National ITS Architecture Theory of Operations

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1 Introduction

1.1 Purpose

The Theory of Operations document is one of a series of deliverables documenting the National Intelligent Transportation System (ITS) Architecture developed under contract to the U.S. Department of Transportation (DOT). The Theory of Operations Document presents a high-level, narrative, technical description of the operation of the National Intelligent Transportation System (ITS) Architecture. This document is intended to serve the transportation professional who is involved in ITS planning and/or implementation and wants to leverage the opportunities presented by the National ITS Architecture. The document, along with the other National ITS Architecture documents, will be of particular interest to those that are developing, or supporting the development of regional ITS systems. This group includes transportation planners, engineers, system integrators, and state and local implementers who are progressing towards integrated ITS implementations. It is intended to provide a better technical understanding of how a deployed ITS operating under the National ITS Architecture framework would operate.

1.2 Scope

This document describes the operation of the National ITS Architecture through a description of the operation of each Service Package defined in the Service Packages document. The document is based on and complements the other National ITS Architecture documents: primarily the Physical Architecture and Service Packages documents.

The Theory of Operations document describes the operation of each Service Package, those deployment oriented slices of the National ITS Architecture that provide specific transportation services. In order to do this the document makes significant use of transaction set diagrams, a representation of the sequence of architecture flows between architecture entities. For Version 7, new service packages and revisions of previous service packages have been incorporated into the transaction set diagrams and their associated narrative descriptions.

Service Packages, which form the basis for the descriptions in this document, provide an accessible, deployment oriented perspective to the National ITS Architecture. They are tailored to fit, separately or in combination, real world transportation problems and needs. Service Packages represent particular groupings of entities defined in the Physical Architecture that correspond to specific transportation services. Service Packages collect one or more Equipment Packages that must work together to deliver a given transportation service (or related group of services) and the Architecture Flows that connect them and other important external systems. In other words, they identify the pieces of the Physical Architecture that are required to implement a particular transportation service. Service Packages have found wide use in the development of regional ITS architectures to illustrate the subsets of architectural entities and interfaces used to implement specific transportation services.

For a complete discussion of service packages-- their definition, analysis, and a number of examples that illustrate ways Service Packages can be applied in regional and project architecture development activities—see the Service Packages Document. For a complete discussion of the elements of the Physical architecture— subsystems, terminators, equipment packages, and architecture flows— see the Physical Architecture Document.

The operation of the Service Packages is described in this document through the use of transaction sets. For each Service Package, there is one or more transaction set diagrams that illustrate the sequence of information exchange (or an example of the sequence of information exchange) between architecture entities to implement the service. Sometimes, the service package activities have been partitioned into distinct phases of activity: for example an information collection phase, an execution phase, and a follow-up phase. In these instances, the distinct phases are illustrated in separate transaction set diagrams.

The transaction set diagrams, when suitably customized for a specific regional ITS architecture, should illustrate the technical roles, responsibilities and procedures of entities from an ITS architecture point-of-view (who sends what information to whom, and when). These structured information-sharing relationships are sometimes called dialogs (especially in the ITS standards development and usage community in which these relationships are important to the message set group of standards).

Where service packages in some cases illustrate a variety of architectural approaches to address a particular user service, so will the transaction set diagram. Thus for both the service package and the transaction set diagram, there is a need to customize the diagrams when used in a specific regional ITS architecture where specific choices have been made as to the operational concepts to be used in a particular service. Along these lines, certain entities may not exist in a region, or may not participate in a particular service - thus architecture flows to and from that entity must be removed from the customized transaction set diagrams, and the resulting diagrams must be analyzed and if necessary further customized to align with the operational concept selected for a service in a region.

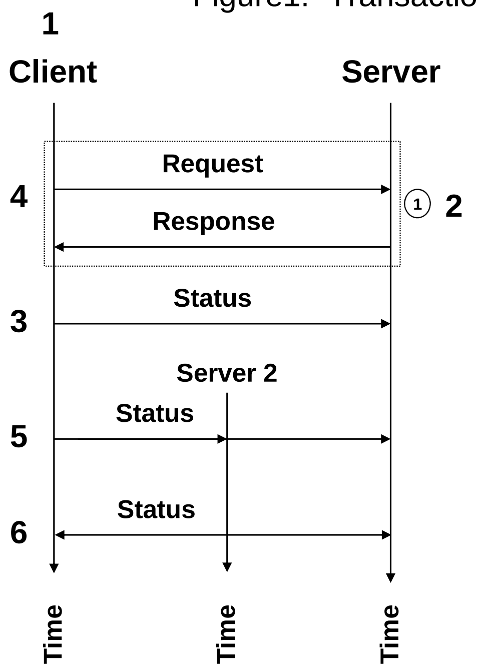
Where a specific sequence of architecture flows, if present, is expected, then these are shown on the diagrams in dotted boxes. Otherwise, architecture flows on the transaction set diagrams may be issued asynchronously. A region, in order to implement a locally selected operational concept, may choose to more rigidly assign architecture flows to a specific sequence, and thus may use the specific sequencing characteristics of the notation when customizing the transaction set diagrams.

Not all architecture flows shown on the transaction set diagrams will be explicitly named in the accompanying narratives which describe the diagrams. In some cases, a summarizing reference may be made to include a variety of flows. This has been done to keep the narratives as brief as possible without sacrificing clarity in the explanation of the diagrams. When included in the narratives, architecture flows are shown in italics.

1.3 Transaction Set Diagram Notation

The transaction set diagrams used in this document have a common notation that is shown in Figure 1 and is summarized in the bullets below. The numbers on Figure 1 correspond to the numbered items in the list below.

Figure1: Transaction Set Diagram Notation



1. Architecture physical entities (Subsystems and Terminators) are represented as labeled vertical lines in the diagrams. While in the example above the two entities are labeled "Client" and "Server", in the diagrams these entities will have the names associated with Subsystems and Terminators in the National ITS Architecture (e.g. "Information Service Provider" or "Traveler"). These represent the sources and destinations of architecture flows (sometimes called "information flows") that either originate or terminate at architecture entities. Time can be viewed in the diagrams as top (sooner) to bottom (later). No particular time scale is implied in the architecture diagrams.

2. Each diagram has a series of numbers in circles that associate sections of the diagrams with the textual description of the Service Package operation described on the page(s) in front of the figure. (The numbers are not intended to illustrate a specific sequence of events.)

3. Architecture flows are represented as horizontal arrows in the diagrams, originating and ending at ITS architecture entities. The transaction set diagram(s) will contain all of the architecture flows assigned to the service package. Some architecture flows may appear more than once on the

diagram(s) for the service package. This is to indicate that the particular architecture flow is involved in the operation of several aspects of the service package. If the transaction set diagrams are used in the development of regional or project ITS architectures, it is likely that some of the architecture flows shown in the complete service package description will not be present in the regional or project architecture. It is intended that the architecture analyst developing a regional or project architecture will customize the transaction set diagrams by deleting unnecessary entities and unnecessary architecture flows. In addition, the analyst will need to add any user defined entities and/or user defined architecture flows.

4. Dotted boxes are drawn around groups of architecture flows that are intended to be in a specific sequence in describing the operation of the service package. A sequence of flows in a "dotted box" may repeat, and this should be noted in the annotation associated with a dotted box. For example, in several of the traveler information transaction set diagrams, there is a sequence of architecture flows allowing a traveler to set trip parameters and then request and receive a trip plan responsive to those parameters. The traveler may choose to modify the parameters and request again (and again…) until deciding to select a specific trip plan (using an architecture flow below the trip request set of flows in the dotted box. In this way it is possible for dotted boxes to be nested. As discussed above, if the transaction set diagrams are used as part of a regional or project architecture, whole dot boxes and their architecture flow contents might be deleted, depending on the operational concept chosen by the region for implementing the transportation service described by the service package. For example, the traveler information transaction diagram discussed above may have a dotted box transaction between the Information Service Provider and a Financial Institution to enable payment for traveler information services. If a local regional ITS architecture operational concept is that such traveler information is "free" to travelers, then the payment transaction set dot box may be deleted in the process of customizing the transaction set diagram for that regional ITS architecture.

   Architecture flows that are not in boxes may be issued at any time. Another way of saying this is that the transactions may be "asynchronous" to other architecture flows or transaction sets of architecture flows. While it may be tempting for an analyst to put a pair of flows in a box, such as "operator inputs" from an operator to a subsystem and "operator status" from a subsystem back to an operator, it is probably best not to when there are scenarios where either of these flows may occur first.

   Finally, there are many cases in the National ITS Architecture where request/response flows (such as illustrated in Figure 1) are a part of a service package. The National ITS Architecture supports several operational concepts for this exchange of information. A single request may result in a single response. Or this set of flows may actually be "subscribe"/response flows, where the request is issued once, and many responses (at regular intervals or on conditional events) may occur. If regional or project operational concepts are developed using these transaction set diagrams, it is recommended that the type of request/ response used be documented in the associated annotation.

5. In order to avoid cluttering the diagrams, when the same flow is issued from an entity to multiple receiving entities, it may be illustrated as shown as an arrow with multiple heads. For example, Figure 1 shows the Client sending a status flow to both the Server and to Server 2.

6. Similarly, bilateral architecture flows (i.e., pairs of flows with the same information description in opposite directions between entities) may be illustrated with two-headed arrows. This assumes of course that either flow may occur at the same time in the sequence of flows (or they may be asynchronous). An example of such a flow would be the architecture flow "incident information" that goes in both directions between an Emergency Management Subsystem and a Traffic Management Subsystem.

1.4 Document Structure

The Theory of Operations document begins with this Introduction section, followed by a section for each group of service packages. Within a section each service package that belongs to the group (for example Traffic Management) is defined and then the operation of the service package is described in text that references the transaction set diagram (or several diagrams for more complex service packages). The sections, and service package groups they describe, are as follows:

Section 2: Traffic Management Service Packages
Section 3: Traveler Information Service Packages
Section 4: Transit Management Service Packages
Section 5: Emergency Management Service Packages
Section 6: Commercial Vehicle Operations Service Packages
Section 7: Maintenance and Construction Operations Service Packages
Section 8: Archived Data Management Service Packages
Section 9: Advanced Vehicle Safety Service Packages

2 Traffic Management

This section provides the Theory of Operations for the Traffic Management Service Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each service package section) to identify these service packages is ATMS—Advanced Traffic Management Systems.

2.1 ATMS01: Network Surveillance

This service package includes traffic detectors, other surveillance equipment, the supporting field equipment, and fixed-point to fixed-point communications to transmit the collected data back to the Traffic Management Subsystem. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this service package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to users and the Information Service Provider Subsystem.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

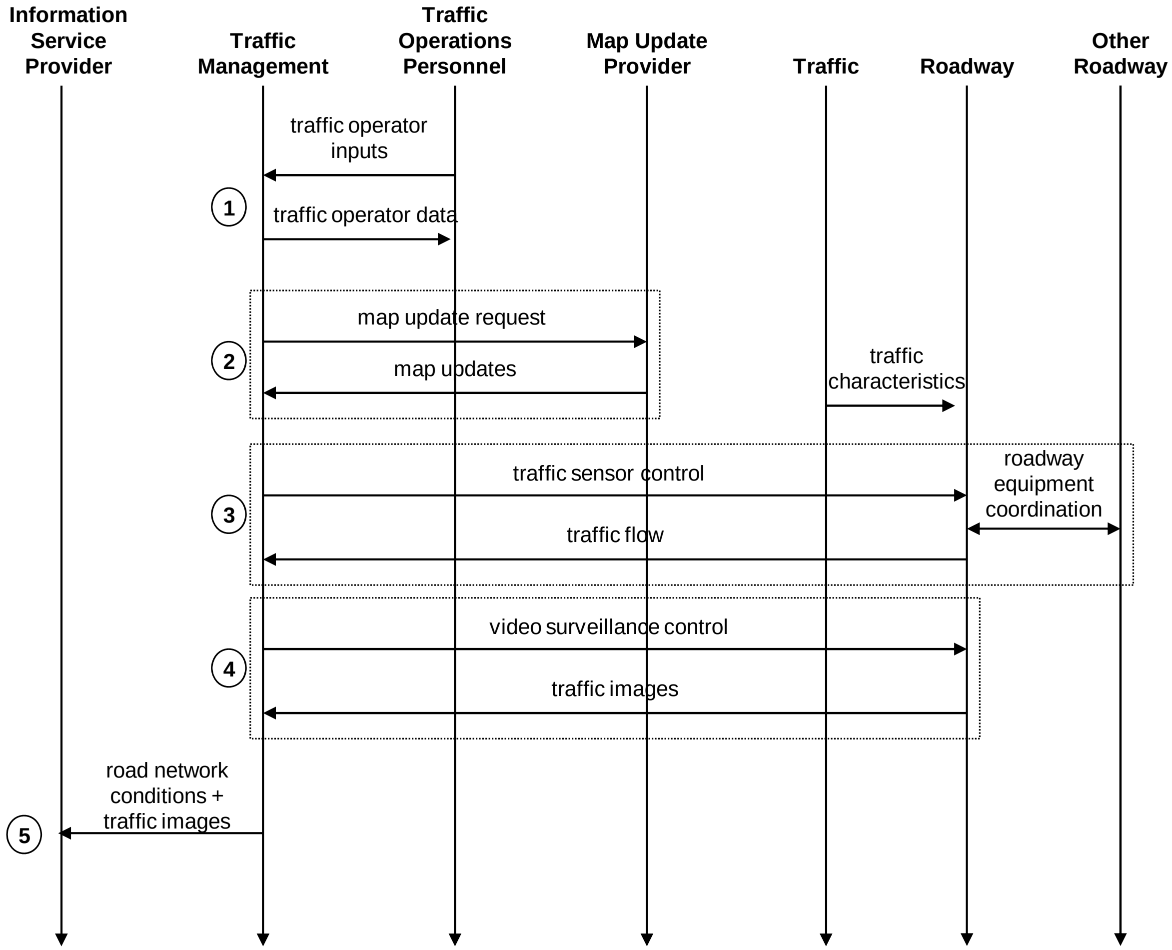
1. Data collected and sent to the Traffic Management Subsystem can be associated with links and nodes of the transportation network. *Map updates* from a Map Update Provider keep this model of the transportation network current, and are available upon request by the Traffic Management Subsystem (*map update request*).

Traffic characteristics represent the conditions sensed by the field equipment. Field sensor parameters can be initialized by the Traffic Management Subsystem, and configured field sensors can send data (*traffic flow*) back to the Traffic Management Subsystems. The *traffic sensor control* message can be optional; in that sensors may be hard-configured in the field, or the message can be a subscription relationship to *traffic flow* (i.e. one *traffic sensor control* message may result in a continuous stream of *traffic flow* information as per the *traffic sensor control* message until the next *traffic sensor control* message). In addition, the (*traffic sensor control*) message can control the sharing of information directly between field equipment deployments (*roadway equipment coordination*).

2. Similarly, the Traffic Management Subsystem can control video equipment (*video surveillance control*) (e.g. pan/tilt/zoom) and receive *traffic images* in return.

3. All (or selected) collected (*road network conditions* and *traffic images*) can be shared with Information Service Providers.

ATMS01: Network Surveillance



2.2 ATMS02: Traffic Probe Surveillance

This service package provides an alternative approach for surveillance of the roadway network. Two general implementation paths are supported by this service package: 1) wide-area wireless communications between the vehicle and center is used to communicate vehicle operational information and status directly to the center, and 2) dedicated short range communications between passing vehicles and the roadside is used to provide equivalent information to the center. The first approach leverages wide area communications equipment that may already be in the vehicle to support personal safety and advanced traveler information services. The second approach utilizes vehicle equipment that supports toll collection, in-vehicle signing, and other short range communications applications identified within the architecture. The service package enables transportation operators and traveler information providers to monitor road conditions, identify incidents, analyze and reduce the collected data, and make it available to users and private information providers. It requires one of the communications options identified above, on-board equipment, data reduction software, and fixed-point to fixed-point links between centers to share the collected information. Both “Opt out” and “Opt in” strategies are available to ensure the user has the ability to turn off the probe functions to ensure individual privacy. Due to the large volume of data collected by probes, data reduction techniques are required, such as the ability to identify and filter out-of-bounds or extreme data reports.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

There are several different approaches to traffic probe surveillance that are covered by this service package, ranging from probe applications that use basic vehicle transponders to applications that collect a richer set of data from intelligent probe vehicles using several different wireless communications options. Increasingly intelligent vehicles know their current location (*position fix*) and have access to travel data such as current vehicle speed and heading and a recent history of stops and starts that can be used to measure current traffic conditions.

1. Vehicles communicate with short range communications equipment in the Roadway Subsystem as they pass through the road network. Information is collected by the Roadway Subsystem (*traffic probe data*), which includes different information depending on implementation approach and passing vehicle equipment.

Vehicles that are equipped with only a transponder provide a unique identifier (*traffic probe data*) as they pass a network of beacons that track the progress of vehicles through the traffic network. The system implements measures to ensure that the privacy of individual vehicles and drivers is preserved.

- In more advanced implementations, intelligent vehicles report their current position, speed, heading and snapshots of events including starts and stops, speed changes, and other information (*traffic probe data*) that can be used to measure traffic conditions. The Roadway may send a *traffic probe reporting management* message to the vehicle to control what kinds of information the vehicle measures and how often and/or where it reports back to the Roadway subsystem.

The short range communications equipment forwards the collected probe data (*traffic probe data*) to a center that collects, processes, uses, and distributes the collected probe data. The center may be an Information Service Provider or Traffic Management Subsystem since traffic probe data supports both traffic operations and traveler information services. Map update providers also collect and use advanced traffic probe data to verify and improve the accuracy of their maps.

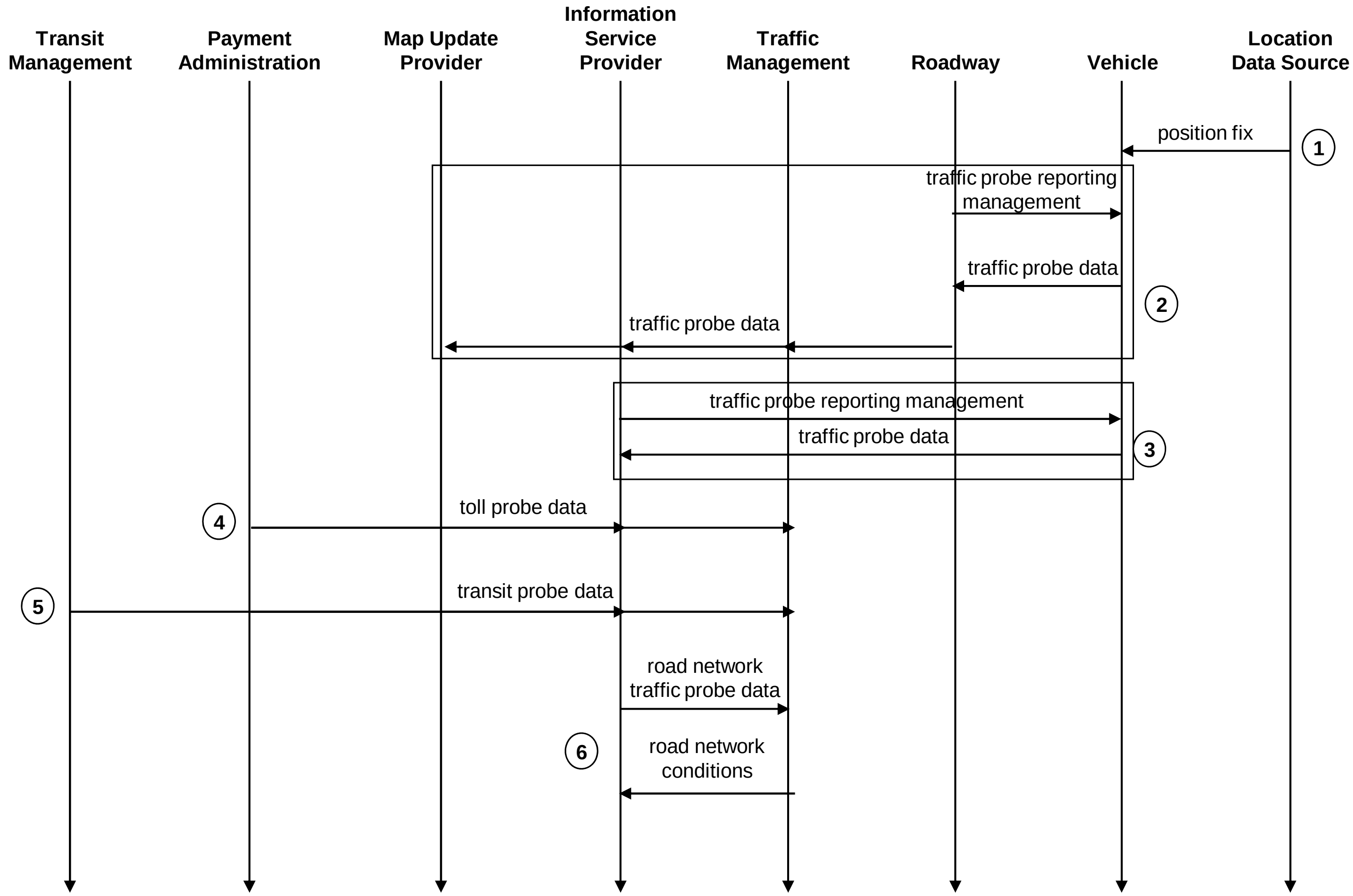
2. The Information Service Provider can also receive *traffic probe data* directly from subscriber vehicles using wide area wireless communications. The Information Service Provider can aggregate the information from all of its subscriber vehicles to determine information about the road network. The ISPS may send a *traffic probe reporting management* message to the Vehicle to control what kinds of information the vehicle measures and how often and/or where it reports back to the ISPS.

3. It is also possible to use vehicles on toll roads as probes. The Payment Administration Subsystem can provide the Traffic Management Subsystem and/or an Information Service Provider with *toll probe data* that is gleaned from transponder communications that support toll road operations.

4. Transit fleets are another potential source for traffic probe data. The Transit Management Subsystem tracks the performance of its transit vehicles and can provide the Traffic Management Subsystem and/or an Information Service Provider with probe information from the transit fleet (*transit probe data*).

5. The Traffic Management Subsystem and Information Service Provider share probe information. The Information Service Provide provides *road network traffic probe data* to the Traffic Management Subsystem which can use it to determine travel times, speeds, etc. about the roadway. The Traffic Management Subsystem can analyze and reduce any collected probe information to determine current and expected traffic conditions. The Traffic Management Subsystem may share the raw data or the aggregated information (*road network conditions*) with an Information Service Provider.

ATMS02: Traffic Probe Surveillance



2.3 ATMS03: Traffic Signal Control

This service package provides the central control and monitoring equipment, communication links, and the signal control equipment that support traffic control at signalized intersections. A range of traffic signal control systems are represented by this service package ranging from fixed-schedule control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. This service package is generally an intra-jurisdictional package. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would also be represented by this package. Coordination of traffic signal systems using real-time communications is covered in the ATMS07-Regional Traffic Management service package. This service package is consistent with typical traffic signal control systems.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Equipment on the Roadway is constantly monitoring traffic conditions (*traffic characteristics*) including volume, speed, density, etc.

2. To obtain information about traffic, the Traffic Management Subsystem can control (*traffic sensor control*) and monitor (*traffic flow*) sensors in or along the Roadway.

3. Pedestrians can request right-of-way (*crossing call*) to cross a roadway. Equipment on the roadway notifies the pedestrian when the request has been granted (*crossing permission*) via display, audio signal or other manner. The Roadway equipment may notify the Traffic Management Subsystem that a pedestrian has requested right-of-way and when the request was or will be granted (*right-of-way request notification*).

4. The Traffic Management Subsystem may obtain information on traffic (*traffic images*) from video equipment. The equipment can be controlled (e.g. pan/tilt/zoom) (*video surveillance control*) by the Traffic Management Subsystem.

