also contains three data elements that define the time-based prediction interval. These data elements are:

- Prediction-begin-time: clock time that starts prediction interval.
- Prediction-end-time: clock time that ends prediction interval
- Prediction-time: length of prediction interval

The predicted conditions specified in the associated link-conditions and link-state messages are referenced to the clock time interval defined by the above data elements.

The Predicted-Link-Conditions message includes the same data elements as contained in Current-Link-Condition message referenced to a prediction time interval.

The Predicted-Link-State message likewise, includes data elements that are referenced to the prediction time interval. The specific data elements included in this link-state message are:

- Predicted-link-average-queue length
- Predicted-link-average-speed
- Predicted-link-max-queue-length
- Predicted-link-stopped-delay

These data elements are particularly useful when the downstream node of the link represents a signalized intersection.

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In a corresponding structure, the two messages defining future node conditions are:

1. Node-Predict: provides the list of nodes for which predicted conditions are being transmitted along with the prediction time interval.
2. Predicted-Node-Conditions: provides the predicted operating status of the nodes during the specified prediction time interval.

6.2.3 Roadway-Network-Environment Set Operation

The roadway-network-environment set is composed of two messages that provide current roadside air quality conditions at a specific roadway location and current roadside weather conditions at a specific roadway location.

The two messages are:

1. Current-Roadside-Air Quality: provides air quality measurements at a single roadway location (measurement station).
2. Current-Roadside-Weather: provides roadside weather measurements at a single roadway location (measurement station).

The current-roadside-air quality message contains three data elements that locate the measurement station with respect to the network, the link and the LRMS station location.

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Two data elements provide the organization-operator name and the station identifier. Finally, the air quality parameter data elements are provided based on the current available measurement from that station.

Likewise, the current-roadside-weather message contains three data elements (network; link; LRMS station location) that locate the roadway weather station. Two data elements provide the organizations-operator name and the station identifier. Finally, the individual weather parameter data elements are provided based on the current available measurements from that station.

Each transmission of these messages provides current data from one measurement station. To obtain data from multiple stations requires multiple message transmissions. In general these messages would be transmitted one time in response to a specific request.

However, they could also be sent on a regular update interval such as every hour on the hour. Tailoring of the individual data elements based on the set of sensors available at each station will be permitted within a message instance. Thus, the data elements of the individual measurements will be optional with respect to each message transmission.

6.2.4 **Current-Priority-Routes Set Operation**

The current-priority-routes set is composed of three messages that provide route information for three classes of priority routes – emergency routes, commercial vehicle routes and transit routes. Each of these messages provides a description of a single route using a sequence of waypoints taken from the SAE-J2354 Standard (reference 2.2.3). Current travel time over the route is provided, as well as route ‘owner’ or ‘user’ organization.

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With respect to a specific route, the route message is communicated to requesting (i.e., subscribing) organization. The communication (i.e., subscription) is in effect only during the period that the route is active in the network. For emergency routes, the active period would be on the order of several minutes to several hours. For commercial vehicle routes, the active period would be the length of time the vehicle is on the route. For transit routes, the active period would be the length of time, transit vehicles are on the route. The transit route is active 24 hour if transit vehicles are always on the route.

The variability of priority routes is another factor that determines the length of a center subscription for these messages. Since transit routes are fixed routes that are in operation for weeks or months, subscriptions would be set up that extend for the same period. Emergency routes are one-time use routes, so that a subscription for route performance data would last only for use by a single emergency vehicle.

The Current-Priority-Route messages include data elements that identify the roadway network (network-identifier), and the TMC, that is managing the operation of the network (Organization-contact-organization-identifier). The message also includes an identification of the event to which the priority route is related (event-identification) and identification number of route (trip-route identity). The specification of the route includes an identification number; a route origin; route destination; sequence of waypoint list and estimated route travel time. These data elements are part of the Trip Guidance Data Elements that are specified by the SAE-J2354 Standards (Message Sets for Advanced Traveler Information Systems). The SAE-J2354 data elements utilized by the priority route messages are:

- Trip-Route Identity
- Trip-Origin Location
- Trip-Destination Location
- Waypoint-SEQUENCE of Waypoint List
- Trip-Estimated Travel Time
- Waypoint Times-SEQUENCE of Waypoint Travel Time

Finally, data elements are included in the message that identify by alphanumeric and name the organization operating/dispatching the priority vehicle.