5. The Traffic Management Subsystem can configure traffic signal systems along the Roadway (*signal system configuration*) including setting control sections and mode of operation (time based or traffic responsive).

6. The Traffic Management Subsystem configures traffic signal control equipment (*signal control device configuration*) including local controllers and system masters located on the Roadway.

7. The Traffic Management Subsystem downloads signal timing parameters (*signal control plans*) to traffic signal controllers operating in basic operation or coordinated systems.

8. The Traffic Management Subsystem can control traffic signal controllers or field masters (*signal control commands*) including clock synchronization.

9. Various equipment on the Roadway can be coordinated (*roadway equipment coordination*) including traffic signal control equipment operated by adjacent jurisdictions.

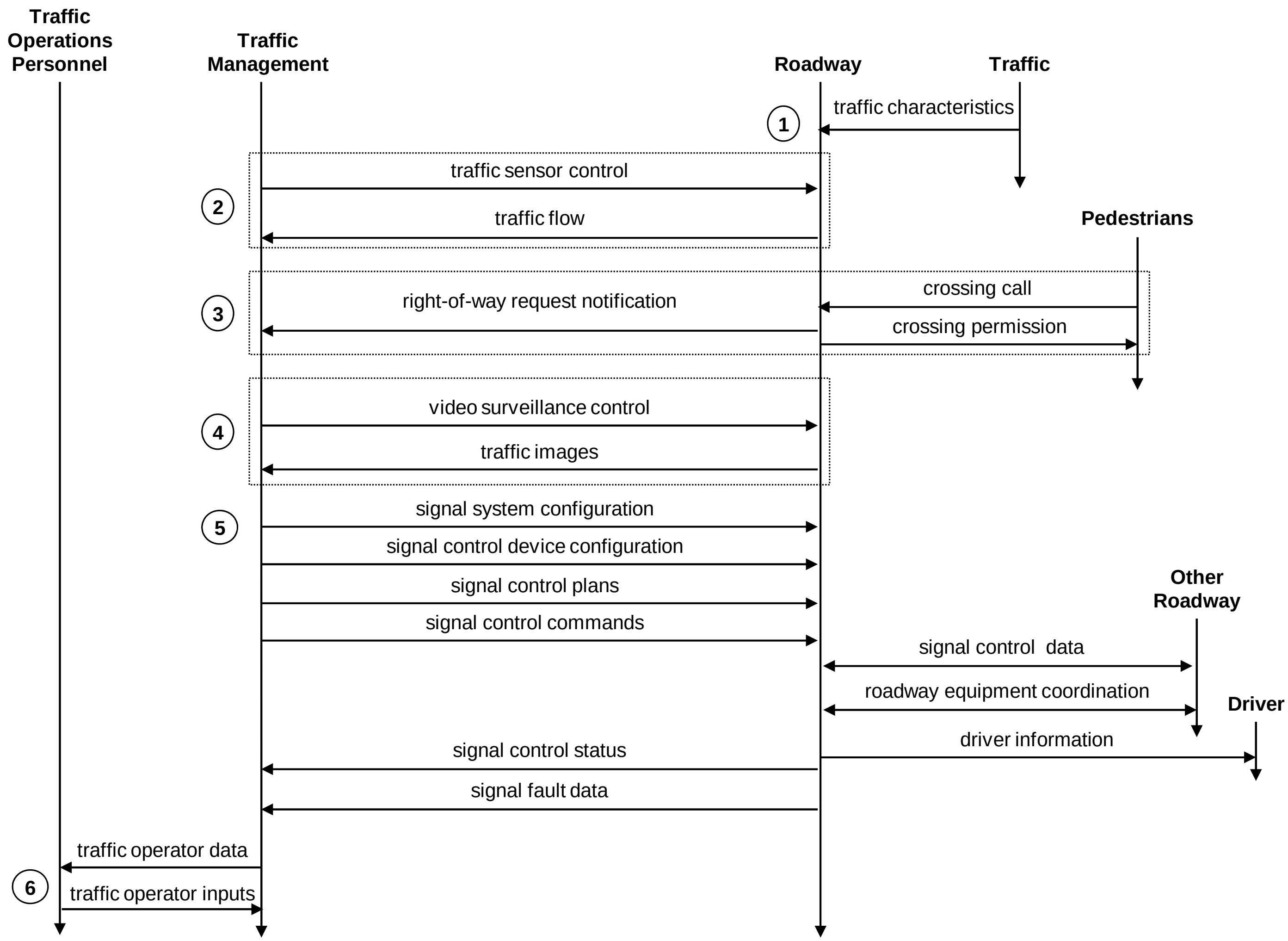
10. Roadway equipment provides the current traffic signal indications (*driver information*) to the Driver while en-route.

11. The Traffic Management Subsystem can receive operational and status data of traffic signal control equipment (*signal control status*) including operating condition and current indications.

12. Additionally, the Traffic Management Subsystem receives faults from the traffic signal control equipment (*signal fault data*).

13. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

ATMS03: Traffic Signal Control



2.4 ATMS04: Traffic Metering

This service package provides central monitoring and control, communications, and field equipment that support metering of traffic. It supports the complete range of metering strategies including ramp, interchange, and mainline metering. This package incorporates the instrumentation included in the Network Surveillance service package (traffic sensors are used to measure traffic flow and queues) to support traffic monitoring so responsive and adaptive metering strategies can be implemented. Also included is configurable field equipment to provide information to drivers approaching a meter, such as advance warning of the meter, its operational status (whether it is currently on or not, how many cars per green are allowed, etc.), lane usage at the meter (including a bypass lane for HOVs) and existing queue at the meter.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel. Equipment on the Roadway is constantly monitoring traffic conditions (*traffic characteristics*) including volume, speed, density, etc.

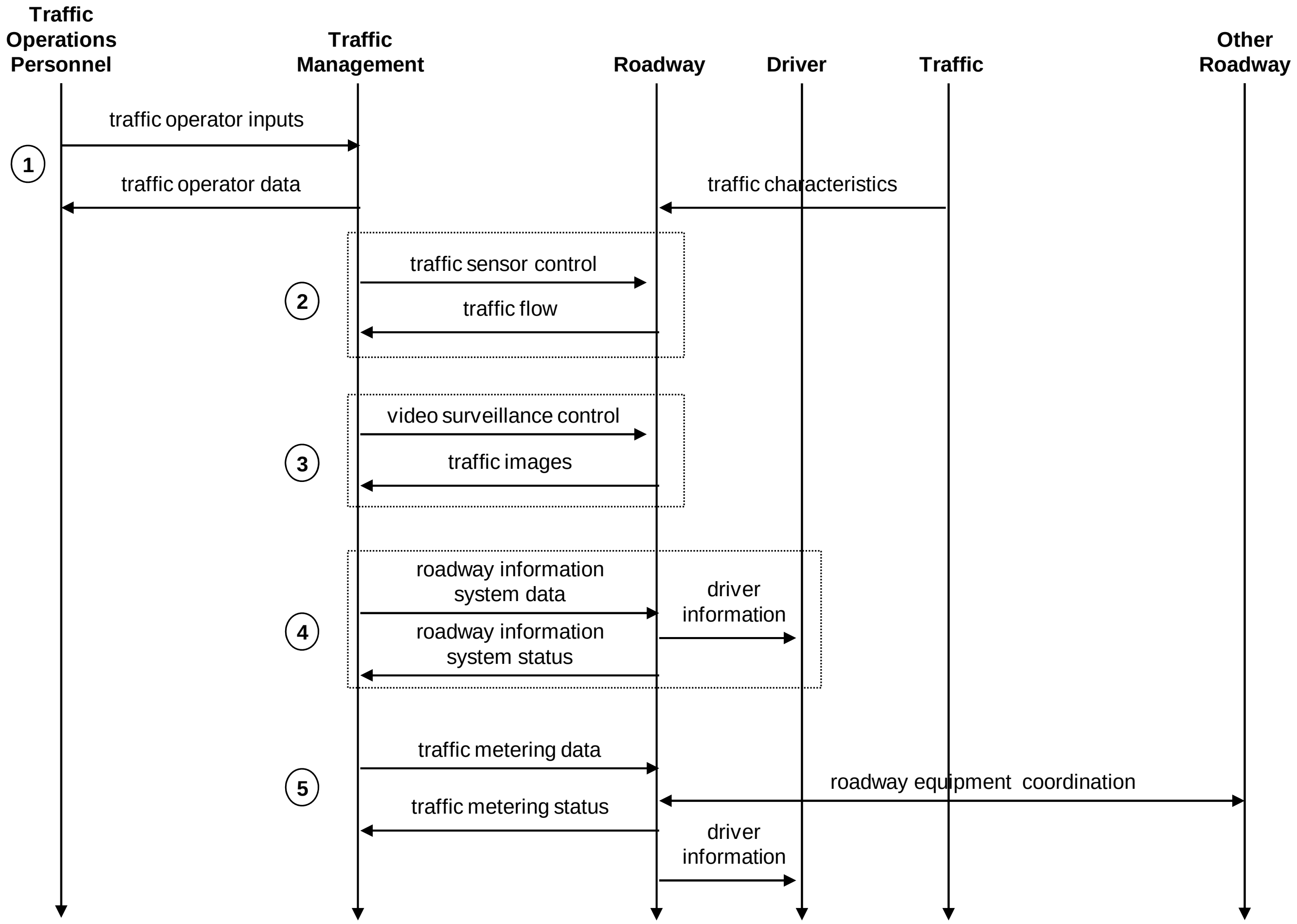
2. To obtain information about traffic, the Traffic Management Subsystem can control (*traffic sensor control*) and monitor (*traffic flow*) sensors in or along the roadway.

3. The Traffic Management Subsystem may obtain information on traffic (*traffic images* from video equipment. The equipment can be controlled e.g. pan/tilt/zoom (*video surveillance control*) by the Traffic Management Subsystem.

4. Traffic Operations Personnel can also control the information displayed to travelers on dynamic message signs or other equipment along the roadway. The Traffic Management Subsystem sends information to the dynamic message signs or other equipment (*roadway information system data*). The equipment on the roadway displays the information (*driver information*) to Drivers. The status of the equipment (*roadway information system status*) is returned to the Traffic Management Subsystem.

5. The Traffic Management Subsystem can configure, download timings and otherwise control (*traffic metering data*) equipment to meter traffic. The Traffic Management Subsystem can monitor the status of the equipment (*traffic metering status*). Roadway equipment can be coordinated (*roadway equipment coordination*) through peer-to-peer or other configurations. Additionally, the roadway equipment provides metering indications (*driver information*) to the driver while en-route.

ATMS04: Traffic Metering



2.5 ATMS05: HOV Lane Management

This service package manages HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals. Preferential treatment is given to HOV lanes using special bypasses, reserved lanes, and exclusive rights-of-way that may vary by time of day. Vehicle occupancy detectors may be installed to verify HOV compliance and to notify enforcement agencies of violations.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

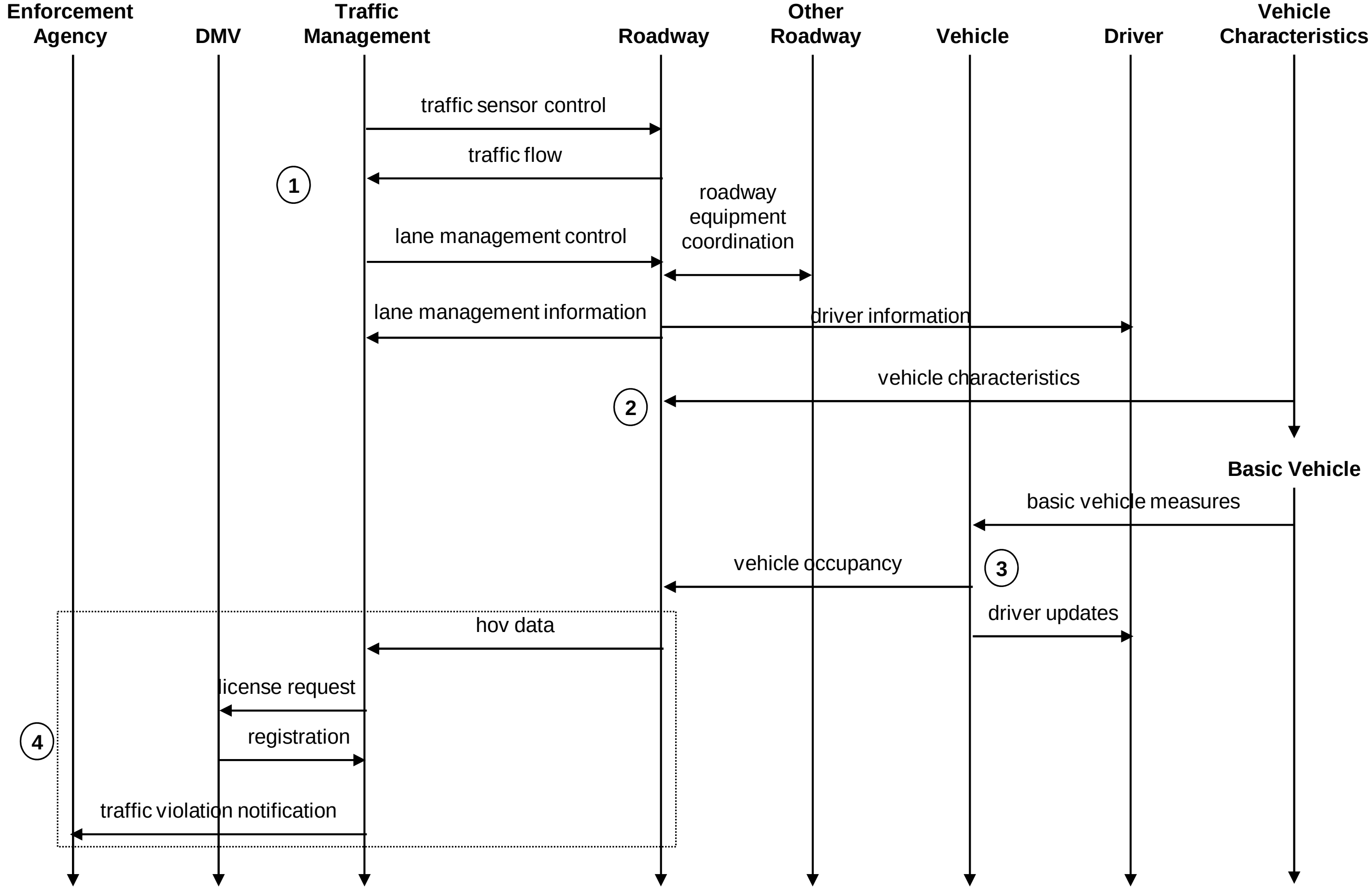
1. To obtain information about traffic, the Traffic Management Subsystem can control (*traffic sensor control*) and asynchronously monitors the volume, speed and other parameters indicating the flow of vehicles (*traffic flow*) along the roadway. The Traffic Management Subsystem can configure, download timings and otherwise control (*lane management control*) equipment along a freeway to control traffic and especially configure lanes for HOV operations. Lane control indicators and message signs can provide *driver information* indicating the status of the HOV lanes. Alternatively, control equipment may receive control inputs directly from sensor equipment along the roadway (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations. Traffic Management Subsystem can monitor the status of the HOV lane control equipment (*lane management information*).

2. Sensors in the Roadway Subsystem monitor passing vehicles to measure vehicle occupancy (*vehicle characteristics*).

3. Alternatively, the Vehicle Subsystem may count occupants and monitor their positioning within the vehicle to enhance vehicle safety (*basic vehicle measures*). The collected *vehicle occupancy* information may also be sent to the Roadway Subsystem using Field-Vehicle Communications. Vehicle occupancy that is measured by the vehicle is also available to the driver (*driver updates*).

4. The Traffic Management Subsystem monitors the flow of traffic and/or vehicle occupancies in HOV lanes (*hov data*). When a violation in the use of an HOV lane is detected, the Traffic Management Subsystem may contact the DMV (*license request*) to determine the registered owner of vehicle (*registration*). Violations (*traffic violation notification*) are reported to an Enforcement Agency.

ATMS05: HOV Lane Management



2.6 ATMS06: Traffic Information Dissemination

This service package provides driver information using roadway equipment such as dynamic message signs or highway advisory radio. A wide range of information can be disseminated including traffic and road conditions, closure and detour information, travel restrictions, incident information, and emergency alerts and driver advisories. This package provides information to drivers at specific equipped locations on the road network. Careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), Transit Management, Emergency Management, and Information Service Providers. A link to the Maintenance and Construction Management subsystem allows real time information on road/bridge closures and restrictions due to maintenance and construction activities to be disseminated. The sharing of transportation operations data described in this service package also supports other services like ATMS09- Traffic Decision Support and Demand Management.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Maintenance and Construction Management Subsystem provides current restrictions (*current asset restrictions*) such as height and weight restrictions to the Traffic Management Subsystem. This information can be sent when new restrictions are put in place or on a set schedule. Similarly the Border Inspection Systems sends *border wait times data*.

2. Traffic Operations Personnel can control (*traffic operator inputs*) the information broadcast to travelers via HAR or other broadcasting equipment. The Traffic Management Subsystem controls (*roadway information system data*) the equipment on the roadway that broadcast information (*broadcast advisories*) to Basic Vehicles.

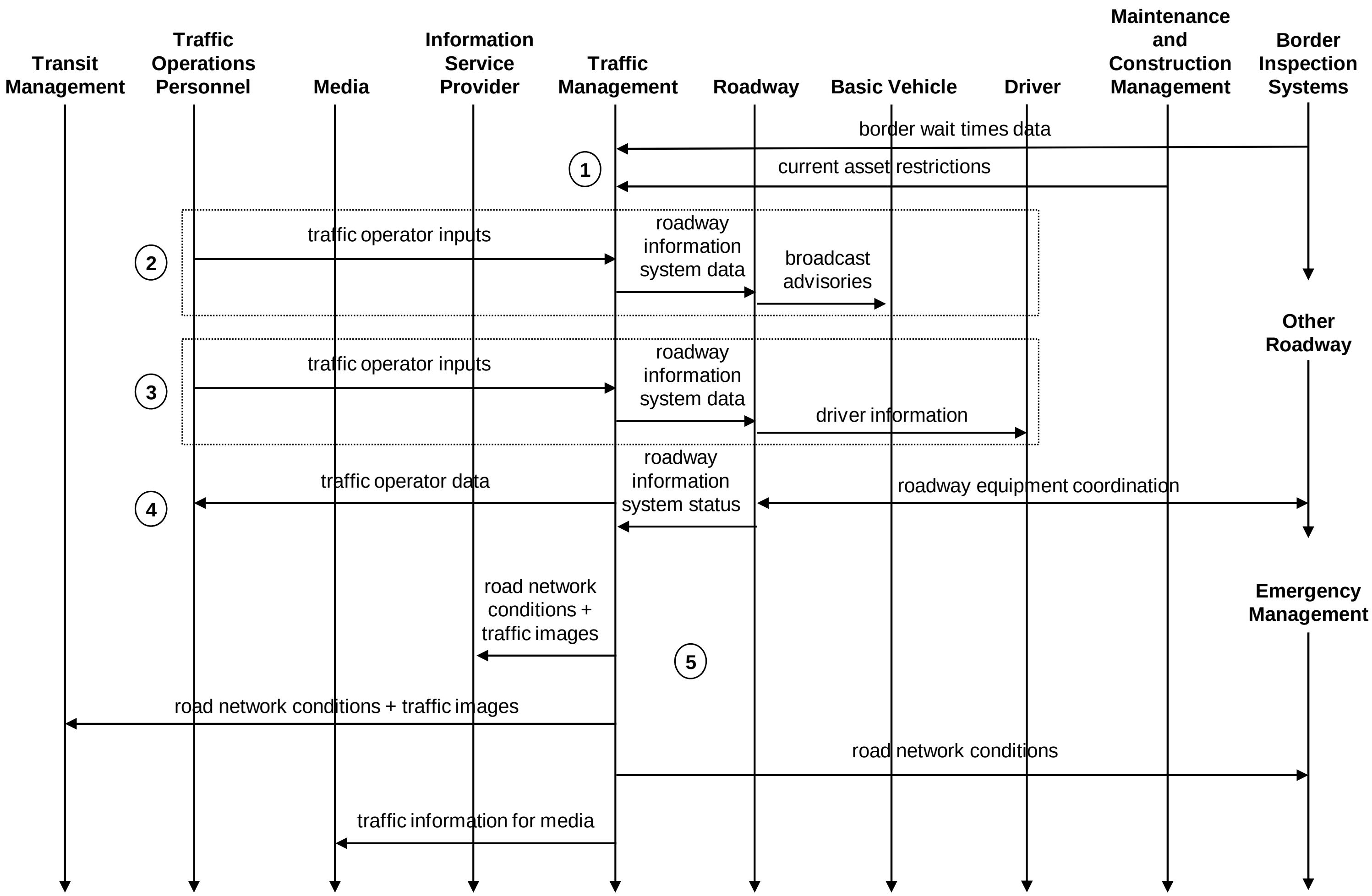
3. Traffic Operations Personnel can also control (*traffic operator inputs*) the information displayed to travelers on dynamic message signs or other equipment along the roadway. The Traffic Management Subsystem controls (*roadway information system data*) the equipment on the roadway that displays information (*driver information*) to Drivers.

4. Roadway equipment can be coordinated (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations. Status of the roadway information equipment (*roadway information system status*) can be monitored by the Traffic Management Subsystem. The entire process is under the asynchronous monitoring (*traffic operator data*) of Traffic Operations Personnel.

5. Traffic Management Subsystem can share the current and/or expected use of the road network (*road network conditions* and *traffic images*) with an Information Service Provider Subsystem, Transit Management Subsystem, Emergency Management Subsystem and/or the Media. This

information can be provided on a set update interval, when conditions change, or on request (request flows not included in the architecture).

ATMS06: Traffic Information Dissemination



2.7 ATMS07: Regional Traffic Management

This service package provides for the sharing of traffic information and control among traffic management centers to support regional traffic management strategies. Regional traffic management strategies that are supported include inter-jurisdictional, real-time coordinated traffic signal control systems and coordination between freeway operations and traffic signal control within a corridor. This service package advances the ATMS03-Traffic Signal Control and ATMS04-Traffic Metering service packages by adding the communications links and integrated control strategies that enable integrated, interjurisdictional traffic management. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Traffic Signal Control and Traffic Metering service packages and adds hardware, software, and fixed-point to fixed-point communications capabilities to implement traffic management strategies that are coordinated between allied traffic management centers. Several levels of coordination are supported from sharing of information through sharing of control between traffic management centers.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

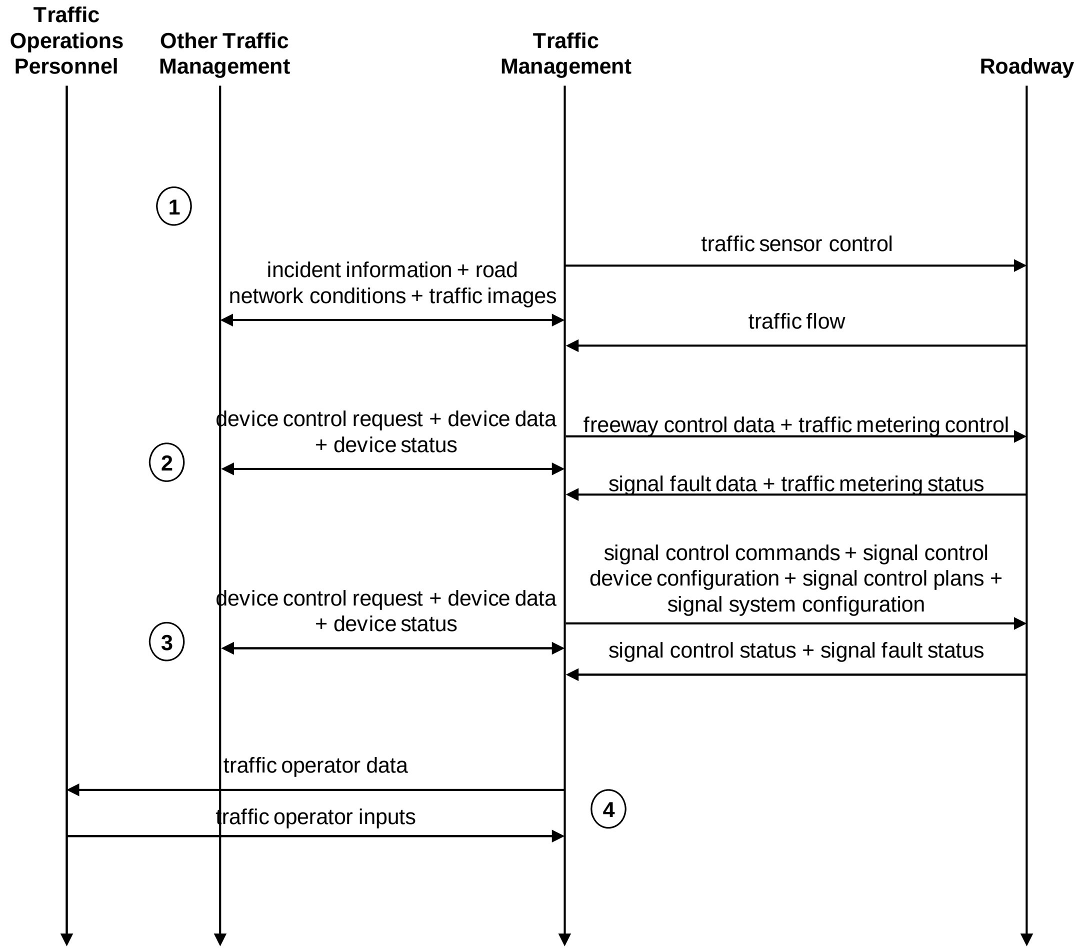
1. To obtain information about traffic, the Traffic Management Subsystem can control (*traffic sensor control*) and monitor (*traffic flow*) sensors in or along the Roadway. Traffic Management Subsystems can share information on traffic conditions (*incident information*, *road network conditions*, *traffic images*) so traffic operations can be coordinated.

2. Traffic Management Subsystems can share (*device control request*, *device data* and *device status*) monitoring (*signal fault data*, *traffic metering status*) and/or control (*freeway control data*, *traffic metering control*) of equipment on freeways. Shared monitoring might allow video images from surveillance cameras to be viewed. Shared control might allow surveillance cameras to be panned, tilted or zoomed or ramp meter control where the metering plan is selected based on the timing scheme of the surface street feeding the ramp.

3. Traffic Management Subsystems share (*device control request*, *device data*, *device status*) monitoring (*signal control status*, *signal fault status*) and/or control (*signal control commands*, *signal control device configuration*, *signal control plans*, *signal system configuration*) of equipment on surface streets. Shared monitoring might include monitoring of traffic signal systems. Shared control might include surveillance cameras that can be panned, tilted or zoomed or selection of traffic signal timing plans during evening hours when a center is not staffed.

4. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

ATMS07: Regional Traffic Management



2.8 ATMS08: Traffic Incident Management System

This service package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The service package includes incident detection capabilities through roadside surveillance devices (e.g. CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers as well as rail operations and event promoters. Information from these diverse sources is collected and correlated by this service package to detect and verify incidents and implement an appropriate response. This service package supports traffic operations personnel in developing an appropriate response in coordination with emergency management, maintenance and construction management, and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications or resource coordination between center subsystems. Incident response also includes presentation of information to affected travelers using the Traffic Information Dissemination service package and dissemination of incident information to travelers through the Broadcast Traveler Information or Interactive Traveler Information service packages. The roadside equipment used to detect and verify incidents also allows the operator to monitor incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other allied response agencies and field service personnel.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Incident information may be displayed on a map of the transportation network. The Traffic Management Subsystem and the Emergency Management Subsystem may use such maps to manage incidents. To keep the base map up to date, an update (*map updates*) can be acquired from a Map Update Provider. The update can be requested (*map update request*) when one is desired. Otherwise, the Map Update Provider could provide an update on a set schedule or as revisions warrant it.

2. An incident can be a planned event. Event promoters can notify the Traffic Management Subsystem and/or the Emergency Management Subsystem of planned events (*event plans*). The details of the events such as time, location and expected crowd size can be provided to assist in preparing the response. If desired, a confirmation (*event confirmation*) that the event plans were received can be sent.

3. The Traffic Management Subsystem can receive schedules of trains (*railroad schedules*) that have at-grade crossings so that street closures can be anticipated and travelers notified and/or response plans implemented. Additionally, the Traffic Management Subsystem can be notified by an Information Service Provider of routes to be taken by groups of vehicles, or special vehicles (*logged vehicle routes*) that might require specialized traffic control stategies.

4. Equipment on the Roadway is constantly monitoring traffic conditions (*traffic characteristics*) such as volume, speed, density, etc. and can be analyzing the data to detect incidents. The Traffic

Management Subsystem can control (*traffic sensor control*) and monitor (*traffic flow*) the sensors in or along the roadway. Roadway equipment can be coordinated (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations. Examples of this coordination might be between field masters and traffic sensors. The Traffic Operations Personnel apply control as part of *traffic operator inputs*, and receive outputs as part of *traffic operator data*.

5. The Media may be monitoring traffic independently and may share information (*external reports*) including the identification of an incident with the Traffic Management Subsystem. Rail Operations may notify the Traffic Management Subsystem of railway-related incidents (*railroad advisories*) or notify the Emergency Management Subsystem of the same (*incident information*).

6. The Emergency Management Subsystem may need to view and/or control (*remote surveillance control*) surveillance cameras and other equipment during an incident. The Traffic Management Subsystem controls the surveillance equipment (*video surveillance control*) and may place limits on their control by other agencies. The Traffic Management Subsystem receives *traffic images* from the surveillance equipment. The images are passed to the Traffic Operations Personnel (as part of *traffic operator data*). The Traffic Management Subsystem can provide the Emergency Management Subsystem with information on the current traffic conditions (*road network conditions*) and video images of the traffic (*traffic images*) to aid in the response to and management of the incident. *Road network conditions* and *traffic images* is also provided to the Information Service Provider to support monitoring by traveler information service providers and their clients. The Traffic Operations Personnel apply control as part of *traffic operator inputs*, and receive outputs as part of *traffic operator data*.

7. Multiple Traffic Management Subsystems may share information (*incident information*, *road network conditions* and *traffic images*) including information on incidents and the response to them. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

8. When an incident is detected, the Traffic Management Subsystem, the Maintenance and Construction Management Subsystem and the Emergency Management Subsystem will notify (*incident information*) the other subsystems and keep them updated throughout an extended incident. The Emergency Management Subsystem also exchanges *incident information* with Rail Operations. The Emergency Management and Traffic Management Subsystems also share *incident information* with the Information Service Provider Subsystem and the Transit Management Subsystem. The Emergency Management and Traffic Management Subsystems provides the Media with incident information that has been reviewed for public distribution (*traffic information for media*).

9. Once an incident is detected and verified, incident response can begin. The *incident response status* is sent from the Emergency Management Subsystem to Traffic Management Subsystem, Maintenance and Construction Management Subsystem, Transit Management Subsystem, and Rail Operations. The Traffic Management Subsystem would also inform the Emergency Management Subsystem of its *incident response status*. In the case where the incident involves response by rail assets, then Rail Operations would inform Emergency Management Subsystem of its *rail incident response status*. The Emergency Management Subsystem may coordinate the response to incidents with Other Emergency Management (*incident response coordination*.) or may coordinate with Other

Emergency Management the incident command assignment or status (*incident command information coordination*).

10. A key to incident response is providing information to emergency vehicles by the Emergency Management Subsystem. The Emergency Systems Operator initiates the providing of information (as part of *emergency operations inputs*). The Emergency Management Subsystem sends *decision support information* to the Emergency Vehicle Subsystem, which might contain information about the incident, information on dispatched resources, and ancillary information such as road and weather conditions. The information is forwarded to the Emergency Personnel with *emergency personnel information presentation*. The Emergency Personnel provide incident and dispatch status to the Emergency Vehicle Subsystem (as part of *emergency personnel inputs*). This *incident status* is sent to the Emergency Management Subsystem, where it is forwarded to the Emergency Systems Operator (as part of *emergency operations status*).

11. Incident command posts may be set up at the scene of the incident to coordinate the overall incident response. The input of incident information and response status (described above) and the request for resources (described below) may be performed by Emergency Personnel on the scene. The architecture represents this as the interface between Emergency Management Subsystem and Emergency Personnel (*incident command information presentation* and *incident command inputs*).

12. The next 3 steps are focused on incident management at or near international border crossings. Here the Border Inspection Systems participate in incident coordination along with the Traffic Management Subsystem and Emergency Management Subsystem, representing departments of transportation and public safety agencies with jurisdictions at or near the border.

13. The Border Inspection Systems may view CCTV camera images (*traffic images*) that can be used to detect and verify traffic incidents at the border. The cameras may also be remotely controlled (*remote surveillance control*) with permission from the Traffic Management Subsystem.

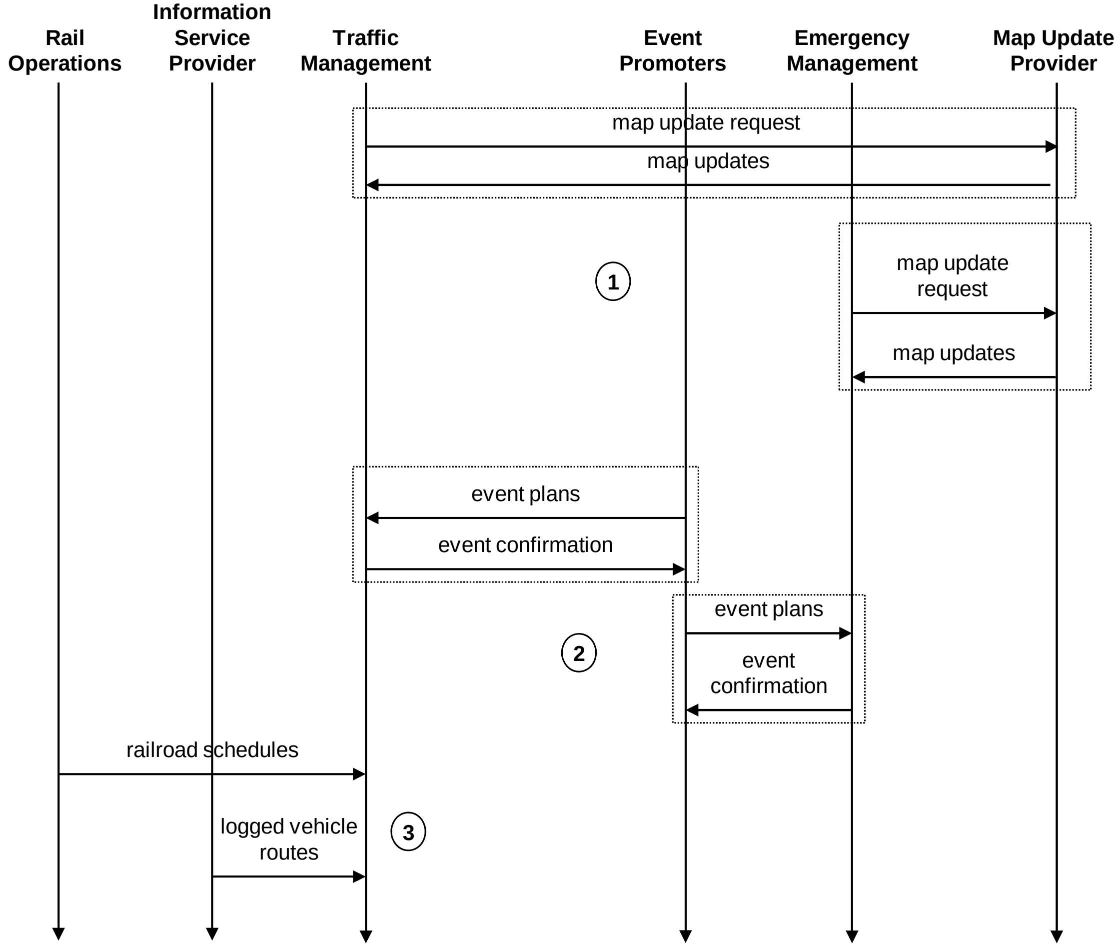
14. When an incident is identified at the border, information about the incident (*border incident information*) is shared between the Border Inspection System, Traffic Management Subsystem, and Emergency Management Subsystem. As public safety responds to the incident, the Border Inspection System and Traffic Management Subsystem are apprised of current response status (*border incident response status* and *incident response status*).

15. To respond to an incident, the Emergency Management Subsystem may request resources (*maint and constr resource request*) such as cones, barricades, sand and help clearing roadway from the Maintenance and Construction Management Subsystem (MCMS). The request is initiated from the Emergency Systems Operator as part of *emergency operations inputs*. This request is presented to the Maintenance and Construction Center Personnel (*maint and constr operations information presentation*). With input from Maintenance and Construction Center Personnel (*maint and constr center personnel inputs*) and Other Maintenance and Construction (*maint and constr resource coordination*), a response to the resource request (*maint and constr resource response*) can be sent to the Emergency Management Subsystem. The response is presented to the Emergency Systems Operator as part of *emergency operations status*.

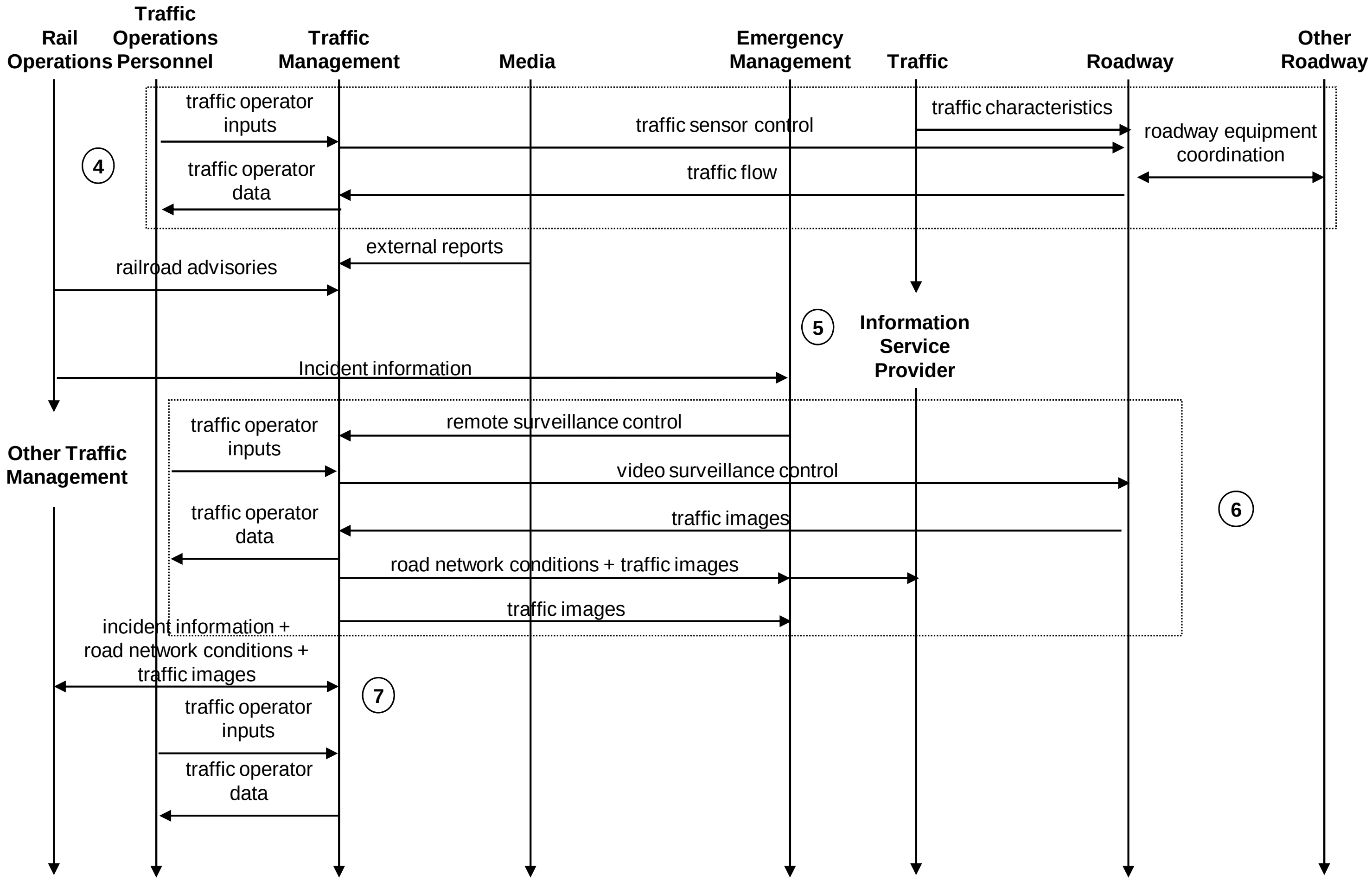
16. In responding to an incident, the Emergency Management Subsystem may need assistance (*resource request*) from the Traffic Management Subsystem. This may be a request for service such as verifying incident location, implementing special traffic control, etc. or a specific request for

resources such as cones, barriers, a front loader, etc. This request goes to the Traffic Operations Personnel (*traffic operator data*). If required, the Traffic Management Subsystem may request resources from the Maintenance and Construction Management Subsystem (*maint and constr resource request*). This request is initiated by the Traffic Operations Personnel as part of *traffic operator inputs*. This request is presented to the Maintenance and Construction Center Personnel (*maint and constr operations information presentation*). With input from Maintenance and Construction Center Personnel (*maint and constr center personnel inputs*) and Other Maintenance and Construction (*maint and constr resource coordination*), a response to the resource request (*maint and constr resource response*) can be sent back to the Traffic Management Subsystem, where it is provided to the Traffic Operations Personnel as part of *traffic operator data*. The Traffic Operations Personnel initiates a response to the request with *traffic operator inputs*. The Traffic Management Subsystem may then respond (*resource deployment status*) to the Emergency Management Subsystem on when the service will be implemented or the requested resource will arrive on the scene. *Resource request* and *resource deployment status* are bi-directional since the Traffic Management Subsystem may also request resources from the Emergency Management Subsystem.

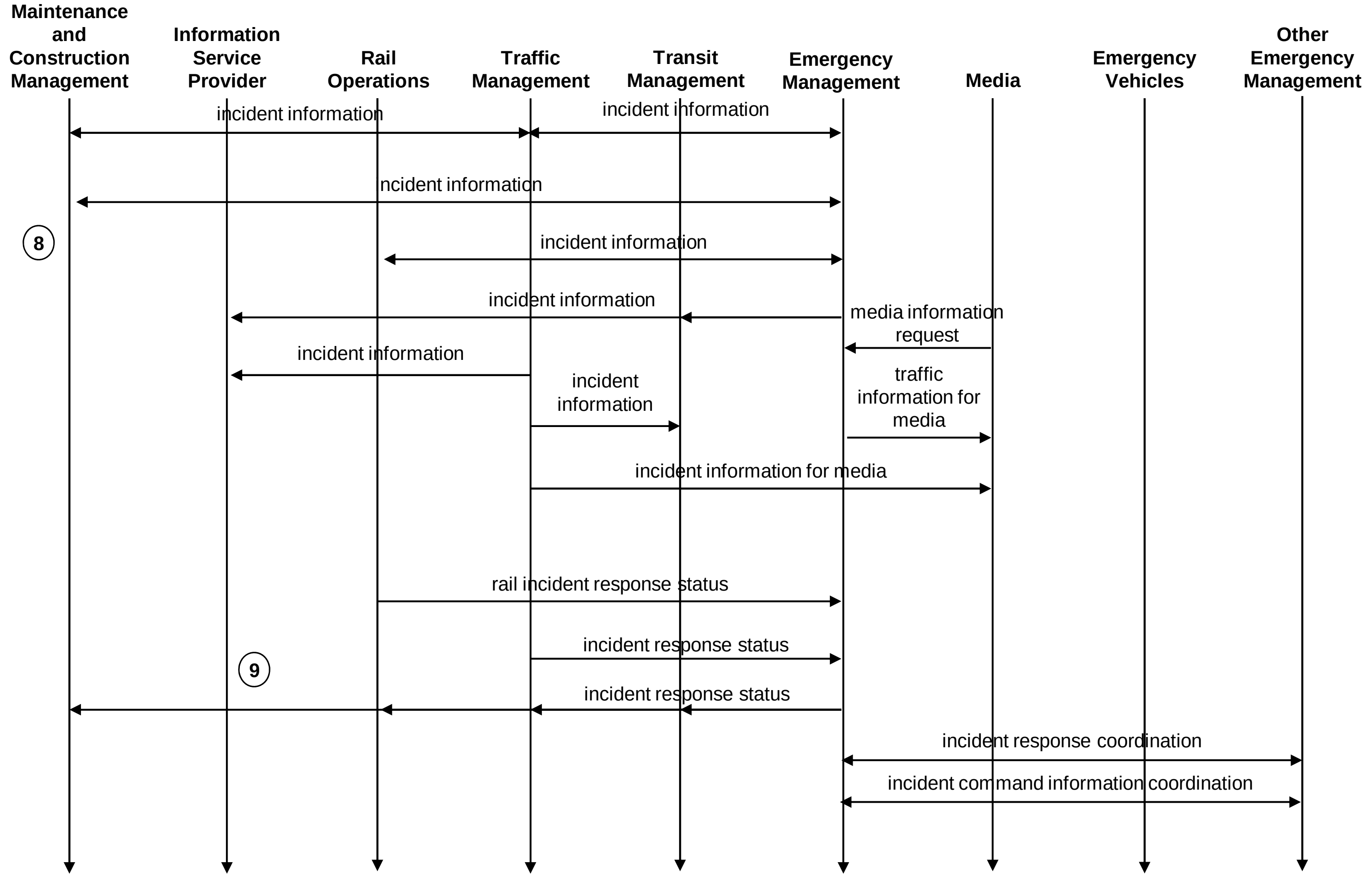
ATMS08: Traffic Incident Management System (1 of 6)
Setup and Pre-Incident Data Collection