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6.2.5 **Current-Parking-State Message Operation**

The Current-Parking-State set contains a single message that, in response to a specific message request, provides a snapshot of available capacity at one or more parking facilities within a traffic network. The message will also be transmitted on a regular interval to any other transportation center that requires parking availability information and has subscribed to the set. The parking message conveys information so that traffic operations can utilize changeable message signs and advisory radio messages to provide parking advisories and routing to the motorists.

The message includes data elements that relate the facility name and location to a specific network and the link that provides access to the facility. The message also includes parking data elements that describe:

- The type of parking facility
- The capacity of the facility
- The status of parking at the facility
- The number of open spaces available
- The name of operator

The message also provides information on the device controlling access to the facility including current status.

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6.3 **Network-Events Message Operation**

The Network-Event messages are a message group that disseminates information related to roadway incidents and planned roadway events that occur on the roadway network. The group includes 5 message sets:

1. **Current-Network-Incidents:** This set consists of 5 messages. These messages provide a description of all incidents currently active in the roadway network.
2. **Planned-Roadway-Events:** This set consists of 5 messages. These messages provide a description of all planned events currently active or scheduled to be active in the roadway network.
3. **Event-Defined-Response:** This set consists of 4 messages. These messages provide descriptions of previously developed response plans that will be employed to mitigate and remove active incidents and events from the roadway network.
4. **Network-Incident-Update:** This set consists of 5 messages. These messages provide an initial description of a newly detected incident or an update description to a single currently active incident.
5. **Roadway-Event-Update:** This set consists of 5 messages. These messages provide an initial description of a newly scheduled event. The set also provides an update description to a single planned event.
6. **Event-Bulletin:** This set consists of 1 message. This message is designed to serve the Department of Transportation event or situation “summary” and “press release” function. The message explains the situation in a way that is easily understood by general users.

6.3.1 **Current-Network-Incidents Set Operation**

The Current-Network-Incident messages are designed to communicate a current description and status of all currently active incidents. The messages of this set are:

- Incident-Identity
- Incident-Location
- Incident-Description
- Incident-Timeline
- Incident-Response

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To communicate the complete status for all incidents, the 5 messages must be transmitted as a set. Publishing these 5 messages for each active incident in the network to each subscribing center constitutes a complete transmission. In general, incident status would be published on a periodic request based on a registered subscription. The update rate would typically be on the order of several minutes to 1 hour. Alternatively, a subscribing center could register for a single or one-time transmission when it wanted complete status of all incidents.

The incident-identity message includes data elements that identifies the incident by number, the organization coordinating the response to the incident and the organizations required as part of the response team.

The incident-location message includes data elements that locate the incident by LRMS profile type, by roadway name and link, and by jurisdiction. All LRMS profile types (reference 2.2.9) are supported by the message, thus as the location message is being formulated only the type applicable to a specific incident is transmitted. Thus, incidents will have their location described based on the type of data available.

The incident-description message includes the data elements that describe the type of incident; the severity of the incident, the condition of the roadway and weather, and the extent of injuries, fatalities, damage and vehicle involved. The status of each incident is described to the fullest extent possible, based on the information available, at the time the message is published. Thus, each incident will have a unique description.

The incident-timeline message includes the data elements that define the time evolution of each incident. Some incidents were just detected, some were confirmed; for others a response was initiated, and some were cleared from the roadway. Since each incident is a unique independent roadway event each timeline will have a unique description.

The incident-response message provides the data elements that identify the response plan in effect for the incident. The message also provides the status of the agencies responding to the incident. In particular, are the responding agencies notified; enroute or on-site?

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6.3.2 **Planned-Roadway-Events Set Operation**

The Planned-Roadway-Event messages are designed to communicate a current description and status of all currently scheduled planned events. Planned events include maintenance events; construction events; special events that have a major effect on roadway operations including roadway closures. The messages of these sets are:

- Event-Identity
- Event-Location
- Event-Description
- Event-Daily-Timeline
- Event-Schedule

To communicate the complete status of all planned events the 5 messages must be transmitted as a set. Publishing these 5 messages for each scheduled event to each subscribing center constitutes a complete transmission. In general event status would be published as a periodic request based on a registered subscription. The update rate would typically be on the order of 1 hour. Alternatively, a subscribing center could register for a single or one-time transmission when it wanted event status.

The event-identity-message includes data elements that identifies the planned event by number, the organization coordinating the response for the event and the type of planned event.

The event-location message includes data elements that locate the event by LRMS profile type, by roadway name and link and by jurisdiction. All LRMS profile types (reference 2.2.9) are supported by this message. Thus, as the location message is being formulated only the type applicable to a specific event is transmitted. Therefore, planned events will have their location described based on the type of data available.

The event-description message includes the data elements that describe the extensiveness and type of event as well as the agencies notified of the event. The description includes data elements for text descriptions, notes and comments.

The event-daily-timeline message includes the data elements that define the daily start and end times for the planned event. Both scheduled start/end times and actual start/end times are included in the message.

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The event-schedule message includes the data elements that define the schedule for all long term multiple day or week events. Typically, these long term events are for roadway maintenance or construction actions. When the long term schedule is modified, these updates are incorporated into this message.

6.3.3 **Event-Defined-Response Set Operation**

The Event-Defined-Response messages are designed to communicate the assignment of a defined response plan to a currently active roadway event (planned or incident). The response to an event includes four components. These components are: the organization controlling the response; a description of the response plan assigned to the event; the agencies providing the resource component of the response and the response component addressing the field devices. The four messages of this set are:

- Response-Organization
- Response-Plan
- Agency-Response
- Device-Response

To communicate the complete response to an active roadway event requires the transmission of the four messages as a set. The publication of this message set would be controlled by the organization coordinating the event response. In general, the event-defined-response message set is published in real time necessary to maintain an effective response to the active event. As the response mitigates the effects of the active event, subscribing organizations may re-transmit these messages to indicate a change in responding to the event. Alternatively, a subscribing center could register for a single or one-time transmission when it wanted an update on the assigned response plan.

The response-organization message includes data elements that specify the coordinating/managing organization for the identified event. Organization names, address, phone numbers and functions are summarized in these data elements. As organizational assignments change, with respect to event management, these changes are published with this message.

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The response-plan message includes the data elements that define the response plan currently operational for a specific event. Data elements include a plan description and author, the list of equipment required for the response and an alternate route plan.

The agency-response message includes the data elements that specify the organizations required to respond to the specified event. Names and Identifiers of responding organizations including responsible on-site personnel and on-site vehicles are included in the message. Where multiple organizations are responding to an event, they are included as a sequence in the message.

The device-response message includes data elements that assign specific field equipment to support the defined response to a specified event. Where multiple field equipment support a response plan with respect to a specific event they are included as a sequence in the message.

6.3.4 **Network-Incident-Update Set Operation**

The Network-Incident-Update messages are designed to communicate a first detection or a specific information update for an active roadway incident. Operationally, this message set communicates only the new or updated messages that provide new information of a specific roadway incident. The message set consists of five messages. These messages are:

- Identity-Update
- Location-Update
- Description-Update
- Timeline-Update
- Response-Update

The messages are transmitted when new information of an active incident is received. It is not necessary for all messages to be transmitted during a specific update only the messages with changed data element need to be transmitted.

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The data elements contained in these update messages are identical to the data elements contained in the messages of the Current-Network-Incident message set. The focus of the update-messages is to quickly disseminate information on a newly detected incident or to update information on a currently active incident. It is not to provide status on all incidents.

Thus, this set of messages is only published in real-time when new/updated information relating to the identity, location, description, timeline and response of an incident is received by a TMC and that information must be distributed to other subscribing transportation centers.

6.3.5 **Roadway-Event-Update Set Operation**

The Roadway-Event-Update messages are designed to communicate a first scheduling of a planned event or a specific update of information related to an active planned event. Operationally, this message set communicates only the new or updated messages that provide new information of a specific roadway incident. The message set consists of five messages. These messages are:

- Event-Identity-Update
- Event-Location-Update
- Event-Description-Update
- Event-Timeline-Update
- Event-Schedule-Update

The messages are transmitted when new information of an active scheduled planned event is received by the coordinating TMC. It is not necessary for all messages to be transmitted during a specific update, only the message with changed data elements needs to be transmitted.

The data elements contained in these update messages are identical to the data elements contained in the messages of the Planned-Roadway-Event message set. The focus of the update messages is to quickly disseminate information on a just scheduled event or provide update information on a currently active event. It is not to provide status on all roadway events.