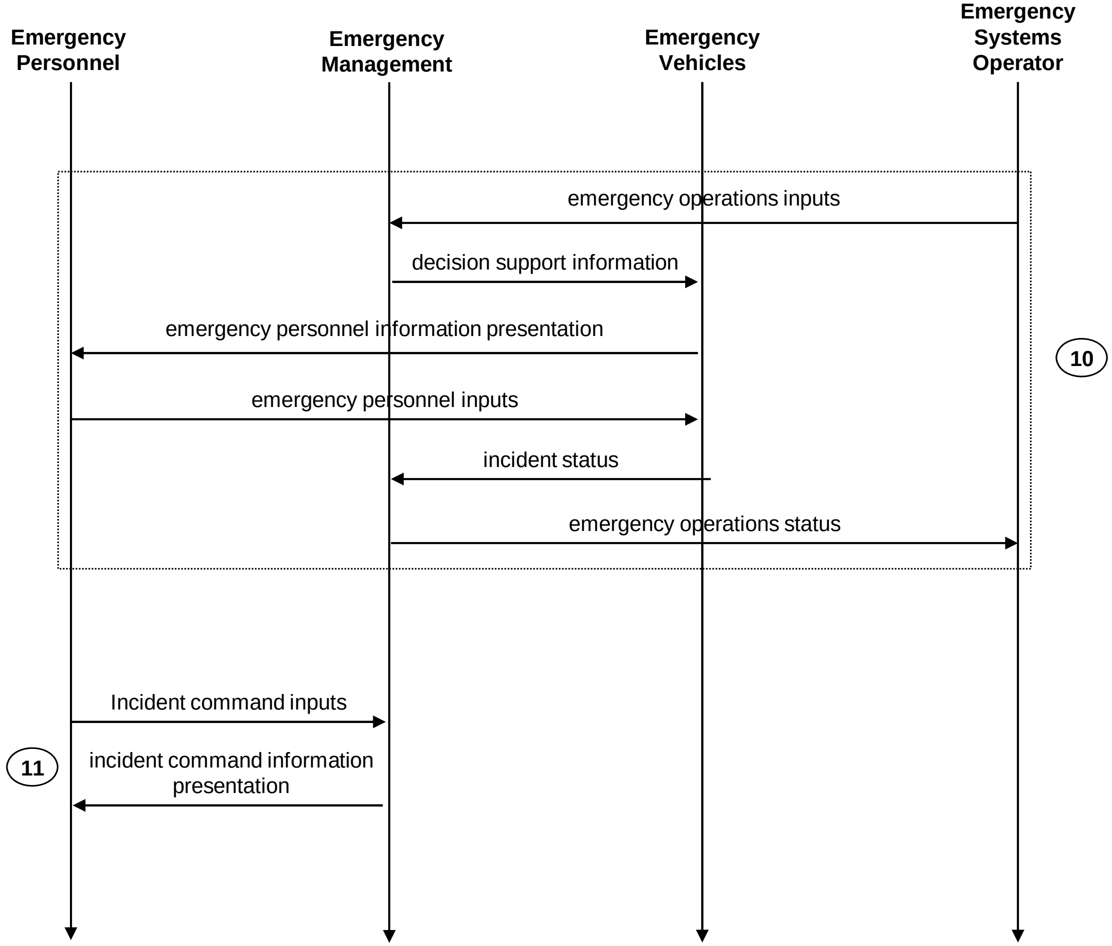
ATMS08: Traffic Incident Management System (2 of 6)
Real-Time Monitoring



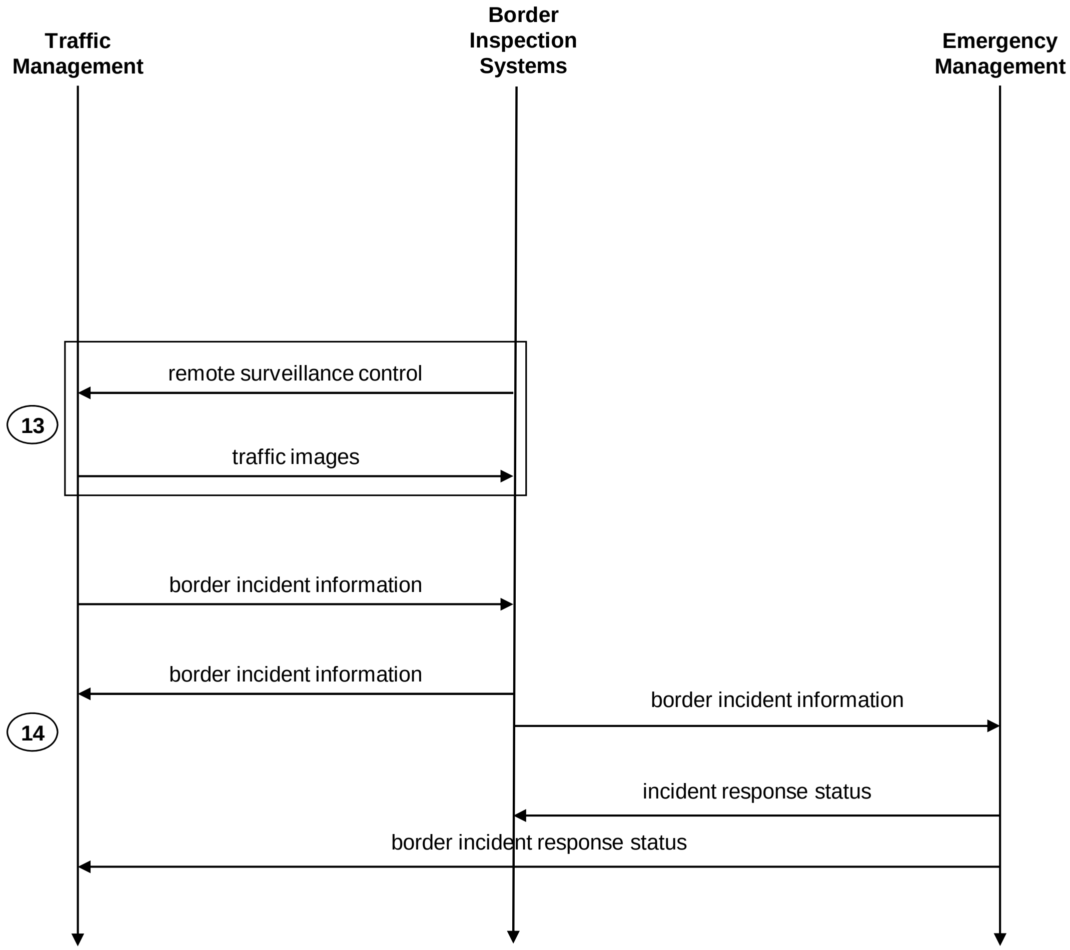
ATMS08: Traffic Incident Management System (3 of 6)
Incident Coordination



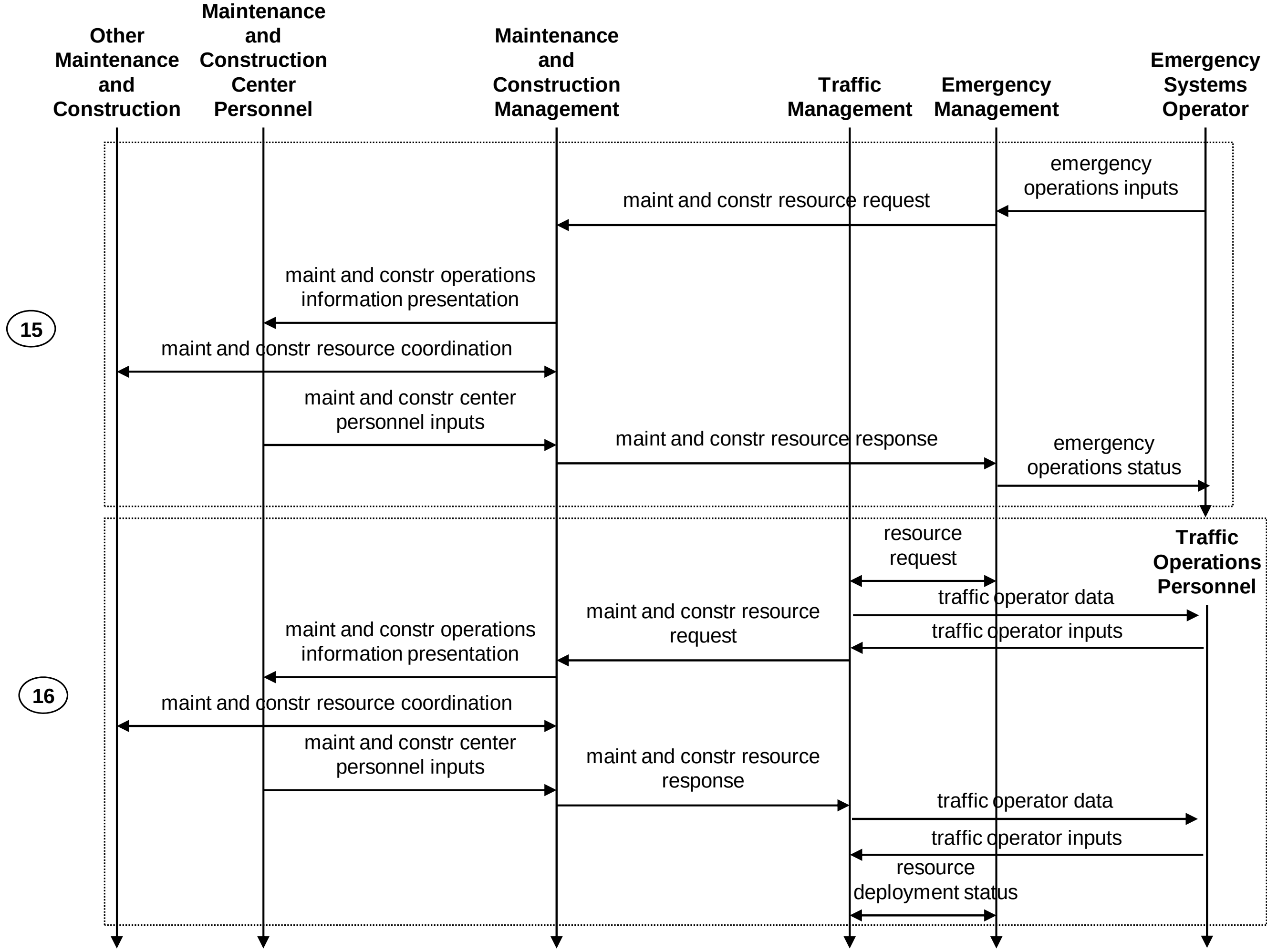
ATMS08: Traffic Incident Management System (4 of 6)
Incident Coordination (Center-Field)



ATMS08: Traffic Incident Management System (5 of 6)
Border Incident Coordination



ATMS08: Traffic Incident Management System (6 of 6)
Resource Coordination to Incidents



2.9 ATMS09: Transportation Decision Support and Demand Management

This service package recommends courses of action to traffic operations personnel based on an assessment of current and forecast road network performance. Recommendations may include predefined incident response plans and regional surface street and freeway control strategies that correct network imbalances. Where applicable, this service package also recommends transit, parking, and toll strategies to influence traveler route and mode choices to support travel demand management (TDM) programs and policies managing both traffic and the environment. TDM recommendations are coordinated with transit, parking, and toll administration centers to support regional implementation of TDM strategies. Incident response and congestion management recommendations are implemented by the local traffic management center and coordinated with other regional centers by other service packages (see ATMS07-Regional Traffic Management and ATMS08-Traffic Incident Management). All recommendations are based on historical evaluation, real-time assessment, and forecast of the roadway network performance based on predicted travel demand patterns. Traffic data is collected from sensors and surveillance equipment as well as other transportation management centers (see ATIS06-Transportation Operations Data Sharing). Forecasted traffic loads are derived from historical data and route plans supplied by the Information Service Provider Subsystem. This service package also collects air quality, parking availability, transit usage, and vehicle occupancy data to support TDM, where applicable.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Data collected by the Traffic Management Subsystem can be associated with links and nodes of the transportation network. An interface to a Map Update Provider is available to keep this model of the transportation network current (*map updates*). The update can be requested (*map update request*) when one is desired. Otherwise, the Map Update Provider could provide an update on a set schedule or as revisions warrant it.

2. To forecast traffic and develop demand management strategies, data on current and historic traffic flow and expected events are needed. Event promoters can notify Traffic Management Subsystem of planned events (*event plans*.) To obtain information on the flow of traffic such as volume and speed, the Traffic Management Subsystem can control (*traffic sensor control*) and monitor (*traffic flow*) sensors in or along the roadway. Traffic information (*road network conditions*) can also be obtained from Other Traffic Managements in the region.

3. A data archive, either a focused archive owned by the agency or a regional data warehouse, may be mined for historical information to support traffic forecast and demand management. Historical traffic data (*archived data products*) are obtained from the Archived Data Management Subsystem on request (*archived data product requests*).

4. Information on current values of transit fares, tolls and parking fees (*fare and price information*) can be obtained from an Information Service Provider (ISP).

5. Information on current or projected air quality for the region (*widearea statistical pollution information*) can be obtained from an Emissions Management Subsystem. This information can be requested (*pollution state data request*) when desired. Otherwise, it can be provided on a set schedule or as revisions warrant it.

6. The Traffic Management Subsystem can share the current and/or expected use of the road network (*road network conditions* and *traffic images*) with an ISP. The information can be requested when desired or it can be provided on a set schedule or when conditions warrant an update. The ISP can provide its view of the network provided by collected probe information (*logged vehicle routes*).

7. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

8. Traffic Management Subsystem receives the current or expected parking availability, fares, etc. (*parking information*) from Parking Management Subsystem. This information can be requested (*parking lot data request*) when desired. Otherwise, it can be provided on a set schedule or as revisions warrant it. Based on the availability of parking, traffic conditions and other factors, a regional traffic management plan can be developed. To implement the plan, parking instructions (*parking lot inputs*) are sent to the Parking Management Subsystem.

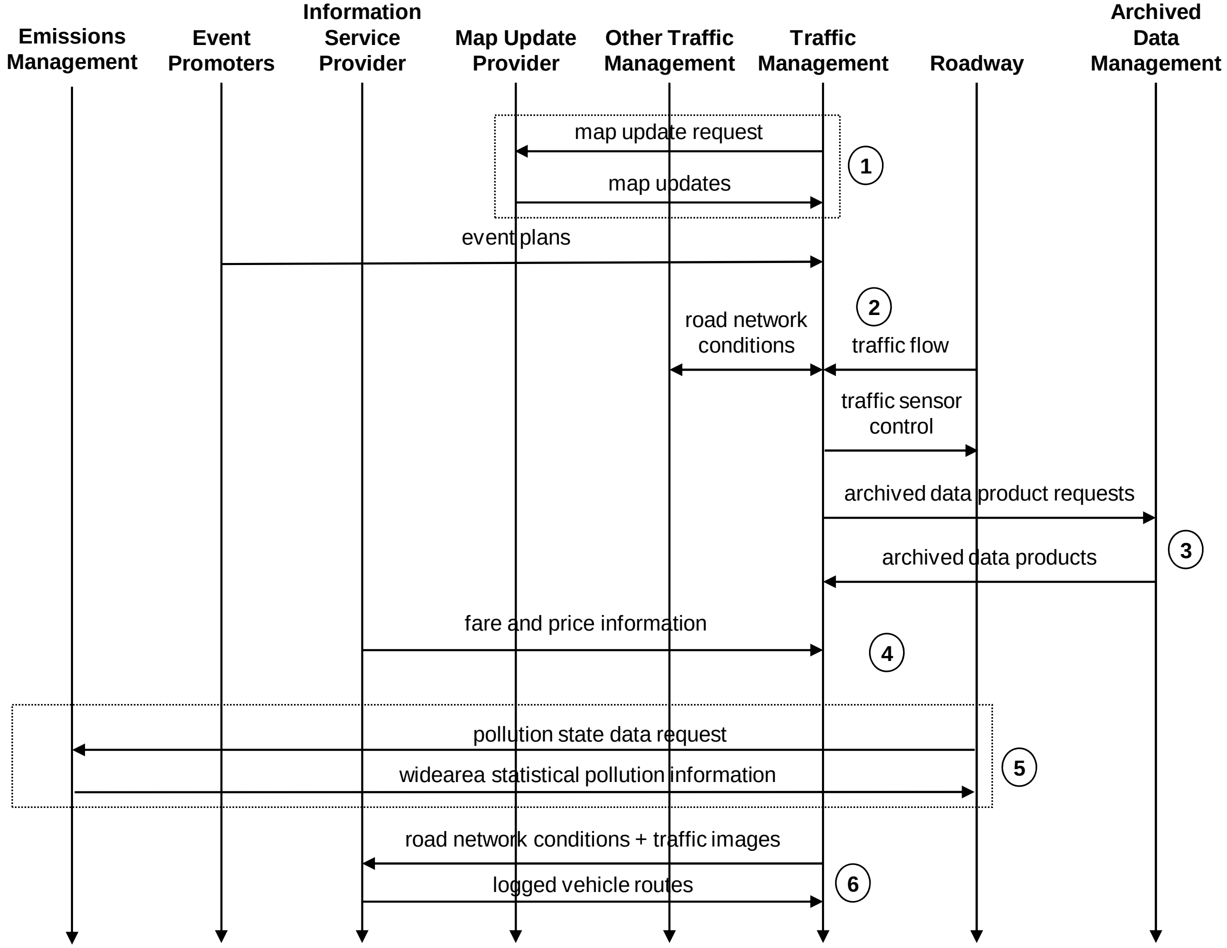
9. To assist in travel demand management, the Traffic Management Subsystem may request (*parking demand management request*) a change in parking prices or procedures. The Parking Management Subsystem may send a response (*parking demand management response*) to indicate when the request was or will be honored.

10. To assist in travel demand management, the Traffic Management Subsystem may request (*toll service change request*) a change in toll prices or procedures. The Payment Administration Subsystem may send a response (*toll service change response*) to indicate when the request was or will be honored.

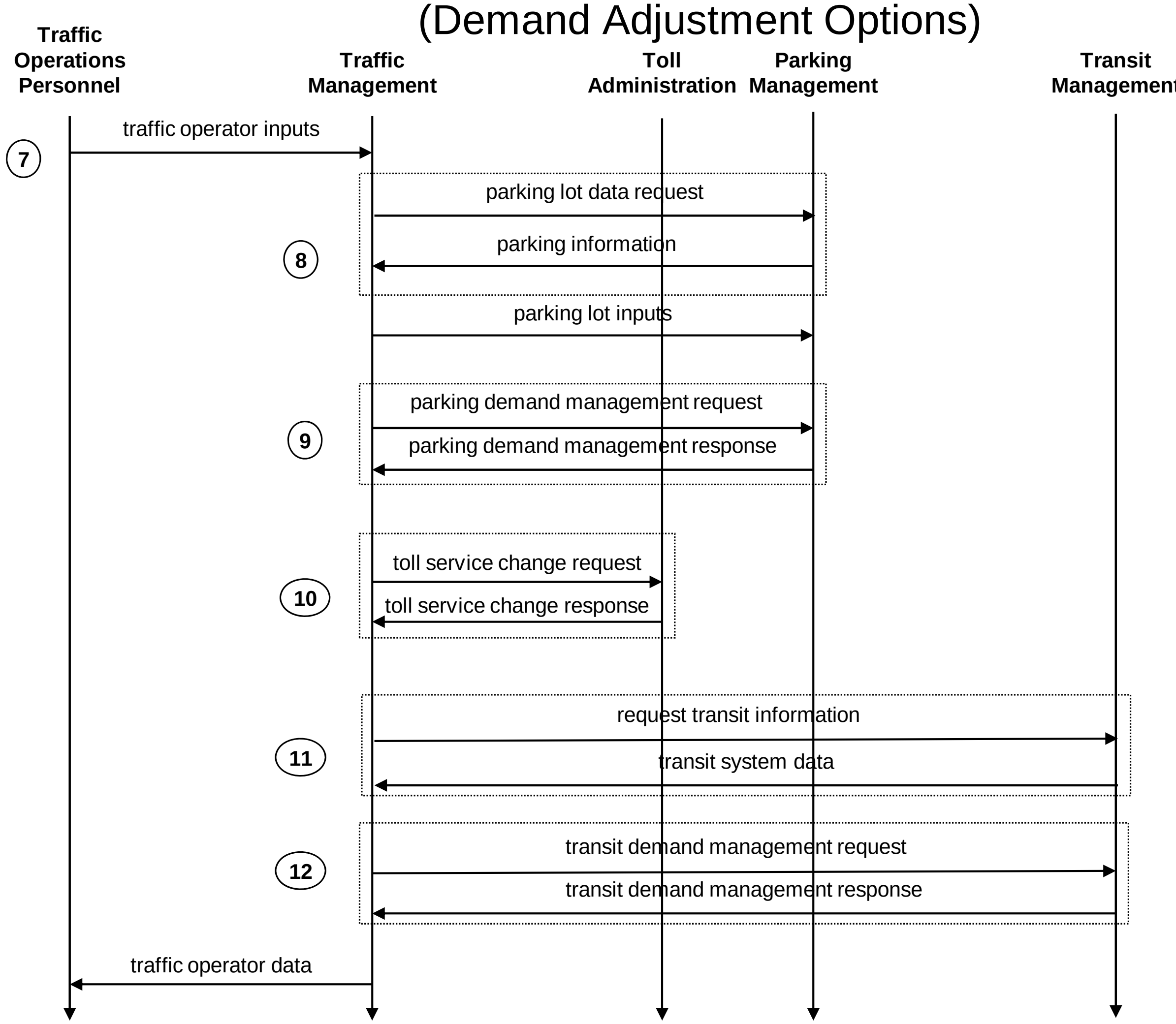
11. Traffic Management Subsystem receives the current transit system operations information indicating current transit routes, the level of service on each route, and the progress of individual vehicles along their routes (*transit system data*) from Transit Management Subsystem. This information can be requested (*request transit information*) when desired. Otherwise, it can be provided on a set schedule or as revisions warrant it.

12. To assist in travel demand management, the Traffic Management Subsystem may request (*transit demand management request*) a change in transit prices or procedures. The Transit Management Subsystem may send a response (*transit demand management response*) informing when the request was or will be honored.

ATMS09: Transportation Decision Support and Demand Management (1 of 2) (Data Collection)



ATMS09: Transportation Decision Support and Demand Management (2 of 2) (Demand Adjustment Options)



2.10 ATMS10: Electronic Toll Collection

This service package provides toll operators with the ability to collect tolls electronically and detect and process violations. The fees that are collected may be adjusted to implement demand management strategies. Field-Vehicle Communication between the roadway equipment and the vehicle is required as well as Fixed Point-Fixed Point interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Toll violations are identified and electronically posted to vehicle owners. Standards, inter-agency coordination, and financial clearinghouse capabilities enable regional, and ultimately national interoperability for these services. Two other service packages, APTS04: Transit Fare Collection Management and ATMS16: Parking Facility Management also provide electronic payment services. These three service packages in combination provide an integrated electronic payment system for transportation services.

The vehicle equipment and roadside readers that these systems utilize can also be used to collect road use statistics for highway authorities. This data can be collected as a natural by-product of the toll collection process or collected by separate readers that are dedicated to probe data collection.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. In preparation for paying tolls, the Driver requests payment of the toll (*request for service*) from the Vehicle. The Roadway Payment Subsystem monitors (*vehicle characteristics*) the physical characteristics of a passing vehicle so it can be classified and then records an image to uniquely identify it.

2. When the Roadway Payment Subsystem detects a vehicle, a (*vehicle payment request*) is made to the Vehicle. The Vehicle issues a *request for payment* from the Traveler Card. When *payment* is received from the Traveler Card, a response (*vehicle payment information*) is sent to the Roadway Payment Subsystem that responds with a *vehicle payment update*. A message (*in-vehicle transaction status*) may be sent by the Vehicle to the Driver to confirm payment.

3. When a toll payment is made, the status of the payment (*roadside transaction status*) may be displayed to the Driver with a signal, sign, or other equipment. Tolls that are collected (*toll transactions*) are sent to the Payment Administration Subsystem. The tolls can be sent as collected or can be aggregated and sent on a set schedule or as warranted. The Payment Administration Subsystem can provide information such as speed and travel time on vehicles paying tolls (*toll probe data*) to the Information Service Provider and Traffic Management Subsystem.

4. Whenever there is any type of significant regional event that requires evacuation, the Emergency Management Subsystem can send a *toll service change request* to the Payment Administration Subsystem in order to temporarily reduce or drop the toll charges to facilitate rapid evacuation via a toll road. The Payment Administration Subsystem makes the appropriate changes and then indicates what has been done or will be done in a *toll service change response* to the Emergency Management Subsystem.

5. An Information Service Provider can provide the current and advanced toll schedules for different types of vehicles (*toll data*) to the Fleet and Freight Management Subsystem. This information can be requested (*toll data request*) or can be provided on a set schedule or as revised.

6. To assist in travel demand management, the Traffic Management Subsystem may make a *toll service change request* to change toll prices or procedures. The Payment Administration Subsystem may send a *toll service change response* to indicate when the request was or will be honored.

7. The toll collection process is under the asynchronous setting of tolls (*toll instructions*) by the Payment Administration Subsystem.