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Thus, this set of messages is only published in real-time when new/updated information relating to the identity, location, description, timeline or schedule of an event is received by a TMC and that information must be distributed to other subscribing transportation centers.

6.3.6 Event-Bulletin Set Operation

The Event Bulletin Message Set summarizes transportation operations data that can support exchange of travel situations and events (congestion, accidents, roadwork, road conditions, dry pavement, road clear, etc.) together with associated interpretation data (e.g. sender, source, quantifiers, time stamps, priority, confidence level).

One message is contained in this set: the Event-Report Message.

6.3.6.1 Event-Report Message Operation

Event Report Messages are designed to serve the Department of Transportation event "summary", "overview" and "press release" functions. They describe the current or expected travel situation, whether normal or abnormal. They seek to explain the situation in ways easily understood by users.

The Event Report Message is intended for information exchange by media with substantial data capacity; e.g. wide area computer networks connecting centers. Event Report Messages can be exchanged between interested parties in language-independent forms suitable for automated processing, sorting and selection. Situation and event information can be sent from TMCs to ISPs for eventual dissemination to travelers. This information may also be of use to centers other than ISPs, especially centers not actively involved in managing the event.

Situations include descriptions of unusual circumstances (e.g. traffic problems; severe weather warnings) and/or current status (e.g. level of service; weather situation). Situation information is created and updated in an originating database, by human operators or by automated systems. It is copied to one or more remote databases by means of messages.

6.3.6.2 Event-Report Functional Definition

The Event Report Message serves parties that send and/or receive travel information (e.g. traffic operations, information, management or control centers, ISPs, telecommunications services, broadcasters, police, highway agencies, public transit operators, breakdown/rescue services, freight operators, individual travelers), each message conveying information relating to *one travel situation* such as an accident, roadwork, snowstorm, or security alert.

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6.3.6.3 Operational Scenarios

Information suppliers normally initiate a message exchange, without receiving a specific request. The supplier is often in the best position to judge the importance of a particular message, or may choose to send the message for operational reasons.

Specific types of information can also be requested in advance, through a process of face-to-face negotiation and agreement. Requests normally establish message selection criteria, determining what kinds of information should be sent. In future, an Event Report Request message (not defined here) may enable message selection criteria to be changed in real time, if desired.

6.3.6.4 Relationship with ATIS National Table

The phrase, cause and advice information defined in the Event Report Message can be mapped directly into the ATIS National Table of standard phrases without translation of code values. SAE J2540 will further define how the ATIS National Table inter-operates with local variations and local additions.

To map ERM partial description information into the ATIS National Table, the ERM Event Type tag (which also equals the code values defined in TMDD 3211) is mapped into the first octet of the ATIS National Table index field. The Event Type phrase code is mapped into the second octet of the ATIS National Table index field. No conversion or translation of code values is required.

To map ATIS National Table values into the ERM, the above process is reversed.

6.3.6.5 Event-Report Data Elements

6.3.6.5.1 Event Situations

One Event Report Message conveys information about **one** travel situation. A travel situation is a set of travel circumstances with a particular cause, or causes (e.g. a specific accident). In map-based displays, each event is typically mapped by one icon.

A situation may be an unusual event (e.g. an accident, or roadwork) or a travel status report (e.g. an indication of level-of-service, roadway conditions, etc).

The definition refers to an actual, real-life situation (e.g. one specific accident and its consequences), not to a class of situations (e.g. accidents in general).

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

EXAMPLE 1:

accident at a location in Minneapolis;
accident at a location in Des Moines

These are two different situations. Although they share the same 'type' of travel circumstances, they refer to two unrelated real-life situations.

EXAMPLE 2:

snow affecting I-35;
snow affecting I-90

If it is the same snowstorm affecting both locations (likely to be geographically close to one another) then they can be regarded as one situation.

If it is two separate snowstorms, in different parts of the country, they should be regarded as two travel situations.

EXAMPLE 3:

roadwork on U.S. 40, at milepoint 10.4 (primary location);
traffic slow on U.S. 40, from milepoint 9.0 (secondary location) to 10.4 (primary location).

Since the slow traffic is related to the roadwork, these constitute one situation. The phrases 'roadwork' and 'traffic slow' relate to a single cause.

EXAMPLE 4:

roadwork on Route 401, at km 10.7
traffic slow on Route 401, from km 24.2 to 27.3.

Since the slow traffic and roadwork are unrelated, these constitute two situations. The phrase 'roadwork' applies to one location, and the phrase 'slow traffic' applies to the other.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

EXAMPLE 5:

roadwork on Route 401, at km 10.7
roadwork on Route 401, from km 24.2 to 27.3.

Since the two sets of roadwork may be regarded as related or unrelated, this can be treated as either one, or two situations. The phrase 'roadwork' applies to both locations, but it may, or may not, be considered to relate to a single cause. Typically an agency might regard related work spread along a route as one situation (e.g. widening; resurfacing) and unrelated work as separate situations.

If in doubt, assume they are separate situations; most likely the public will see it that way. Also, messages are simpler and easier to use if very complex situations are broken down into relatively simple situations on different routes, at specific locations.

EXAMPLE 6:

roadwork on Route 40, at milepost 120.67
roadwork on Route 295, from milepost 214.2 to 217.8.

If Routes 40 and 295 intersect at the roadwork location, so the roadwork affects both routes, this can be treated as one situation, shown by one icon on a map. If Routes 40 and 295 do not connect at the roadwork, this is typically two situations.

Situations can be created and tracked according to the operational practices of the participating agencies, so long as these do not confuse the public in respect of what is happening on the ground.

6.3.6.5.2 **Event-Report Views**

One Event Report Message may convey the information needed to construct one or more *views* of the situation. A *view* is a perspective of a situation from a particular approach route, or direction, from which a certain description (i.e. a certain set of phrases) applies.

If the same description applies to all directions of approach, there is only one view of the situation. In other cases, there is one view for each different description (typically, for each direction of travel, on each road affected).

Views are important because some traveler information systems (e.g. FM subcarrier systems) are designed from the driver's perspective, so on these systems, individual messages convey views rather than whole situations.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

EXAMPLE 1:

accident, at a location in Minneapolis

Since no further details are given, the description which applies to both (or all) directions of approach is simply 'accident'.

If the descriptions are different according to the direction of approach, there is one view per direction of approach.

EXAMPLE 2:

roadwork on Route 401, at km 10.4

traffic slow on Route 401, westbound from km 14.2 (secondary location) to km 10.4 (primary location)

traffic stopped on Route 401, eastbound from km 9.0 (secondary location) to km 10.4 (primary location)

Since the roadwork, traffic slow and traffic stopped all share the same cause, there is one travel situation.

Since the eastbound and westbound descriptions are not the same, there are two views. The description 'roadwork, traffic slow' applies to one direction, and the description 'roadwork, traffic stopped' applies to the other.

6.3.6.5.3 **Situation Elements and Phrases**

Situations comprise one or more **situation elements**. Each situation element comprises a common set of circumstances (described by a particular group of phrases) that extend throughout a specified roadway location, or a common set of area locations. A location may be a roadway point, a section of road, or a named area. Also, a roadway location may include only one direction of travel, the other, or both. Further details of location definition usages are given in Section 6.3.6.7.

Each situation element contains at least one phrase describing the travel situation. The set of phrases describing a situation element constitute its partial situation description (e.g. Phrase 1: roadwork; Phrase 2: traffic slow). The partial description, with its corresponding attributes (locations affected, time, etc.) fully describes the situation element. The whole message fully describes the entire situation. The partial description would in this case read: Roadwork. Traffic slow.

Message Set Standard

6.0 Concept of Operations (Cont'd)

Each view will consist of one or more situation elements. Any given situation element may be present in one or more views. The view for a particular roadway and travel direction is constructed by compiling all situation elements affecting that roadway and travel direction (including any affecting *both* travel directions on that roadway). Typically, either *one* or *two* situation elements is sufficient to define the view on a particular roadway, comprising those phrases affecting traffic going in the direction of the view, and those phrases affecting both traffic directions.

6.3.6.5.4 Event Causes, Advice and Quantifiers

Where several phrases are used to describe a situation, a subset of the phrases can be declared to be the 'cause' of the situation. In English language descriptions, the first 'cause' follows the words 'due to' and any subsequent causes follow the word 'and' (e.g. ... due to *snow* and *fog*).

About 900 phrases are currently defined in the Event Report Message and are formed using subgroups from the ITIS code list. Additional phrases can be added to the data dictionaries as required. In addition to the phrase codes, which are used for phrases and causes, advice codes are also available; e.g. drive carefully. Advice can be appended to any phrase or combination of phrases, either before or after each phrase. The only difference between 'advice' and 'phrases' is that advice is never used on its own.