8. The Information Service Provider and the Fleet and Freight Management Subsystem receive current and advanced toll schedules for different types of vehicles (*toll data*). This information can be requested (*toll data request*) or it can be sent on a set schedule or as revisions warrant.

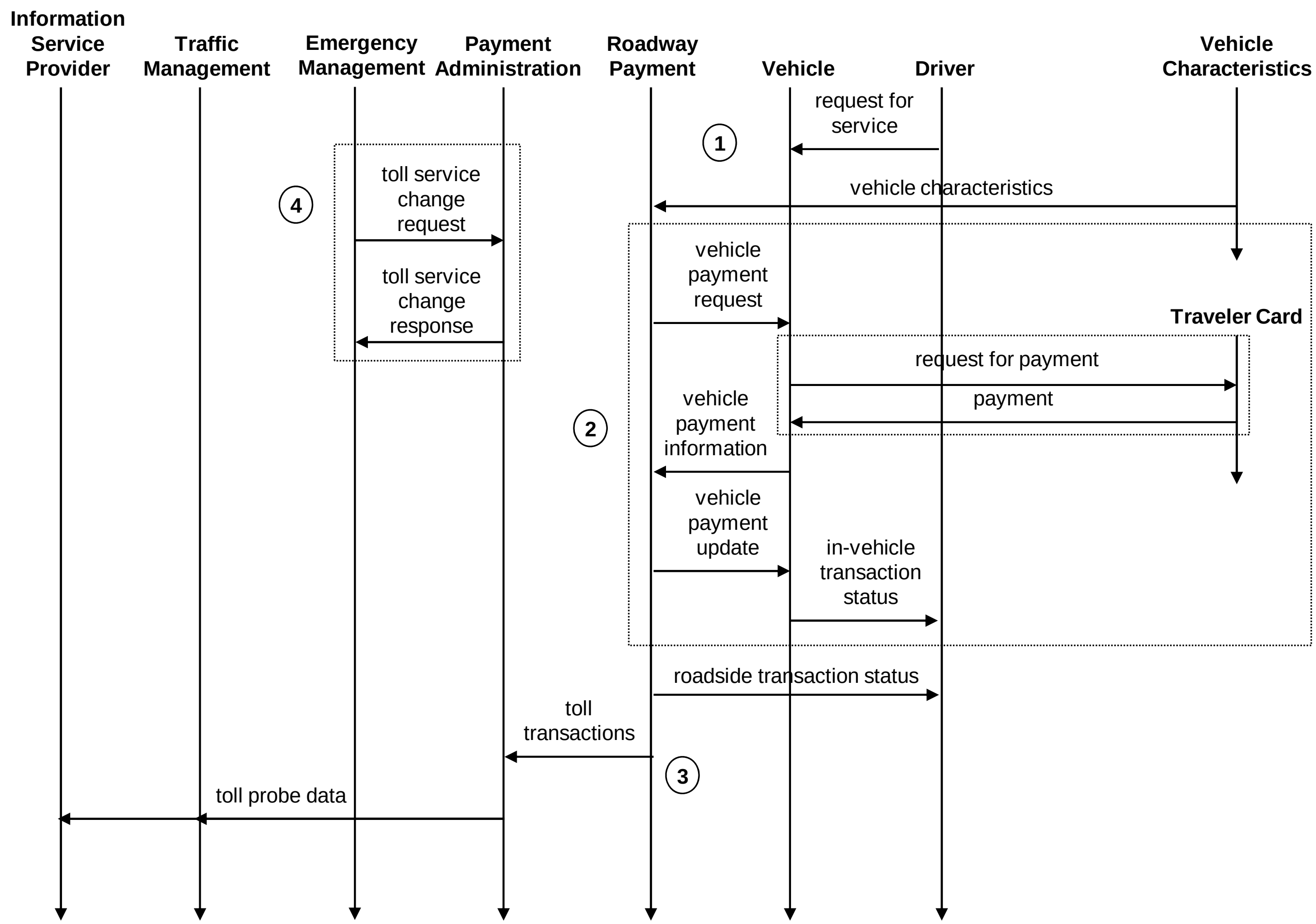
9. Tolls that are collected (*toll transactions*) by the Roadway Payment Subsystem are sent to the Payment Administration Subsystem. The tolls can be sent as collected or can be aggregated and sent on a set schedule or as warranted. The Payment Administration Subsystem sends the payments (*payment request*) to a Financial Institution. The Financial Institution may respond with *transaction status*. When an invalid payment is detected, the Payment Administration Subsystem may contact the DMV (*license request*) to determine the registered owner of the offending vehicle (*registration*). Violations (*payment violation notification*) are reported to an Enforcement Agency.

10. The Payment Administrator can request (*payment administration requests*) information on payment operation. When requested or on a set schedule, the Payment Administration Subsystem provides a *payment information presentation* to the Payment Administrator.

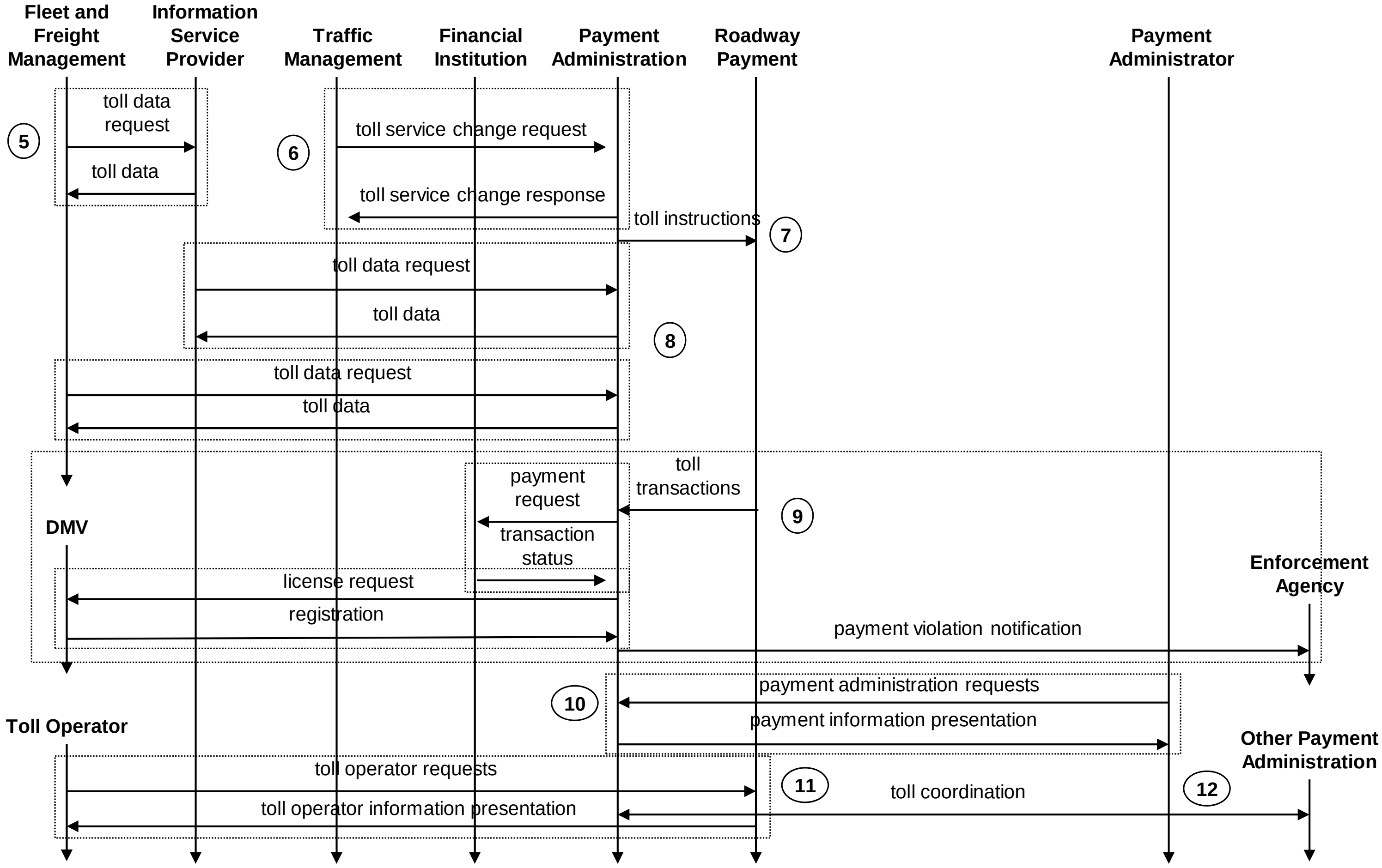
11. The Toll Operator can make *toll operator requests* for information on toll operations. When requested or on a set schedule, the Roadway Payment Subsystem provides a *toll operator information presentation* to the Toll Operator.

12. The Payment Administration Subsystem can support reciprocity between toll agencies/service centers. The Payment Administration Subsystem exchanges information (*toll coordination*) to support reconciliation of toll charges by customers that are enrolled with Other Payment Administrations. Additionally, toll schedule information, customer information and other toll service information are provided to coordinate toll operations.

ATMS10: Electronic Toll Collection (1 of 2)
Real-Time Transactions



ATMS10: Electronic Toll Collection (2 of 2)
Non Real-Time Transactions



2.11 ATMS11: Emissions Monitoring and Management

This service package monitors individual vehicle emissions and provides general air quality monitoring using distributed sensors to collect the data. The collected information is transmitted to the emissions management subsystem for processing. Both area wide air quality monitoring and point emissions monitoring are supported by this service package. For area wide monitoring, this service package measures air quality, identifies sectors that are non-compliant with air quality standards, and collects, stores and reports supporting statistical data. For point emissions monitoring, this service package collects data from on-board diagnostic systems and measures tail pipe emissions to identify vehicles that exceed emissions standards and/or clean vehicles that could be released from standard emissions tests, depending on policy and regulations. Summary emissions information or warnings can also be displayed to drivers. The gathered information can be used to implement environmentally sensitive TDM programs, policies, and regulations.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Emissions Management Subsystem (EMMS) collects air quality information using distributed sensors. Environmental *pollutant levels* are monitored using sensors that provide *area pollution data* back to the EMMS. The EMMS controls the air quality sensors (*pollution sensor control*).

2. The Emissions Management Subsystem (EMMS) also monitors emissions of passing vehicles. Passing vehicles may support this monitoring by collecting *basic vehicle measures* and providing *vehicle diagnostics data* that includes drive train performance and collected emissions data to the Roadway using Field-Vehicle Communications. The EMMS provides the current criteria of acceptable emission levels and control parameters (*emissions sensor control*) to the monitoring equipment on the Roadway. The equipment receives and/or measures emissions of passing vehicles and identifies vehicles (*vehicle characteristics*) that meet or exceed the acceptable standards. *Vehicle emissions data* is sent from the Roadway to the Emissions Management Subsystem.

3. There are several ways to handle vehicles that exceed acceptable emissions levels. First, roadway equipment can be coordinated (*roadway equipment coordination*) to allow the emission equipment to cause a prescribed message to appear on a roadway information device (e.g., DMS) to notify the offending driver (*driver information*). This equipment coordination can be peer-to-peer, master-slave, or in other configurations. Second, Field-Vehicle Communications can be used to communicate emissions information to vehicles (*vehicle signage data*) which then present the information to their drivers (*driver updates*).

4. Alternatively, emissions violations detected by the Emissions Management Subsystem may be sent to the DMV (*license request*) to determine the registered owner of the vehicle (*registration*). Violations (*emissions violation notification*) are reported to an Enforcement Agency.

5. The Emissions Management Operator can request pollution data compliance levels for a specific region (*pollution data parameters*) from the Emissions Management Subsystem. The Emissions

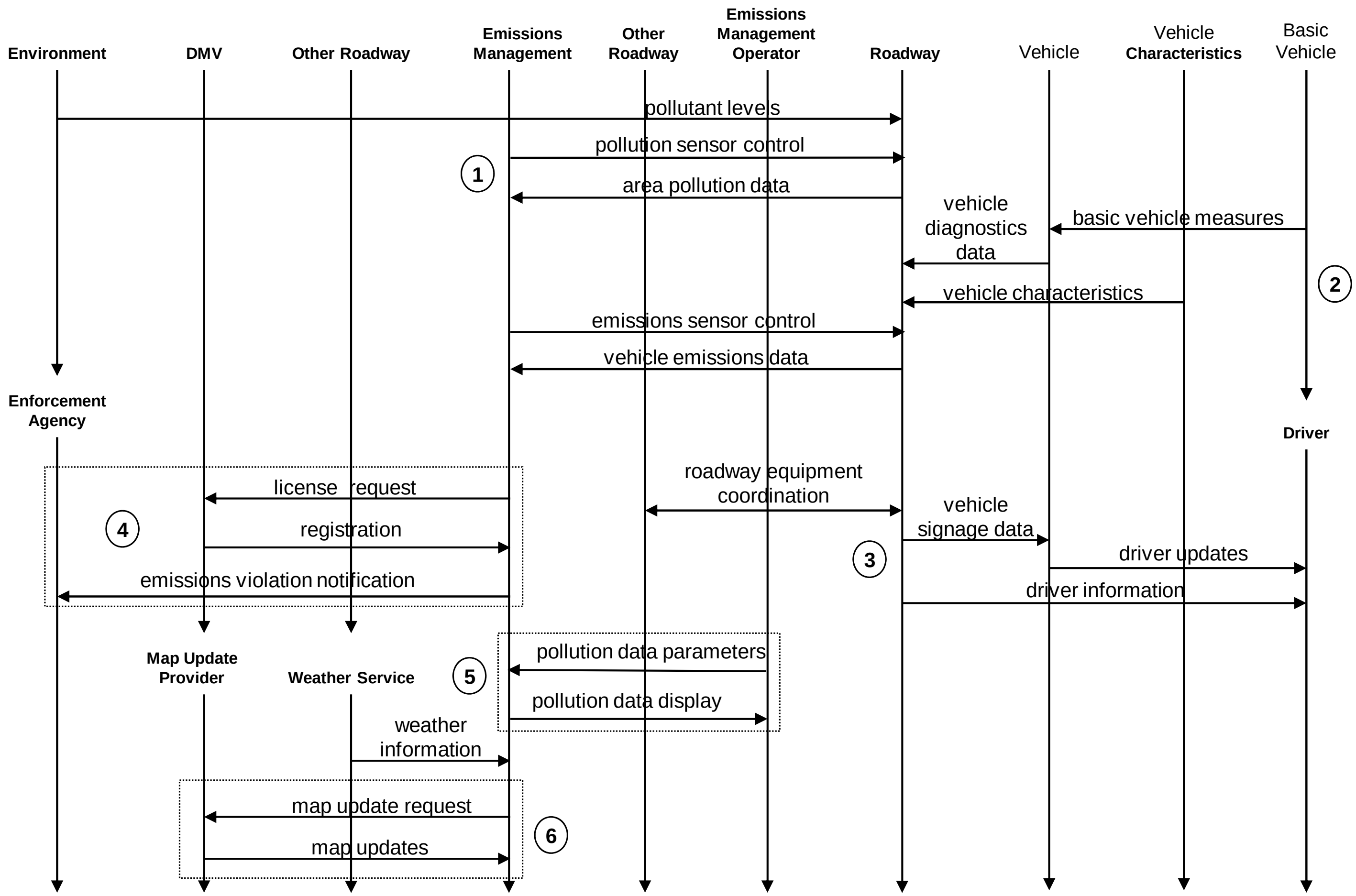
Management Subsystem responds with reference and/or current pollution status details (*pollution data display*) for the specified area.

6. The Emissions Management Subsystem analyzes the results of the collected area pollution data, factors in the *weather information* provided by the Weather Service, and may choose to display the information on a map of the transportation network. To keep the base map up to date, *map updates* can be acquired from a Map Update Provider upon request (*map update request*), on a set schedule, or as revisions warrant it.

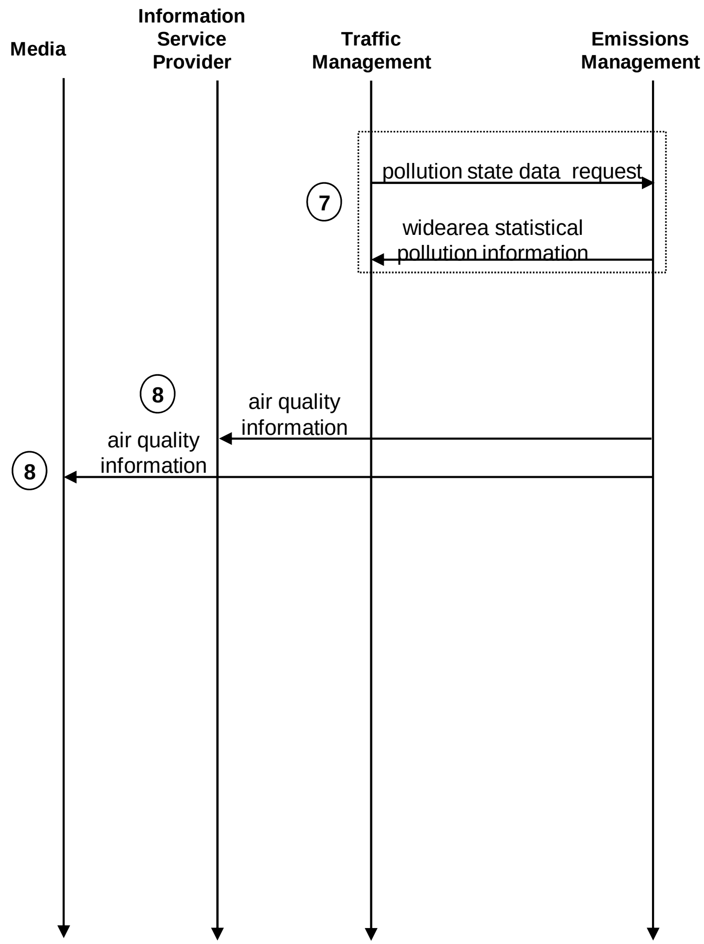
7. Area-specific pollution information may be provided to the Traffic Management Subsystem (*widearea statistical pollution information*) upon request (*pollution state data request*). This information may be used by the TMS to assist in the implementation of environmentally sensitive Travel Demand Management (TDM) programs, policies, and regulations.

8. Area-specific pollution information (*air quality information*) may also be provided to the Information Service Provider and the Media for dissemination to travelers.

ATMS11: Emissions Monitoring and Management (1 of 2)
Emissions and Pollution Monitoring and Management



ATMS11: Emissions Monitoring and Management (2 of 2)
Pollution Information Dissemination



2.12 ATMS12: Roadside Lighting System Control

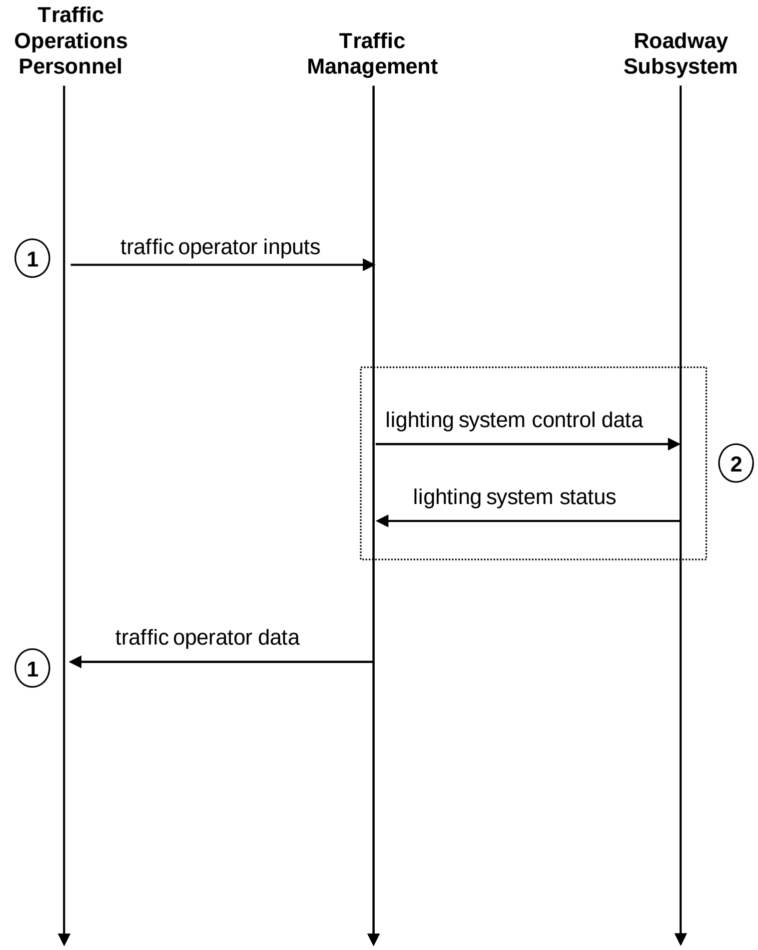
This service package includes systems that manage electrical lighting systems by monitoring operational conditions and using the lighting controls to vary the amount of light provided along the roadside. These systems allow a center to control lights based on traffic conditions, time-of-day, and the occurrence of incidents. Such systems can increase the safety of a roadway segment by increasing lighting and conserve energy at times when conditions warrant a reduction in the amount of lighting.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel. Operator input affects the control of the lighting system and status collected from the lighting system is reported to the operator.

2. The Traffic Management Subsystem remotely controls the operation of roadside lighting systems (*lighting system control data*), issuing requests for data, commands that alter locally stored configuration data, or commands that directly control the lighting equipment. Operational status of the lighting systems is monitored by the Traffic Management Subsystem (*lighting system status*).