Some traveler information systems use predetermined combinations of phrases and quantifiers. This approach is necessary where bandwidth for data transmission is extremely limited, and/or where the characteristics of the communications channel are so noisy that messages must be very brief (e.g. FM subcarrier systems, AM phase modulation systems). These limitations do not apply to Event Report Message data transfers. Therefore, use of predetermined phrase and quantifier combinations - an approach which complicates and extends the message list, and at the same time restricts users to a limited combination subset - is not adopted in this proposed standard.

6.3.6.5.5 Situation Locations and Routes

A travel situation may affect one, or several locations (e.g. both roads crossing at an intersection; all roads affected by a snowstorm).

Each element of the situation affects a distinctive subset of the locations, normally one or more defined stretches of roadway and/or a set of predefined, named areas. A particular set of phrases apply throughout the locations included in a situation element.

A single route or location may contain one or more travel situations at a particular time.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

6.3.6.5.6 Predefined Travel Situation Locations

Normally, travel situation locations are defined in real time to cover actual roadwork, accident, delay, etc., locations. However for road condition prediction systems which estimate road conditions over wide areas, it may be more convenient to predefine road condition situation locations, e.g. I-25, Denver - Colorado Springs. In this case, each distinctive roadway condition within the predefined segment can be described by a separate situation element (e.g. I-25, Denver - Castle Rock, Icy Patches; I-25 Castle Rock - Colorado Springs, Wet and Icy Road).

Predefined segments may also be arranged in a hierarchy, so that longer segments are subdivided into shorter, lower-level stretches, as illustrated above. In this case, a single Event Report Message may include partial situation descriptions that apply at the various, overlapping hierarchical levels.

6.3.6.6 Event-Report Updates

Travel information is often split into different messages, e.g. as it is known at different times, or for different routes. To obtain all travel information relating to one area typically implies accumulation of many Event Report Messages from one or many information sources.

Some travel situations may be subject to frequent updates. All may be updated from time to time. In the Event Report Message, situations are updated by repeating the whole message when any part of it changes. This avoids the need to number each part of the message and keeps message processing simple; also, the system is robust in the event of lost messages. Most importantly, each "press release" is complete in its own right, without reference to large numbers of earlier messages.

6.3.6.6.1 Event-Report Update Times

Every situation element must contain an Element-Update-Time. This is used to indicate the time when the situation element description was most recently validated (actually observed or calculated, or otherwise confirmed to be correct). These times are given in 24 hour UTC (Zulu, or GMT) time.

Some messages contain information which will become effective at a known time in the future, called the **start time**. Messages without a start time are effective immediately.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

6.3.6.6.2 Event-Report Valid Period

Each situation element shall include either a specified timeline estimated duration or an expiry time.

6.3.6.7 Event-Report Location References

Most Event Report Messages contain location references. Typically, these indicate the location of a travel situation described in the message. Situation element locations can also be used to indicate the location of the cause of the problem (e.g. on another route), or to give details of a detour.

In the Event Report Message, locations can be areas, sections of roadway, or points. Also, a location may include only one travel direction, the other, or both. Several named areas may be grouped into a single situation element, provided that all the areas are affected by the same situation (e.g. a winter storm) and provided that the partial situation description (i.e. the collection of phrases) applies to all of the areas being grouped.

The Event Report Message limits the number of location referencing options to be supported in order to increase interoperability at an affordable development cost. For this reason, only a subset of the LRMS is currently supported in this version of the Event Report Message.

Distance marker (milepoint) systems *were* selected as most transportation agencies have such systems in place. Route number/milepoint references give a unique identification that normally is on every highway. In this method, the locations are given by the jurisdiction, road number and kilometer/milepost reference (e.g. MN, I-35, 22.765). This method is used in all Event Report Message data exchanges to provide a consistent base reference.

Coordinate systems like latitude/longitude or UTM coordinates define unique points on the earth, but most of these do not lie on roads. Ambiguities can arise when different databases digitize roads differently. Also, coordinates cannot define which road is affected where roads cross. Coordinates do, however, provide a check on distance marker references. Where roads are rerouted a discrepancy may show up if *both distance markers and coordinates are exchanged*. Therefore, coordinates were selected as well as distance markers in the Event Report Message.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

6.3.6.7.1 Primary and secondary locations

Many location references in ITS applications extend geographically through several adjacent sections of road, etc. The concept of primary and secondary locations is used in the Event Report Message to indicate the extremities of the affected sections, without having to list all the intervening places. To avoid ambiguity, both primary and secondary locations must lie on the same named or numbered route.

For example, if an accident occurs at km 41.2 on Route 401, and the resulting queue extends back to km 47.4, the situation location can be defined as Route 401, km 41.2 - 47.4.

Km 41.2 is defined as the **primary location**, and km 47.4 the **secondary location**. For situation locations, by convention, the primary location is taken to mean the end where the cause of the problem can be found, wherever a cause can be pinpointed geographically.

6.3.6.8 Free Text Data Elements

Two kinds of free text are supported in the Event Report Message: additional description text added to standard phrases, causes, advice and quantifiers; or comments, not for end users.

Additional description text is added to the end of the standard phrases, causes, advice and quantifiers contained in the situation element description.

Use of free text in additional descriptions is discouraged, as many traveler information systems cannot sort it automatically or convey it to end users as high quality speech. Almost all travel situations can be adequately described by standard machine-readable phrases, causes, advice and quantifiers, such that the use of additional free text is rarely necessary.

Comments are not to be passed on to the public. Typically they are used for TMC operator information.

Additional descriptions and comments are allowed to contain commas and end-of-line characters within the data element. The start and end of the text are defined by quotes "... " which are not allowed within the visible strings.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

6.4 **Traffic-Request Message Operation**

The Traffic-Request messages are a message group that can be used by any center-based transportation system to: request traffic data; request field device status; request field device control. Within the context of DATEX-ASN protocol, these are single subscription requests. These request messages are published by any advanced transportation system (i.e., transit; emergency management; advanced traveler information; other traffic management; etc.) to a specific advanced traffic management system. The response to the request is a publication of the requested traffic data elements and/or status of field devices. For the field device control requests, the response is a return message (a control-response message). This return message provides positive feedback with respect to granting control of the specific field device.

6.4.1 **Traffic-Status-Request Set Operation**

This set of status request messages contains specific defined messages for:

1. Network Events: including planned events and incidents.
2. Traffic Data: for a specific network link (roadway) or network node (intersection).
3. Parking Data: for a specific parking facility referenced by name.
4. Priority Route Data: for a specific type of priority route.
5. Environmental Data: for a specific emissions or weather station.
6. Video Surveillance: for a specific CCTV camera a request for a video feed.
7. Control Status: for a specific field device or signal controller.

The messages responding to the request message types are:

- For network event requests, the network update messages (4.3.4: network-incident-update; 4.3.5: roadway-event-update).
- For traffic requests, the current network state message (2.1.3: Current-Link-State).
- For parking data requests, the current parking state message (2.5).

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

- For priority route data requests, the current-priority-route messages (2.4.1: current-emergency-routes; 2.4.2: current-cv-routes; 2.4.3: current-transit-routes)
- For environmental data requests, the roadway-network-environmental messages (2.3.1: current-roadside-air quality; 2.3.2: current-roadside-weather).
- For video surveillance requests, the responding center sends a video feed to the assigned video-port of the requesting center.
- For control status, the traffic-device-status messages (5.1: field-device-status; 5.2: surface-street-device status).

The responding status messages are sent once, as soon as possible after the request is received.

6.4.2 **Traffic-Control-Request Set Operation**

This set of two control request messages contain specific defined messages for:

1. Control of field devices (Device-Control-Request): these devices include: ramp meter; DMS; HAR; CCTV; gate controller.
2. Control of signalized intersections (Street-Control-Request): the signalized controllers provide control of intersections; control of arterial and control of network sections.

The Device-Control-Request message identifies the organization requesting control and the operating organization of the field device. It also provides data elements that specify the type of field device along with identification number and location information with respect to node and link identifiers.

The Street-Control-Request message also identifies the organization requesting control and the operating organization of the field device. It also provides specific Identifiers that identify the individual signalized intersection, arterial or street network section for which control is requested.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

6.4.3 **Control-Response Set Operation**

This set of messages responds directly to each control request message. In addition, to returning (or reflecting) the request message data elements, the response message appends a data element with one of three specific responses:

These responses are:

Response 1 – Control granted, Device on-line.

Response 2 – Control transfer denied, Device in Use.