ATMS12: Roadside Lighting System Control



2.13 ATMS13: Standard Railroad Grade Crossing

This service package manages highway traffic at highway-rail intersections (HRIs) where operational requirements do not dictate more advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Both passive (e.g., the crossbuck sign) and active warning systems (e.g., flashing lights and gates) are supported. (Note that passive systems exercise only the single interface between the roadway subsystem and the driver in the architecture definition.) These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification by interfaced wayside equipment of an approaching train. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported to both highway and railroad officials through wayside interfaces and interfaces to the traffic management subsystem.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

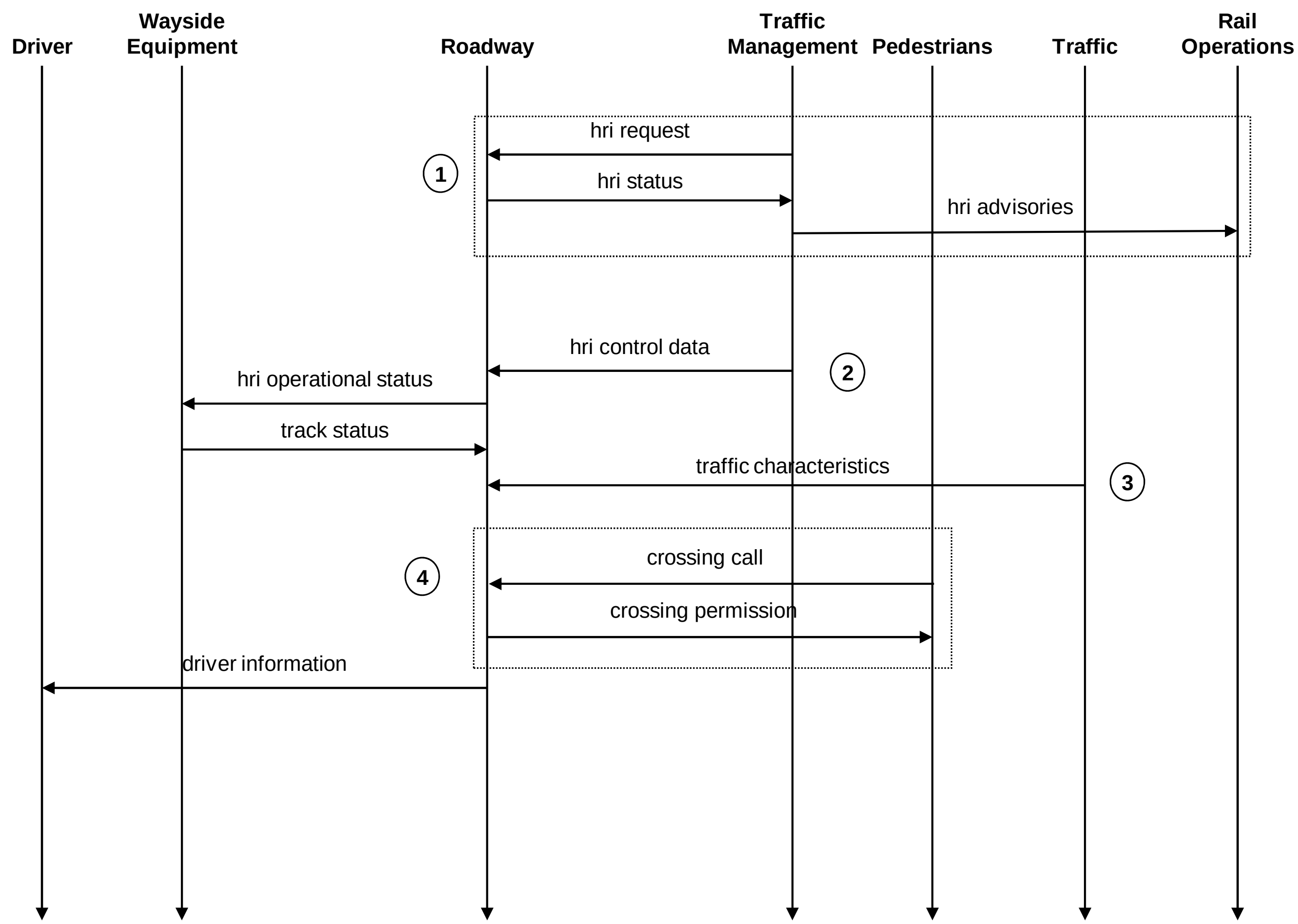
1. The status of highway-rail intersection equipment (*hri status*) including both the current state and mode of operation and the current equipment condition is monitored by the Traffic Management Subsystem. This information can be requested (*hri request*) by the Traffic Management Subsystem or the Roadway Subsystem can send it when warranted, when a problem is detected or on a set interval. When an equipment problem is identified or anytime conditions require attention, the Traffic Management Subsystem will notify (*hri advisories*) the Rail Operations.

2. The Traffic Management Subsystem may use equipment such as signals or gates (*hri control data*) at highway-rail intersections to control traffic through the intersections. The Roadway equipment sends the status of the equipment including both the current state and mode of operation and the current equipment condition (*hri operational status*) to the Wayside Equipment. The Wayside Equipment sends notification of an arriving train and the status of the equipment (*track status*) to the Roadway equipment.

3. Equipment on the Roadway can be used to constantly monitor (*traffic characteristics*) highway-rail intersections. Surveillance cameras can be used to view the intersections.

4. Pedestrians can request right-of-way (*crossing call*) to cross a highway-rail intersection. Equipment on the roadway notifies the pedestrian when the request has been granted (*crossing permission*) via display, audio signal or other manner. Information (*driver information*) on the current or expected status of the tracks including message signs and flashing crossbucks can be displayed for Drivers.

ATMS13: Standard Railroad Grade Crossing



2.14 ATMS14: Advanced Railroad Grade Crossing

This service package manages highway traffic at highway-rail intersections (HRIs) where operational requirements demand advanced features (e.g., where rail operational speeds are greater than 80 miles per hour). This service package includes all capabilities from the Standard Railroad Grade Crossing service package and augments these with additional safety features to mitigate the risks associated with higher rail speeds. The active warning systems supported by this service package include positive barrier systems that preclude entrance into the intersection when the barriers are activated. Like the Standard package, the HRI equipment is activated on notification by wayside interface equipment which detects, or communicates with the approaching train. In this service package, the wayside equipment provides additional information about the arriving train so that the train's direction of travel, estimated time of arrival, and estimated duration of closure may be derived. This enhanced information may be conveyed to the driver prior to, or in context with, warning system activation. This service package also includes additional detection capabilities that enable it to detect an entrapped or otherwise immobilized vehicle within the HRI and provide an immediate notification to highway and railroad officials.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Equipment on the Roadway constantly monitors (*traffic characteristics*) highway-rail intersections. Vehicles may be tracked through the intersection. The equipment may detect when the intersection is blocked. When a blockage is detected, the Traffic Management Subsystem and the Wayside Equipment are notified (*intersection blockage notification*). Then the Traffic Management Subsystem will notify (*hri advisories*) the Rail Operations.

2. The status of highway-rail intersection equipment (*hri status*) including both the current state and mode of operation and the current equipment condition is monitored by the Traffic Management Subsystem. The status can be requested (*hri request*) by the Traffic Management Subsystem or the Roadway Subsystem can send it when warranted, when a problem is detected or on a set interval.

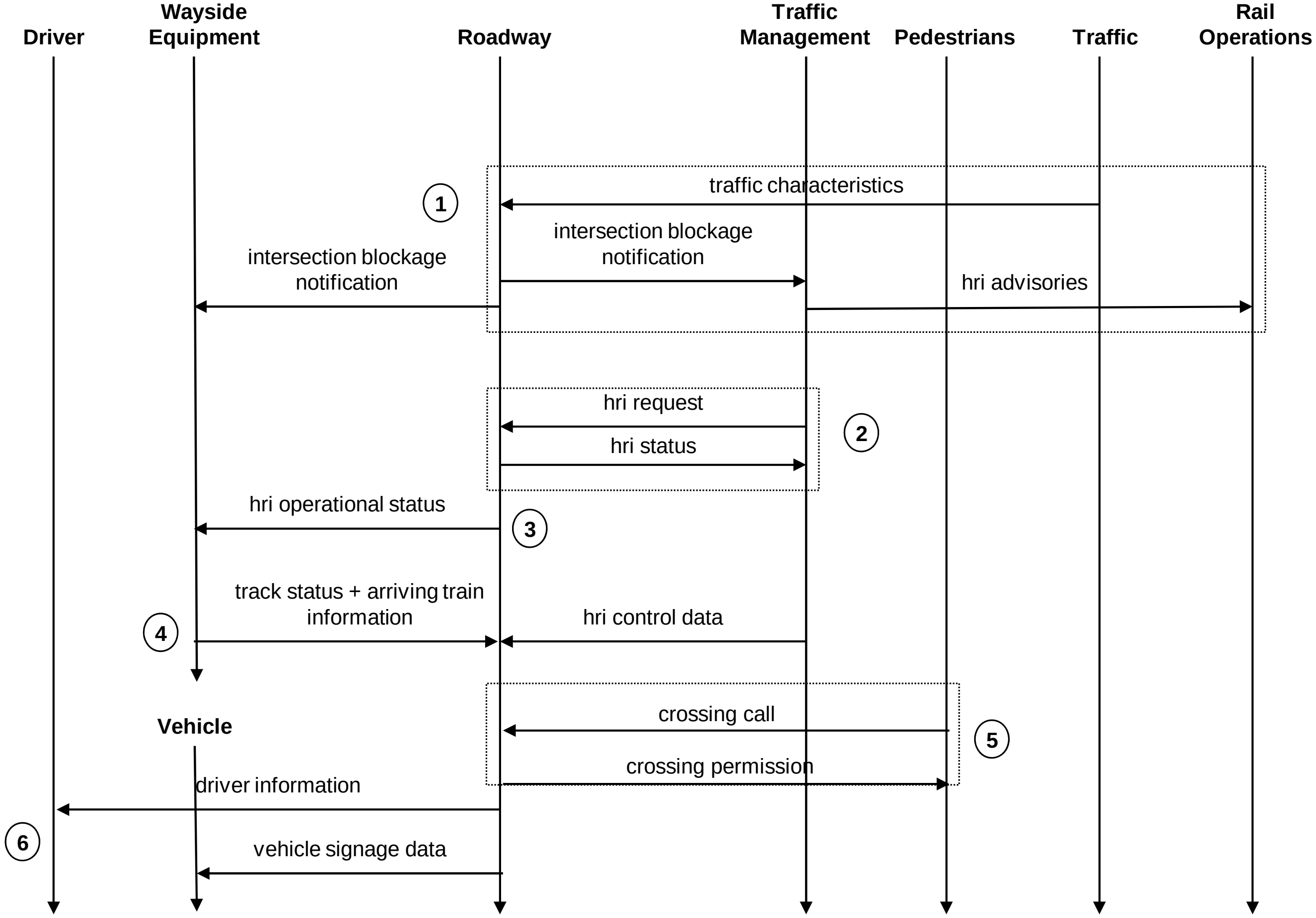
3. The Roadway equipment sends the status of the equipment including both the current state and mode of operation and the current equipment condition (*hri operational status*) to the Wayside Equipment.

4. The Traffic Management Subsystem will control equipment (*hri control data*) at highway-rail intersections. The Traffic Management Subsystem may use surveillance cameras to monitor the intersections, gates or signals to control traffic through the intersections or signs or signals to display information on train crossings to travelers. The equipment on the Roadway can receive information on arriving trains (*track status* and *arriving train information*) from the Wayside Equipment. This information includes the current status of the tracks and when a train is expected and/or how long the train crossing is expected to last can be displayed for Drivers.

5. Pedestrians can request right-of-way (*crossing call*) to cross a highway-rail intersection. Equipment on the roadway notifies the pedestrian when the request has been granted (*crossing permission*) via display, audio signal or other manner.

6. Information (*driver information*) on the current or expected status of the tracks including message signs and flashing crossbucks can be displayed for Drivers. Alternatively, grade crossing status may be communicated to the vehicle using Field-Vehicle Communications (*vehicle signage data*).

ATMS14: Advanced Railroad Grade Crossing



2.15 ATMS15: Railroad Operations Coordination

This service package provides an additional level of strategic coordination between freight rail operations and traffic management centers. Rail operations provides train schedules, maintenance schedules, and any other forecast events that will result in highway-rail intersection (HRI) closures. This information is used to develop forecast HRI closure times and durations that may be used in advanced traffic control strategies or to enhance the quality of traveler information.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

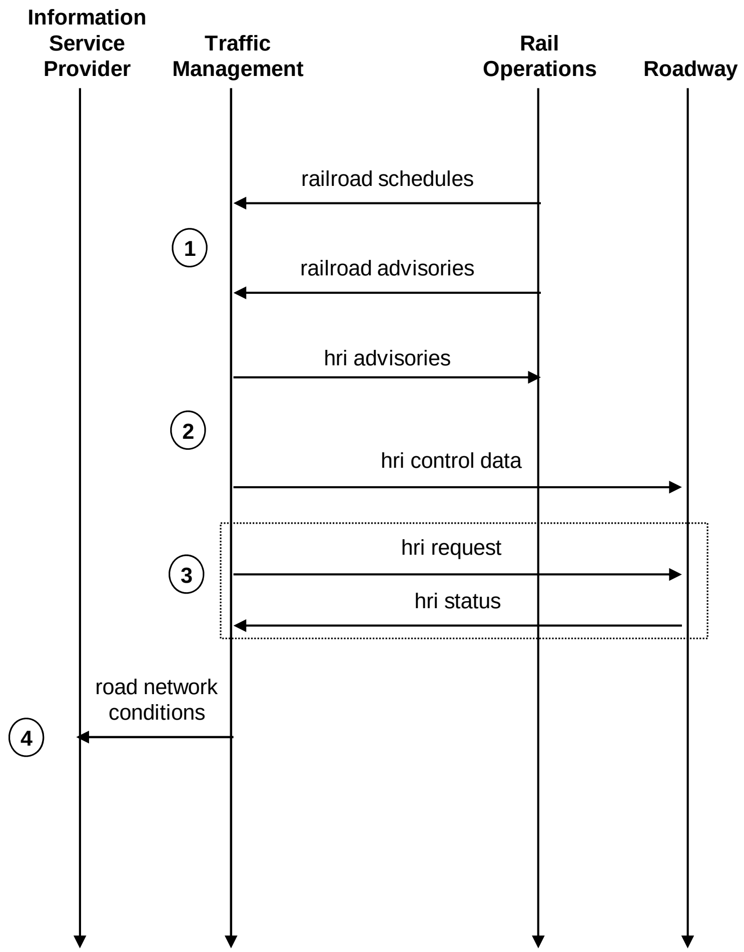
1. The Rail Operations system sends train schedules, maintenance schedules, and other information that supports forecast of highway-rail intersection closures (*railroad schedules*) to the Traffic Management Subsystem. The Rail Operations also notifies the Traffic Management Subsystem of railway-related incidents or other advisories (*railroad advisories*).

2. When an equipment problem is identified or anytime conditions require attention, the Traffic Management Subsystem will notify (*hri advisories*) the Rail Operations. The Traffic Management Subsystem will control equipment (*hri control data*) at highway-rail intersections. The Traffic Management Subsystem may use surveillance cameras to monitor the intersections, gates or signals to control traffic through the intersections or signs or signals to display information on train crossings to travelers. Further functions are provided by ATMS13, Standard Railroad Grade Crossing, and ATMS14, Advanced Railroad Grade Crossing.

3. The status of highway-rail intersection equipment (*hri status*) including both the current state and mode of operation and the current equipment condition is monitored by the Traffic Management Subsystem. The status can be requested (*hri request*) by the Traffic Management Subsystem or the Roadway Subsystem can send it when warranted, either when a problem is detected or on a set interval.

4. The Traffic Management Subsystem can share the current and/or expected status of highway-rail intersections (*road network conditions*) with an Information Service Provider.

ATMS15: Railroad Operations Coordination



2.16 ATMS16: Parking Facility Management

This service package provides enhanced monitoring and management of parking facilities. It assists in the management of parking operations, coordinates with transportation authorities, and supports electronic collection of parking fees. This service package collects current parking status, shares this data with Information Service Providers and Traffic Management, and collects parking fees using the same in-vehicle equipment utilized for electronic toll collection or contact or proximity traveler cards used for electronic payment. Two other service packages, APTS04: Transit Fare Collection Management and ATMS10: Electronic Toll Collection also provide electronic payment services. These three service packages in combination provide an integrated electronic payment system for transportation services.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

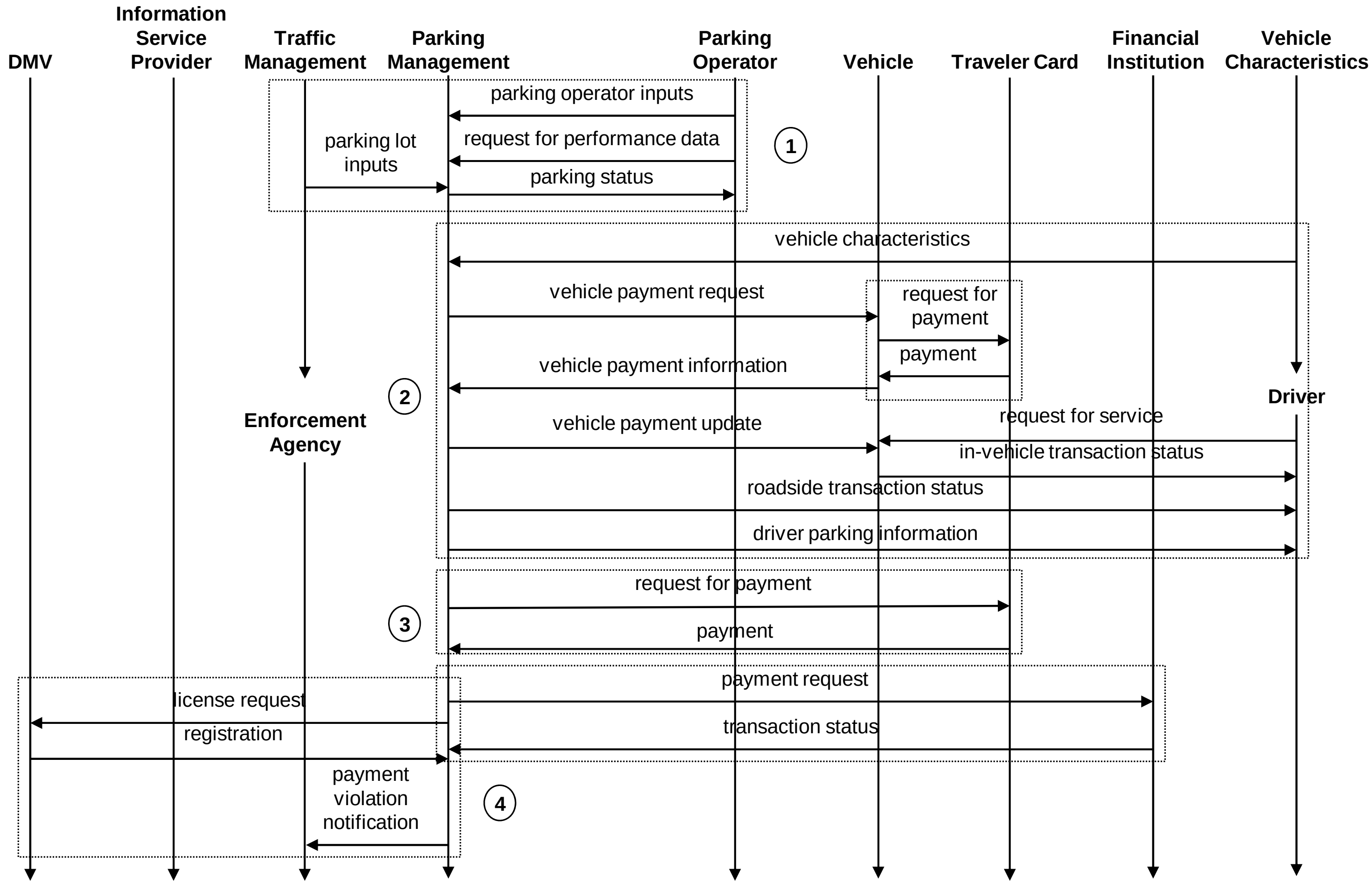
1. The Parking Operator monitors (*parking status*) and controls (*parking operator inputs*) and makes requests for current parking service performance data (*request for performance data*) from the Parking Management Subsystem. Instructions for operation of local parking facilities to support regional traffic management objectives (e.g., which parking lot exits to use) may be sent by the Traffic Management Subsystem to the Parking Management Subsystem (*parking lot inputs*).

2. The Parking Management Subsystem detects passing vehicles and may identify the vehicles (*vehicle characteristics*). When a vehicle is detected, a request (*vehicle payment request*) is made to the Vehicle. The Vehicle requests payment (*request for payment*) from the Traveler Card. When *payment* is received from the Traveler Card, a response (*vehicle payment information*) is sent to the Parking Management Subsystem which responds with a *vehicle payment update*. The Driver may request advanced payment of parking lot charges (*request for service*). A message (*in-vehicle transaction status*) may be sent by the Vehicle to the Driver to confirm payment and/or alert the driver about a payment issue. When a parking payment is made, the status of the payment (*roadside transaction status*) may be displayed to the Driver with a signal, sign or other equipment on the roadside. In addition, the Parking Management System can provide general parking information to drivers including lot status, parking availability, and directions to available spaces, entrances, and exits (*driver parking information*) through use of dynamic message signs or other technologies.

3. Alternatively, when a vehicle is detected by the Parking Management Subsystem, a request for payment of parking fees (*request for payment*) may be made directly to the Traveler Card (without first interfacing with ITS equipment onboard the Vehicle). The Traveler Card responds with the *payment*. The Parking Management Subsystem can send payments as collected or can aggregate them and send on a set schedule or as warranted (*payment request*) to a Financial Institution. The Financial Institution may respond with the *transaction status*.

4. When an invalid payment is detected, the Parking Management Subsystem may contact the DMV (*license request*) to determine the registered owner of the offending vehicle (*registration*). Violations (*payment violation notification*) are reported to an Enforcement Agency.

ATMS16: Parking Facility Management



2.17 ATMS17: Regional Parking Management

This service package supports communication and coordination between equipped parking facilities and also supports regional coordination between parking facilities and traffic and transit management systems. This service package also shares information with transit management systems and information service providers to support multimodal travel planning, including parking reservation capabilities. Information including current parking availability, system status, and operating strategies are shared to enable local parking facility management that supports regional transportation strategies.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Based on the availability, traffic conditions and other factors, regional parking and traffic management plans can be developed. To support this planning, periodically the Traffic Management Subsystem may request information (*parking lot data request*) from the Parking Management Subsystem. The *parking information* returned from the Parking Management Subsystem includes information about the current or expected parking availability.

2. An Information Service Provider receives information on current parking availability and fares (*parking information*) from the Parking Management Subsystem. This information can be requested (*parking lot data request*) when desired. Otherwise, it can be provided on a set schedule or as revisions warrant it.

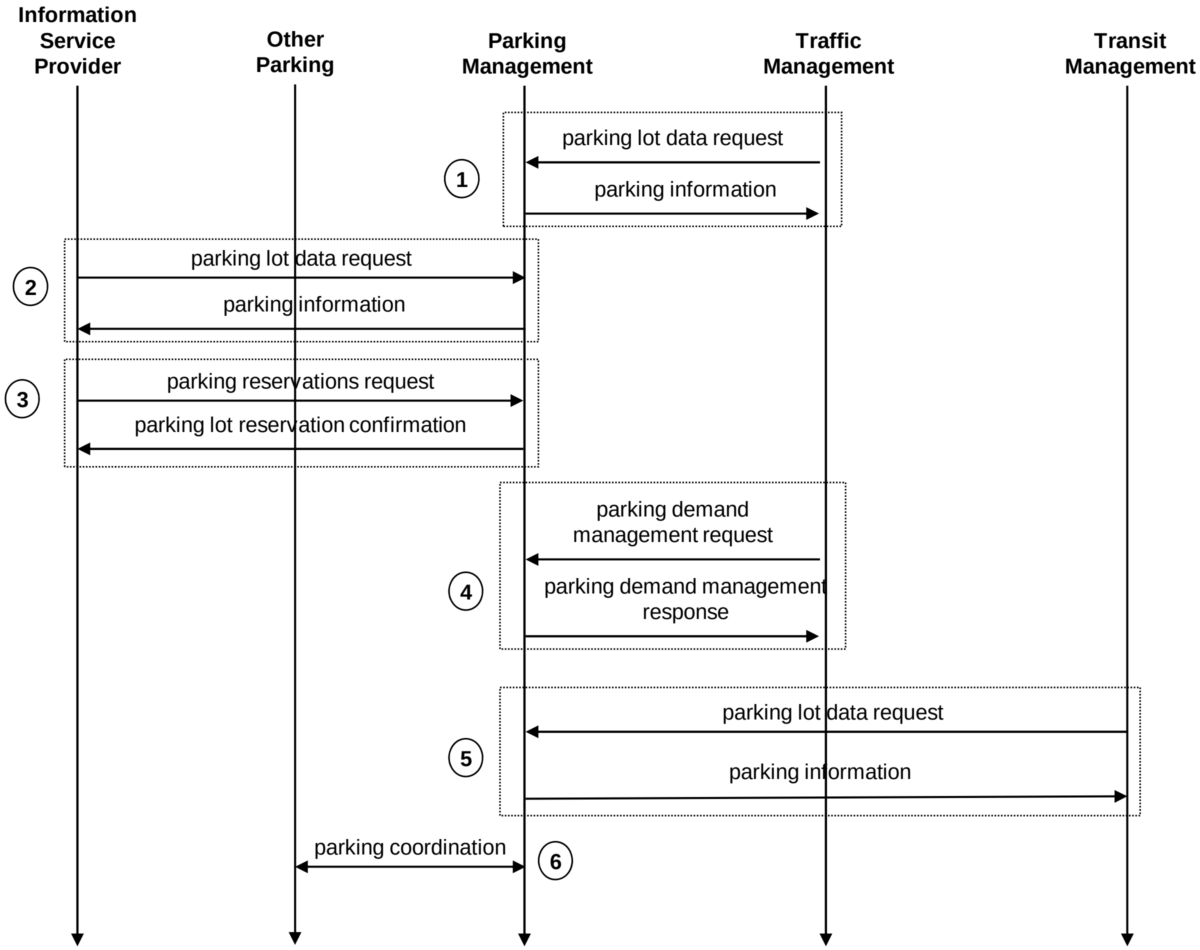
3. An Information Service Provider can make parking reservations for travelers (*parking reservations request*) with the Parking Management Subsystem. The Parking Management Subsystem can send a confirmation (*parking lot reservation confirmation*) when a reservation has been made.