Response 3 – Control transfer denied, Device off-line

If response 1 is returned, the requesting transportation center would then transmit control messages from Message Group 6 (see Table 4-1). These messages would effect actual control (at the center-to-center level) from the remote center to the field or signalized intersection control device.

If response 2 is returned, indicating the device is in use, the requesting transportation center would wait a time out interval and request again.

If response 3 is returned, indicating the device is off-line, the requesting transportation center would assess the status of the device. Device status would be determined by transmitting status request messages (from message set 4.1 for the specific field device or intersection controller).

After a transfer of control is granted, the requesting center sends control messages from message group 6 (see Table 4-1). These group 6 control messages are published at a frequency commensurate with the need to modify or update overall control policies and strategies.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

6.5 **Traffic-Device-Status Message Operation**

The Traffic-Device-Status messages are a group that disseminates device status information in response to a device status request. The device message is published to the center-based system that made the single subscription request. Status messages of traffic devices are only published in response to subscription request. The status device status messages are divided into two sets. The sets are:

- Field-Device-Status
- Surface-Street-Device-Status

6.5.1 **Field-Device-Status Set Operation**

This message set communicates the status of field devices in response to a device-status request message generated by a center-based transportation system. Status messages are available for the following types of field devices:

- Ramp Meter
- Dynamic Message Sign
- Highway Advisory Radio
- CCTV Camera
- Gate Controller

Each message in this set specifies the current status information for a single field device. To obtain status of several devices in a single class (for example; several ramp meters) requires first the transmission of several status request messages. Each status request message is directed to one field device class and one field device (defined by device identifier). The structure of these messages in no way is restricted to the current classes of field devices. As additional device classes are added to Traffic Management Data Dictionary, field-device-status messages will be added to this message set.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

6.5.2 **Surface-Street-Device Status Set Operation**

This message set communicates the status of signalized intersections in response to a control-status request message generated by a center-based transportation system. Status messages are available for the following types of signalized controller:

- Single intersection controller.
- Group of intersection controllers as along on a single arterial.
- Group of intersection controllers controlled as a sectionalized traffic network.

Each message in this set specifies the current signalized status for a single traffic intersection; a single arterial or a single section of a network. To obtain status of several intersections or several arterial or several network sections, requires first the transmission of several status request messages. Each status request message is directed to one intersection or one arterial or one network section. The data elements of these messages provide a snapshot of the current control parameters. The control parameters are unique to each class of controller (intersection, arterial or network section).

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

6.6 **Traffic-Control Message Operation**

The Traffic-Control messages are a group of messages that allows a Traffic Management Center (or other advanced transportation centers) to remotely control traffic field devices or signalized intersections. The field device and intersections normally are controlled by a locally based traffic management center. This message group provides a standardized method for exercising control of locally based traffic device from a remote center. The remote center could be any transportation management center including transit, emergency, traveler information or other traffic center.

The traffic-control messages are divided into two sets. The sets are:

- Field-Device-Control
- Surface-Street-Control

6.6.1 **Field-Device-Control Set Operation**

Each message in this set communicates a specific sequence of data elements that modifies the current control settings for a specific field device. Control messages are available for the following types of field devices:

- Ramp Meter
- Dynamic Message Sign
- Highway Advisory Radio
- CCTV Camera
- Gate Controller

Each instance of control message specifies the next set of control parameters for the single field device. A single instance of a control message mode changes the current control values to a new set for a single field device. Additional control messages are required to continue to effect control of the device.

These control messages will be wrapped as a registered subscription following the DATEX-ASN profile for a SNMP Request message. When this control message is occupied by the receiving system, it generates the approximate SNMP message to the field device. The data elements remain unchanged.

Message Set Standard

6.0 *Concept of Operations (Cont'd)*

6.6.2 **Surface-Street-Control Set Operation**

This message set communicates a specific sequence of data elements that modifies the current control settings for surface street intersection controllers. Control messages are available for:

- Individual Intersections
- Intersections interconnected along an arterial
- Intersections interconnected within a network section

Each instance of control message specifies the 'next' set of control parameters. For a single intersection, the set of control parameters includes cycle length, split and phase preemption. For an arterial of intersections, the set of control parameters includes cycle length, split and offset. These parameters would be bundled into a set of timing plans. Thus, the control messages would effect a change of arterial timing plans.

For a network of intersection, the set of control parameters would be changed by effecting a new timing plan on the network.