4. To assist in travel demand management, the Traffic Management Subsystem may request (*parking demand management request*) a change in parking prices or procedures. The Parking Management Subsystem may send a *parking demand management response* indicating when the request was or will be honored.

5. The Transit Management Subsystem can coordinate with the Parking Management Subsystem also. The Transit Management Subsystem can make a *parking lot data request* about parking availability so as to advise transit riders where to park before boarding a transit vehicle. In response to the request, on a set schedule or as conditions warrant, the Parking Management Subsystem may respond by sending the requested *parking information*.

6. The Parking Management Subsystem may exchange information (*parking coordination*) to support reconciliation of parking charges by customers that are enrolled with Other Parking systems. Additionally, parking fee information, parking availability and other parking information may be exchanged with Other Parking systems to coordinate parking operations.

ATMS17: Regional Parking Management



2.18 ATMS18: Reversible Lane Management

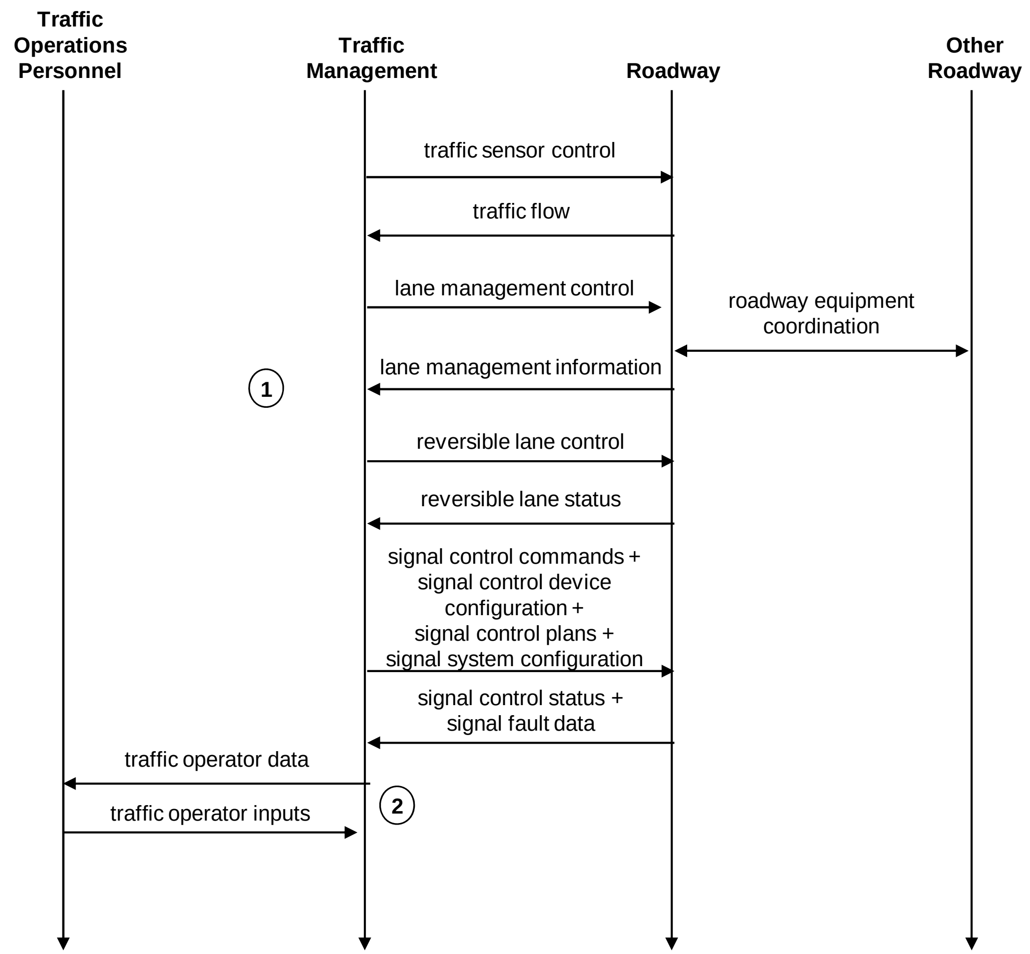
This service package provides for the management of reversible lane facilities. In addition to standard surveillance capabilities, this service package includes sensory functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. The package includes the field equipment, physical lane access controls, and associated control electronics that manage and control these special lanes. This service package also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and special events.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. To obtain information about traffic in reversible lanes, the Traffic Management Subsystem can control (*traffic sensor control*) and monitor (*traffic flow*) sensors in or along the roadway. It also monitors (*signal control status* and *signal fault data*) and controls (*signal control commands*, *signal control device configuration*, *signal control plans*, and *signal system configuration*) traffic on surface streets and freeways using equipment on the Roadway. The equipment includes signals, automated signs, message signs, etc. that are used to direct traffic on roadways with reversible lanes. The Traffic Management Subsystem also monitors the current reversible lane status and the operational status of the reversible lane control equipment (*reversible lane status*). The TMS controls (*reversible lane control*) equipment including sensory functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. This equipment on the Roadway can be coordinated (*roadway equipment coordination*) with other equipment such as traffic signals, ramp meters, DMS, etc. through peer-to-peer, master-slave or other configurations.

2. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

ATMS18: Reversible Lane Management



2.19 ATMS19: Speed Warning and Enforcement

This service package monitors vehicle speeds and supports warning drivers when their speed is excessive. Also the service includes notifications to an enforcement agency to enforce the speed limit of the roadway. Speed monitoring can be made via spot speed or average speed measurements. Roadside equipment can display the speed of passing vehicles and/or suggest a safe driving speed. Environmental conditions and vehicle characteristics may be monitored and factored into the safe speed advisories that are provided to the motorist. For example, warnings can be generated recognizing the limitations of a given vehicle for the geometry of the roadway such as rollover risk for tall vehicles.

This service focuses on monitoring of vehicle speeds and enforcement of the speed limit while the variable speed limits service (covered in ATMS22-Variable Speed Limits service package) focuses on varying the posted speed limits to create more uniform speeds along a roadway, to promote safer driving during adverse conditions (such as fog) and/or to reduce air pollution.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Maintenance and Construction Management Subsystem (MCMS) can monitor vehicle speeds on a roadway. Speed monitoring is critically important in construction zones where maintenance personnel are working. The MCMS configures and controls automated speed monitoring, speed warning, and speed enforcement systems (*speed monitoring control*) on the Roadway.

2. Equipment on the Roadway measures traffic volume, speed, density and other characteristics (*traffic characteristics*). Equipment can identify specific vehicles and their speeds (*vehicle characteristics*). The current weather and roadway conditions (*environmental conditions*), which can impact the speed limit, are also monitored.

3. The equipment on the Roadway used for speed monitoring and enforcement can be coordinated with signs, signals, and Field-Vehicle Communications equipment (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations.

4. Drivers can be notified (*driver information*) en-route of their speed through signs, signals or other equipment on the Roadway. Alternatively, Field-Vehicle Communications can be used to send current speed information and warnings to the vehicle for presentation to the driver (*vehicle signage data*).

5. The MCMS monitors the speed monitoring system status including current operational state and logged information including measured speeds, warning messages displayed, and violation records (*speed monitoring information*).

6. The entire process is under the monitoring (*maint and constr operations information presentation*) and control (*maint and constr center personnel inputs*) of Maintenance and Construction Center Personnel.

7. The MCMS can request speed enforcement (*request for enforcement*) from the Enforcement Agency when needed to address safety issues in a work zone or other special situations.

8. The Traffic Management Subsystem can also monitor speeds on roadways. The Traffic Management Subsystem would configure and control automated speed monitoring, speed warning, and speed enforcement systems (*speed monitoring control*) on the Roadway.

9. Equipment on or along the Roadway measures traffic volume, speed, density and other characteristics (*traffic characteristics*). Equipment can identify specific vehicles and their speeds (*vehicle characteristics*). The current weather and roadway conditions (*environmental conditions*), which can impact the speed limit, are also monitored.

10. The equipment on the Roadway used for speed monitoring and enforcement can be coordinated with signs, signals, and Field-Vehicle Communications equipment (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations.

11. Drivers can be notified (*driver information*) en-route of their speed through signs, signals or other equipment on the Roadway. Alternatively, Field-Vehicle Communications can be used to send current speed information and warnings to the vehicle for presentation to the driver (*vehicle signage data*).

12. The Traffic Management Subsystem monitors the speed monitoring system status including current operational state and logged information including measured speeds, warning messages displayed, and violation records (*speed monitoring information*).

13. The entire process is under the monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

14. The Traffic Management Subsystem can request speed enforcement (*request for enforcement*) from the Enforcement Agency when needed to address safety issues or other special situations.

15. Speed monitoring can also be performed by an Enforcement Agency. The Enforcement Agency would configure and control automated speed monitoring, speed warning, and speed enforcement systems (*speed monitoring control*) on the Roadway.

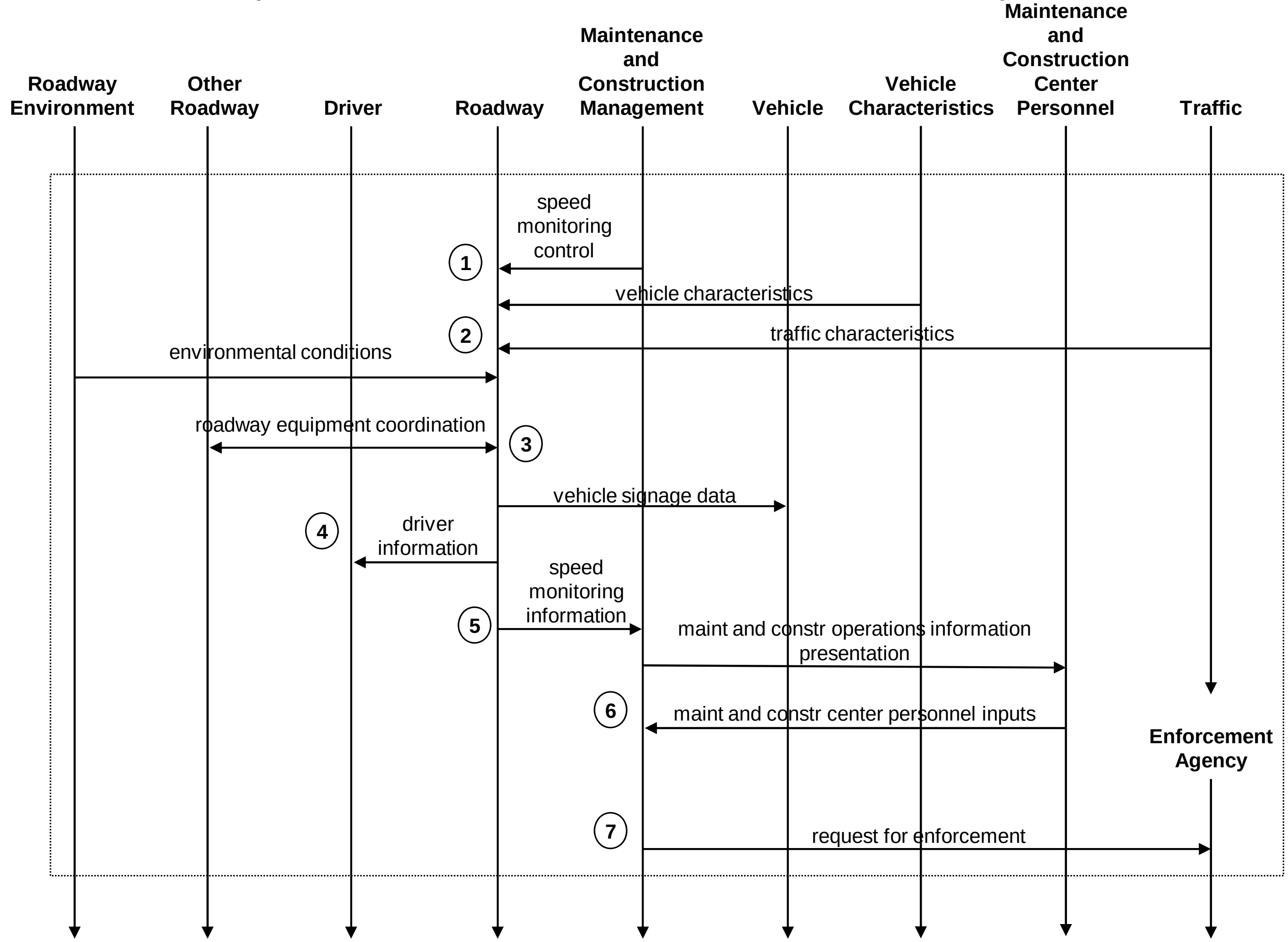
16. Equipment can identify specific vehicles and their speeds (*vehicle characteristics*). The current weather and roadway conditions (*environmental conditions*), which can impact the speed limit, are also monitored.

17. The equipment on the Roadway used for speed monitoring and enforcement can be coordinated (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations.

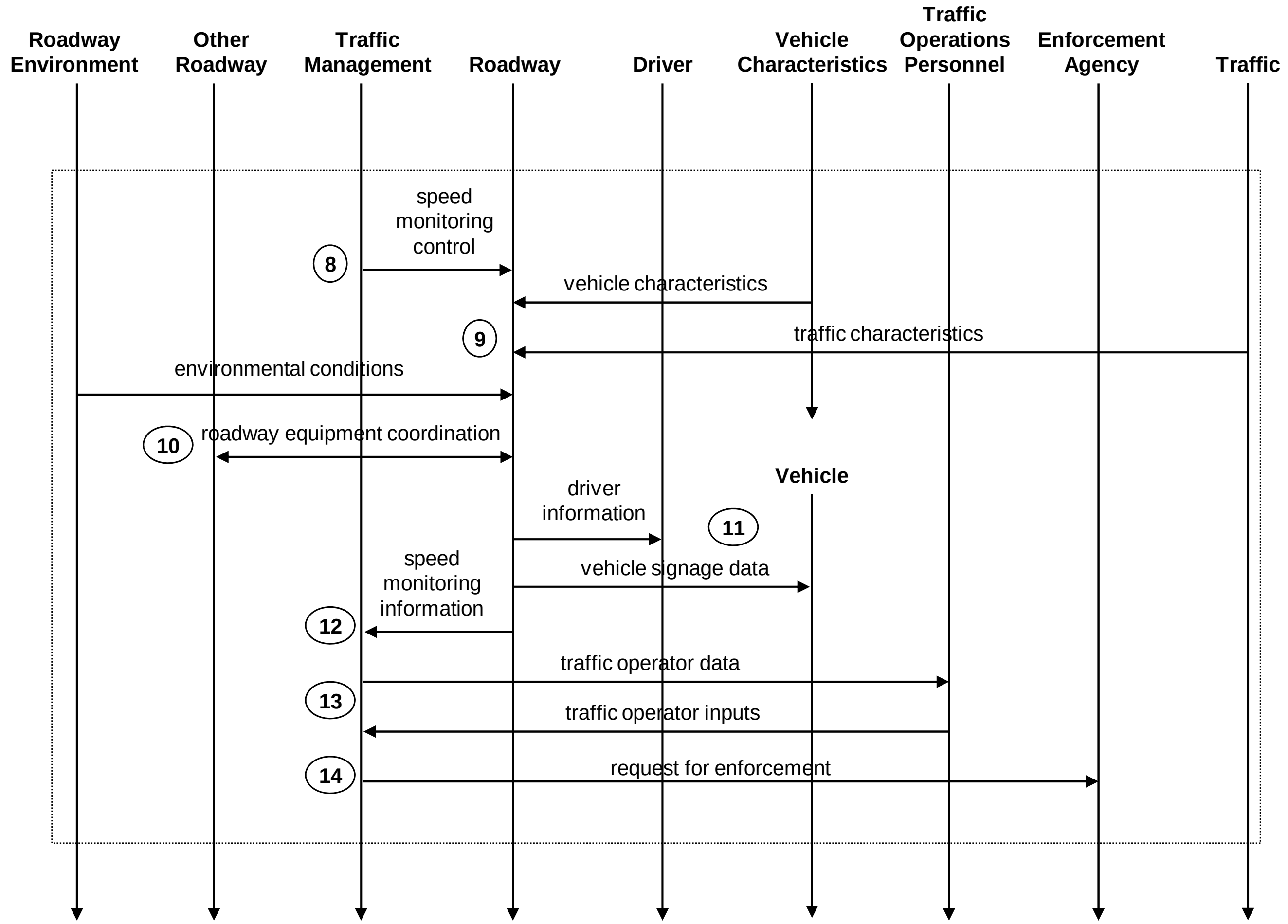
18. The Enforcement Agency monitors the speed monitoring system status including current operational state and logged information including measured speeds, warning messages displayed, and violation records (*speed monitoring information*).

19. The Enforcement Agency would be notified when a speed violation (*traffic violation notification*) was detected by equipment on the Roadway.

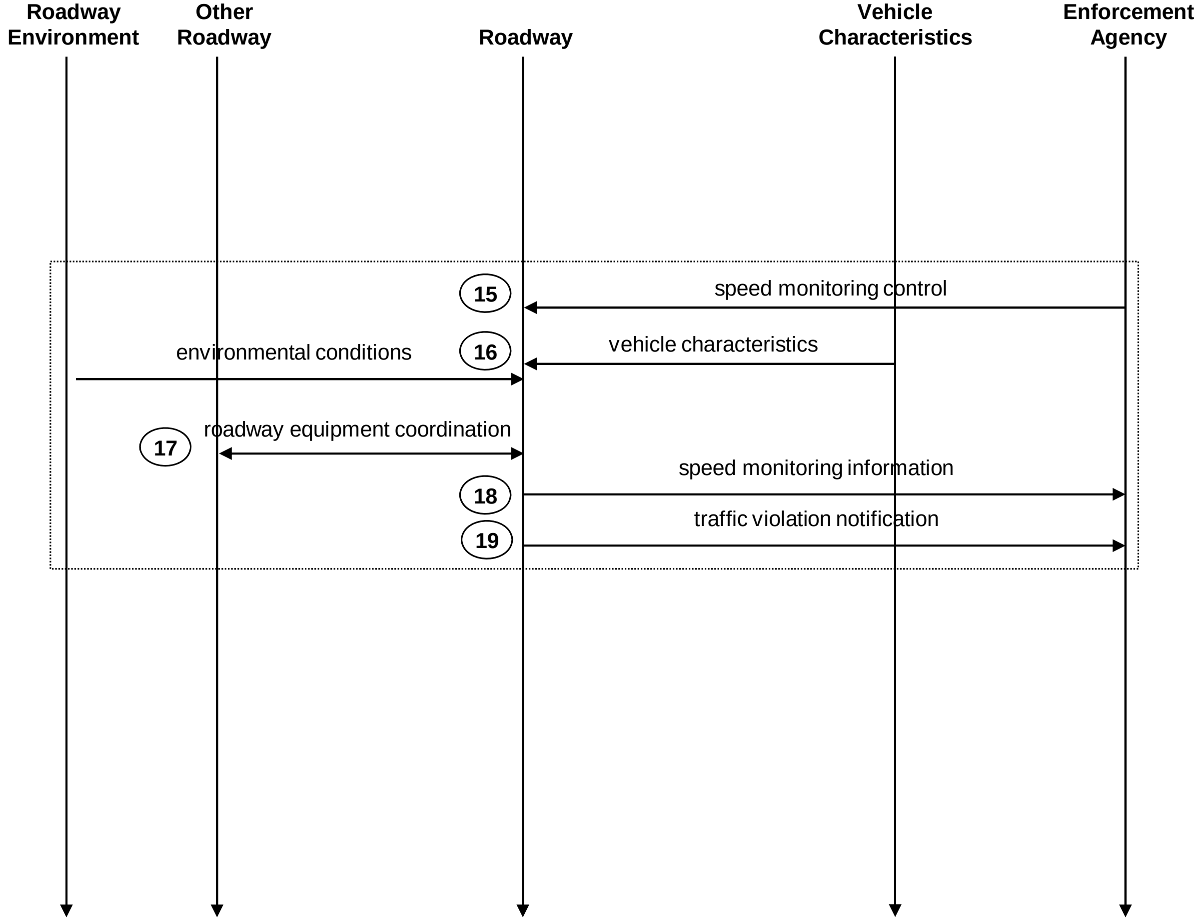
ATMS19: Speed Warning and Enforcement (1 of 3) (Maintenance and Construction Controlled)



ATMS19: Speed Warning and Enforcement (2 of 3) (Traffic Management Controlled)



ATMS19: Speed Monitoring (3 of 3) (Enforcement Agency Controlled)



2.20 ATMS20: Drawbridge Management

This service package supports systems that manage drawbridges at rivers and canals and other multimodal crossings (other than railroad grade crossings which are specifically covered by other service packages). The equipment managed by this service package includes control devices (e.g., gates, warning lights, dynamic message signs) at the drawbridge as well as the information systems that are used to keep travelers apprised of current and forecasted drawbridge status.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Multimodal Crossing provides the operational status and pending requests for right-of-way from marine traffic at the drawbridge (*multimodal crossing status*) to the Traffic Management Subsystem and Roadway equipment.

2. The Roadway equipment can in turn request an opening of the draw bridge (*right-of-way request notification*) for a marine vessel.

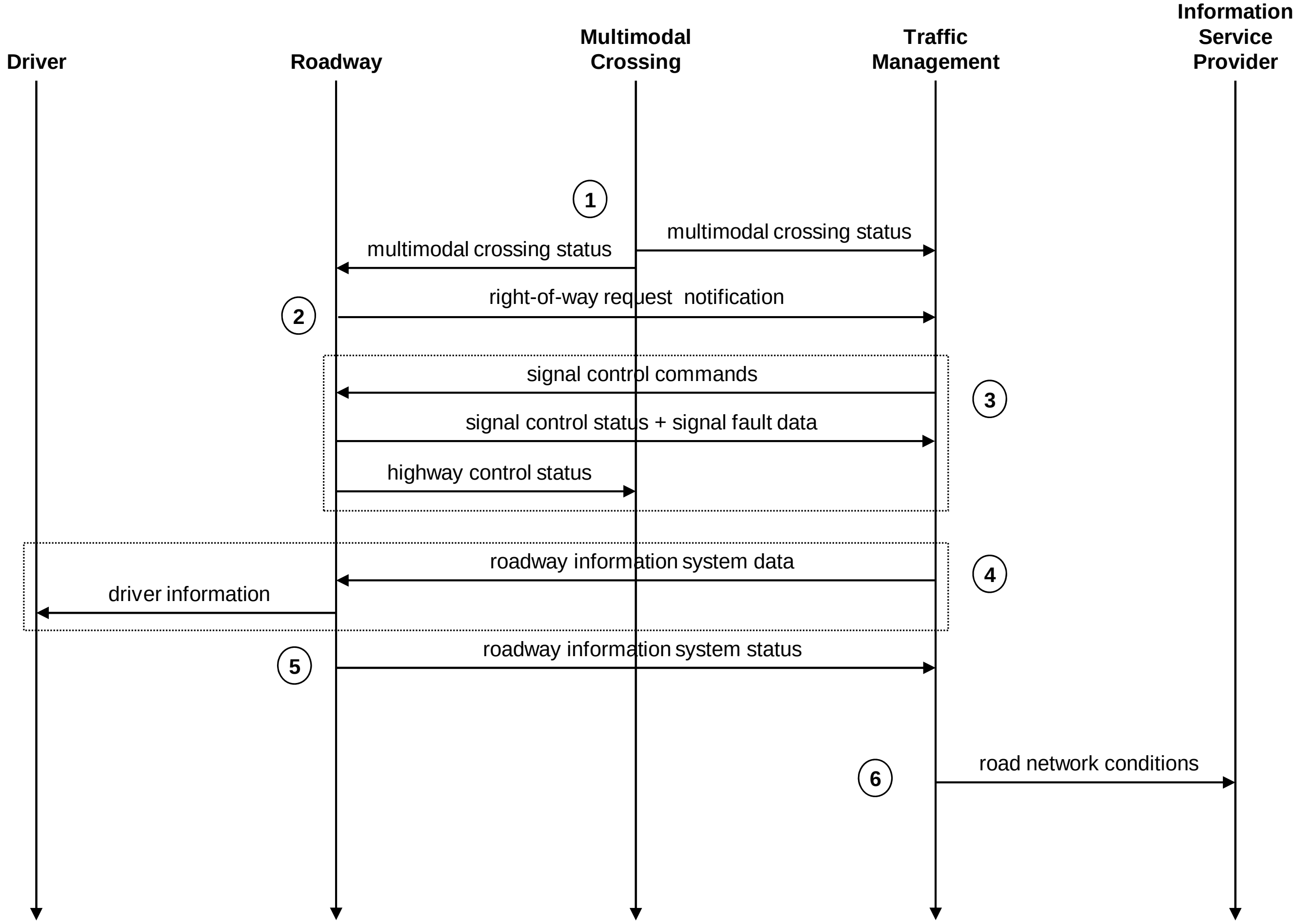
3. The Traffic Management Subsystem can configure, download timings and otherwise control (*signal control commands*) signal equipment along the roadway to control traffic approaching a drawbridge. Traffic Management Subsystem can monitor the status of this equipment (*signal control status* and *signal fault data*). Signals can be used to stop vehicular traffic for a draw bridge opening. Additionally, this equipment can supply information on the current status of the traffic control equipment indicating right-of-way availability to marine traffic at the drawbridge (*highway control status*) to the Multimodal Crossing.

4. The Traffic Management Subsystem controls (*roadway information system data*) the equipment such as DMS and HAR on the Roadway that provides information (*driver information*) including the current status of the drawbridge and time of planned openings to Drivers.

5. The Traffic Management Subsystem continues asynchronous monitoring (*roadway information system status*) of this equipment.

6. The Traffic Management Subsystem can share the current and/or expected status of the drawbridge (*road network conditions*) with an Information Service Provider.

ATMS20: Drawbridge Management



2.21 ATMS21: Roadway Closure Management

This service package closes roadways to vehicular traffic when driving conditions are unsafe, maintenance must be performed, and other scenarios where access to the roadway must be prohibited. The service package includes automatic or remotely controlled gates or barriers that control access to roadway segments including ramps and traffic lanes. Remote control systems allow the gates to be controlled from a central location or from a vehicle at the gate/barrier location, improving system efficiency and reducing personnel exposure to unsafe conditions during severe weather and other situations where roads must be closed. Surveillance systems allow operating personnel to visually verify the safe activation of the closure system and driver information systems (e.g., DMS) provide closure information to motorists in the vicinity of the closure. The equipment managed by this service package includes the control and monitoring systems, the field devices (e.g., gates, warning lights, DMS, CCTV cameras) at the closure location(s), and the information systems that notify other systems of a closure. This service package covers general road closure applications; specific closure systems that are used at railroad grade crossings, drawbridges, reversible lanes, etc. are covered by other ATMS service packages.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Traffic Management Subsystem remotely controls the operation of gates or barriers (*barrier system control*) used to control access to roadways. Operational status of the gates or barriers may be monitored by the Traffic Management Subsystem (*barrier system status*).

2. The Traffic Management Subsystem may obtain images (*traffic images*) from surveillance equipment on the Roadway. In addition to monitoring traffic conditions, the equipment can be used to monitor the operation of barrier systems. The equipment is controlled (pan, tilt, and zoom) (*video surveillance control*) by the Traffic Management Subsystem.

3. The Traffic Management Subsystem controls (*roadway information system data*) and monitors (*roadway information system status*) driver information systems such as DMS and HAR at the Roadway, providing *driver information* including the current status of barrier systems and times of closures and openings. The barrier system itself may communicate directly with driver information equipment at the Roadway to provide road closure information (*roadway equipment coordination*).

4. When a gate or barrier system is deployed, thus limiting access to a roadway, the Traffic Management Subsystem notifies (*road network conditions*) the Information Service Provider, Emergency Management, Transit Management, and Maintenance and Construction Management Subsystems.

5. The Emergency System Operator can initiate a request for operation of gates or barriers in order to close roads (part of *emergency operations inputs*). The request is forwarded from the Emergency Management Subsystem to the TMS (*emergency traffic control request* or *road closure notification*). The TMS will provide information back to the Emergency Management Subsystem regarding the

gate or barrier actions they have taken (*emergency traffic control information*). This information will be passed to the Emergency System Operator (as part of *emergency operations status*).

6. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

7. The Maintenance and Construction Management Subsystem may also remotely controls the operation of gates or barriers (*barrier system control*) used to control access to roadways. Operational status of the gates or barriers may be monitored by the Maintenance and Construction Management Subsystem (*barrier system status*).

8. The Maintenance and Construction Management Subsystem may also obtain images (*traffic images*) from surveillance equipment on the Roadway. In addition to monitoring traffic conditions, the equipment can be used to monitor the operation of barrier systems. The equipment is controlled (pan, tilt, and zoom) (*video surveillance control*) by the Maintenance and Construction Management Subsystem.

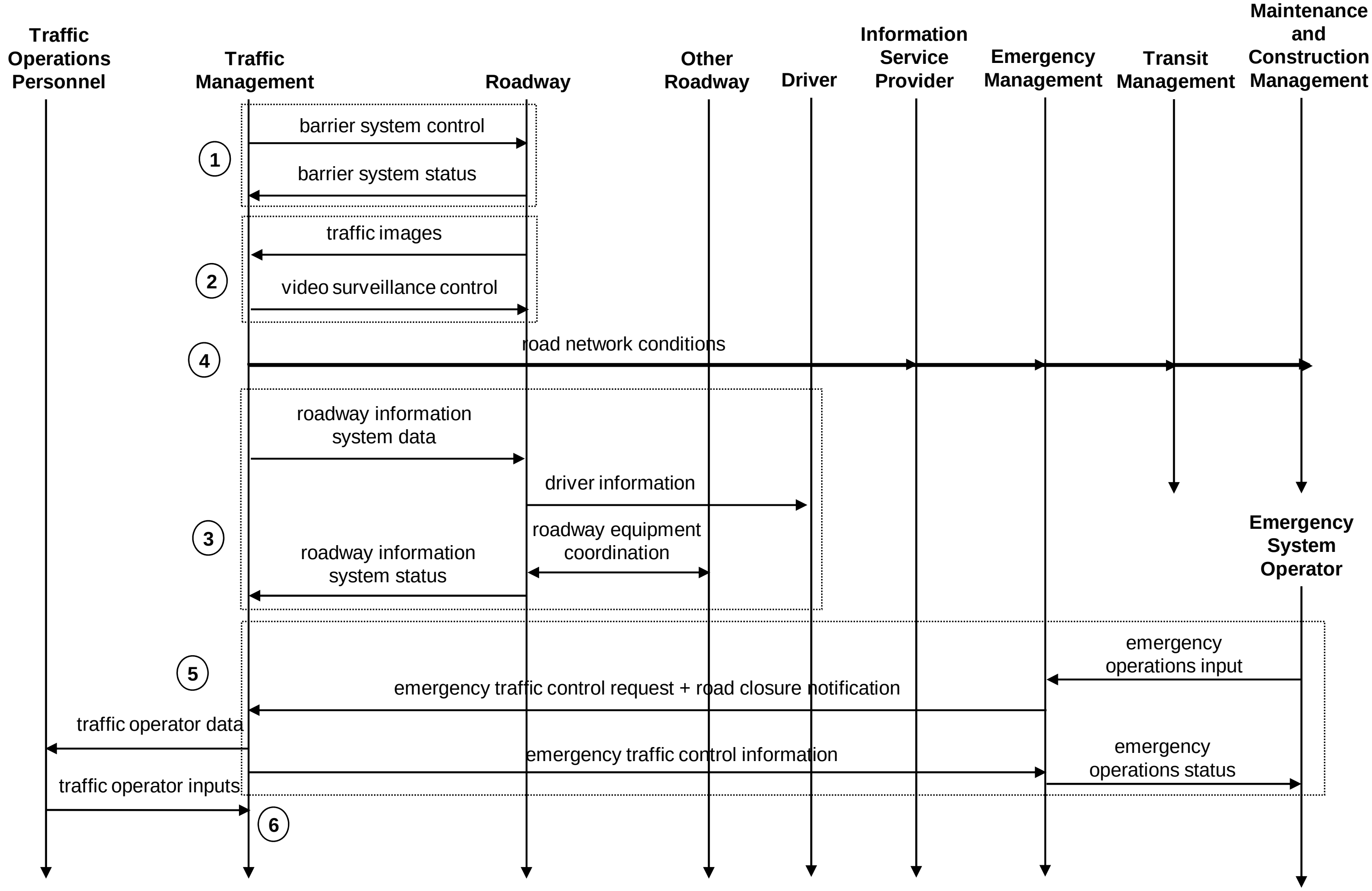
9. The Maintenance and Construction Management Subsystem controls (*roadway information system data*) and monitors (*roadway information system status*) driver information systems such as DMS and HAR at the Roadway, providing *driver information* including the current status of barrier systems and times of closures and openings.

10. The set of Maintenance and Construction Management interfaces is under the asynchronous monitoring (*maint and constr operations information presentation*) and control (*maint and constr center personnel inputs*) of Maintenance and Construction Center Personnel.

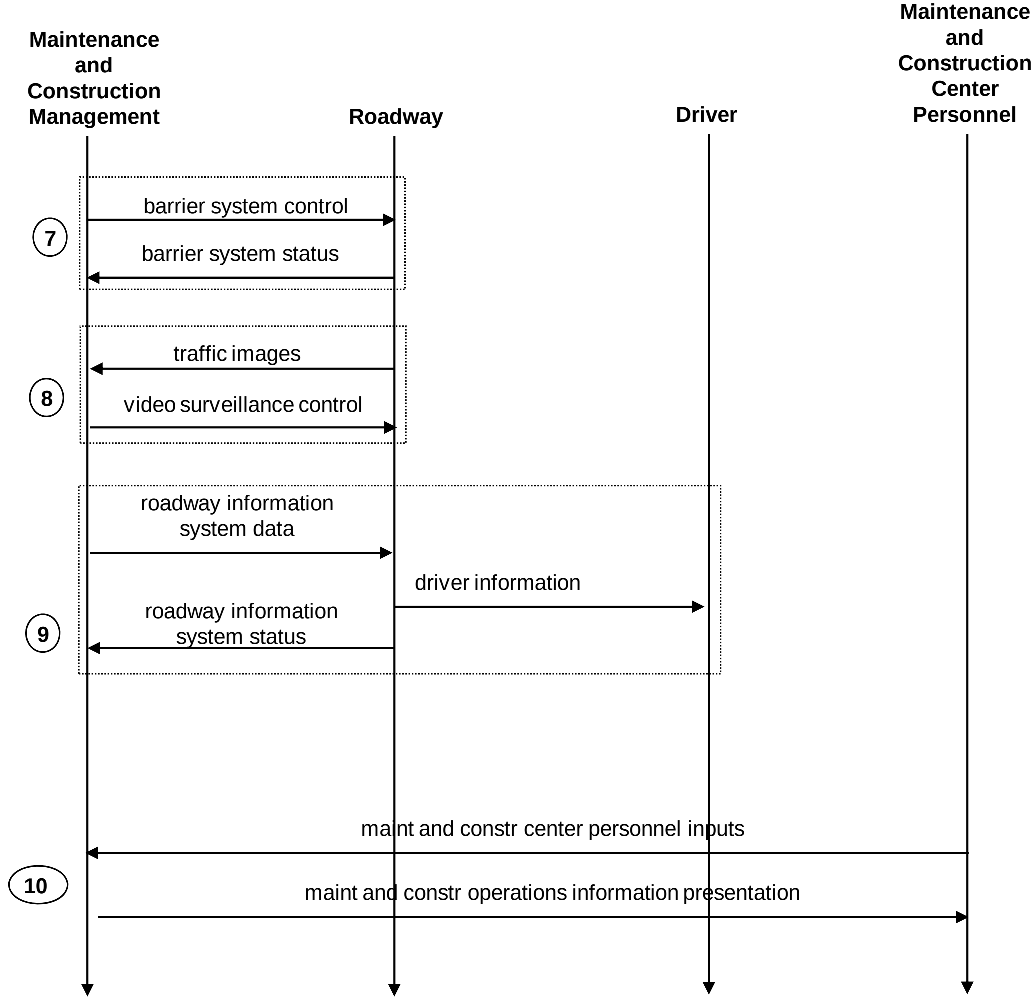
11. The Maintenance and Construction Vehicle Subsystem may also remotely controls the operation of gates or barriers (*barrier system control*) used to control access to roadways. This control is initiated by the Maintenance and Construction Field Personnel (as part of *maint and constr field personnel inputs*). Operational status of the gates or barriers may be monitored by the Maintenance and Construction Vehicle Subsystem (*barrier system status*). The status is passed along to the Maintenance and Construction Field Personnel (as part of *maint and constr field personnel information presentation*).

12. Finally, the Emergency Vehicle Subsystem may remotely controls the operation of gates or barriers (*barrier system control*) used to control access to roadways. This control is initiated by the Emergency Personnel (as part of *emergency personnel inputs*). Operational status of the gates or barriers may be monitored by the Emergency Vehicle Subsystem (*barrier system status*). The status is passed along to the Emergency Personnel (as part of *emergency personnel information presentation*).

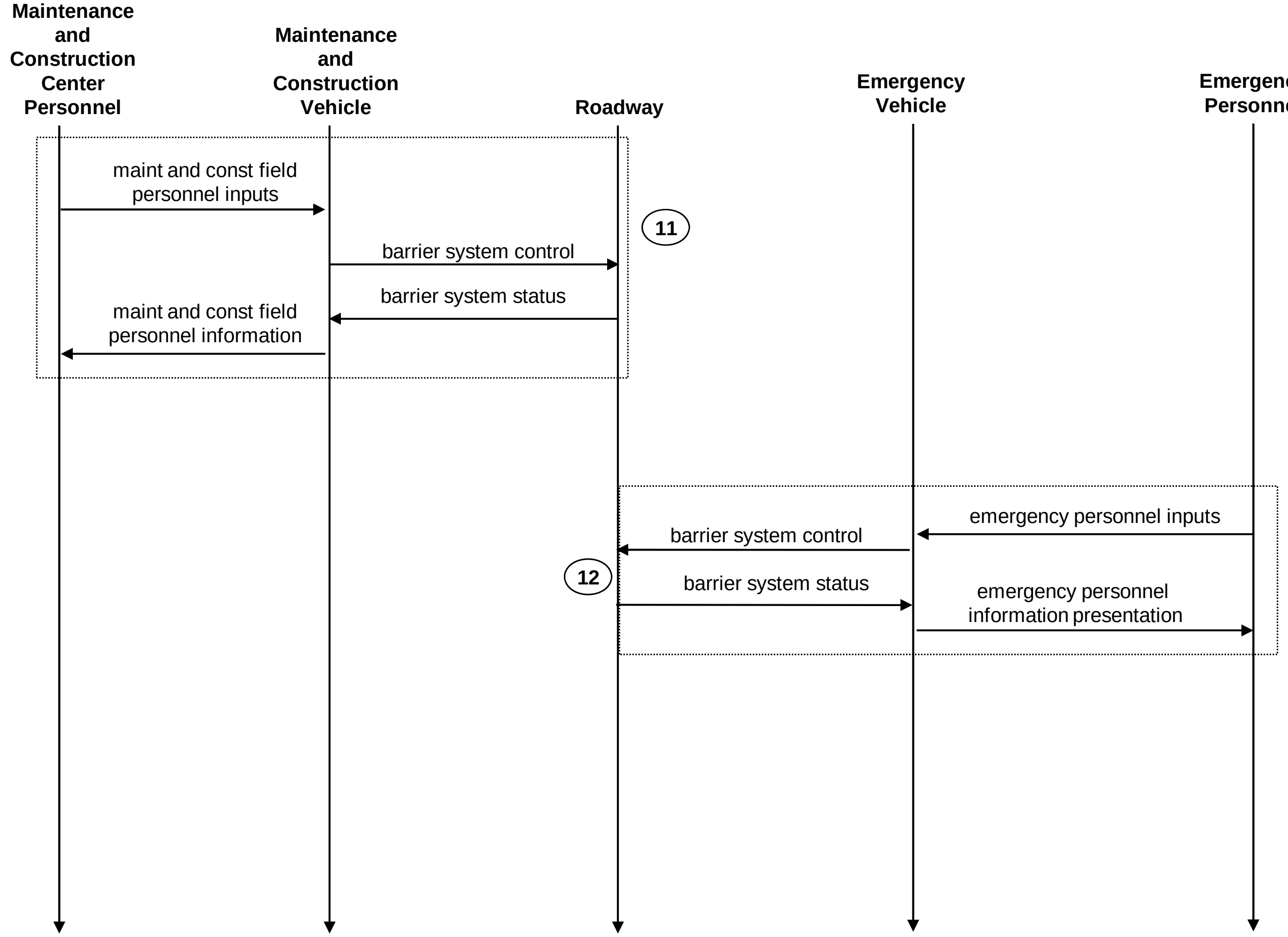
ATMS21: Roadway Closure Management (1 of 3)
Traffic Management Interfaces



ATMS21: Roadway Closure Management (2 of 3)
Maintenance and Construction Interfaces



ATMS21: Roadway Closure Management (3 of 3)
Vehicle Interfaces



2.22 ATMS22: Variable Speed Limits

This service package sets variable speed limits along a roadway to create more uniform speeds, to promote safer driving during adverse conditions (such as fog), and/or to reduce air pollution. Also known as speed harmonization, this service monitors traffic and environmental conditions along the roadway. Based on the measured data, the system calculates and sets suitable speed limits, usually by lane. Equipment over and along the roadway displays the speed limits and additional information such as basic safety rules and current traffic information. The system can be centrally monitored and controlled by a traffic management center or it can be autonomous.

This service establishes variable speed limits and communicates the speed limits to drivers. Speed warnings and enforcement of speeds limits, including variable speed limits, is covered in the ATMS19-Automated Speed Warning and Enforcement service package.

Variable speed limits are an Active Traffic Management (ATM) strategy and are typically used in conjunction with other ATM strategies (such as ATMS23-Dynamic Lane Management and Shoulder Use and ATMS24-Dynamic Roadway Warning).

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

Equipment on the Roadway is constantly monitoring traffic conditions (*traffic characteristics*) including volume, speed, density, etc. which are used to determine the appropriate speed limit of each lane.

1. The current weather and roadway conditions (*environmental conditions*), which can impact the speed limit, are also monitored.

2. To obtain information about traffic, the Traffic Management Subsystem can control (*traffic sensor control*) and monitor (*traffic flow*) sensors in or along the Roadway.

3. The Traffic Management Subsystem may obtain information on traffic (*traffic images*) from video equipment. The equipment can be controlled (e.g. pan/tilt/zoom) (*video surveillance control*) by the Traffic Management Subsystem.

4. The Traffic Management Subsystem controls (*variable speed limit control*) the variable speed limit equipment on or along the roadway including that which displays the current speed limit (*driver information*) to Drivers.

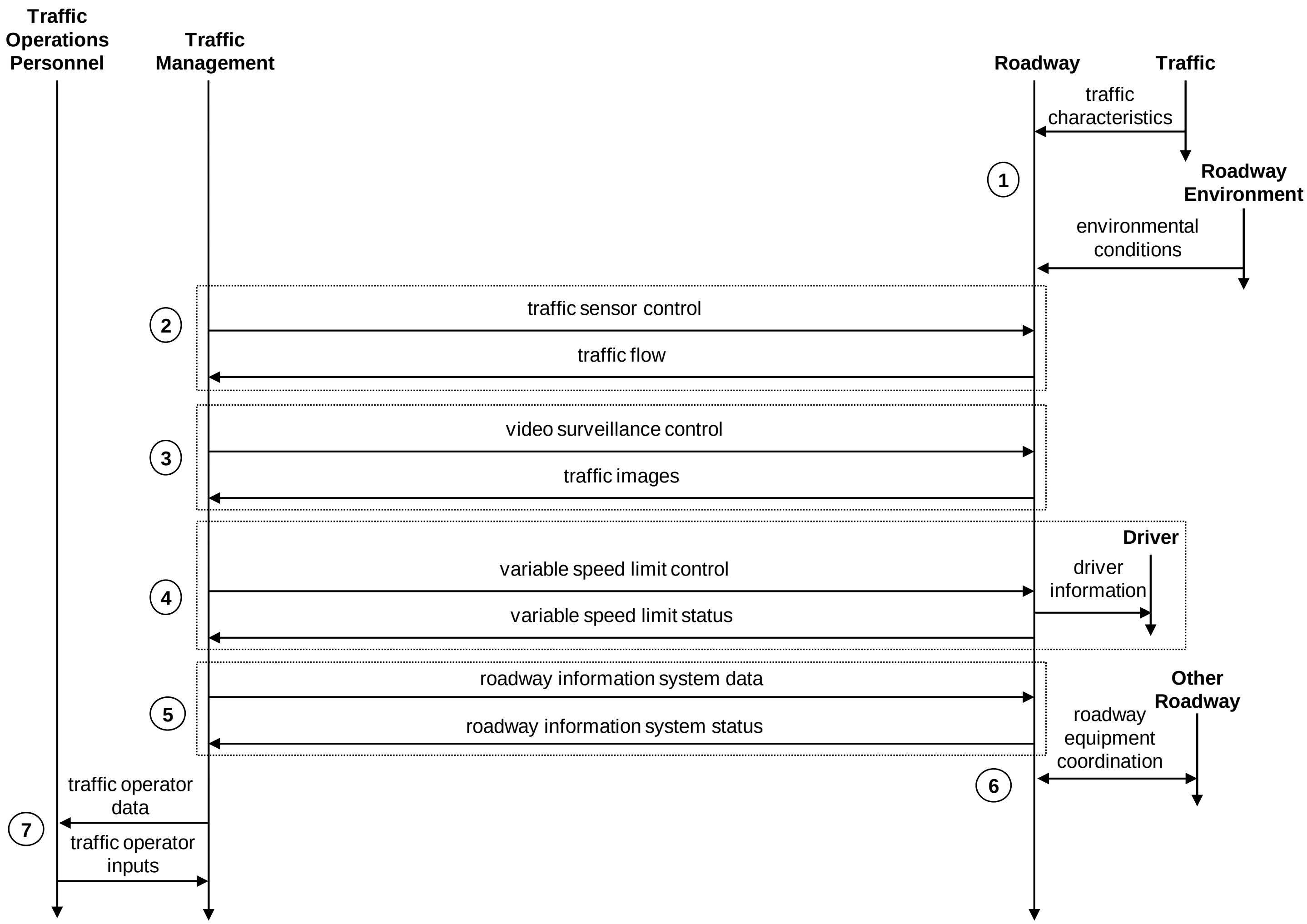
5. The Traffic Management Subsystem can monitor the status of this equipment (*variable speed limit status*).

6. The Traffic Management Subsystem can configure, download messages and otherwise control (*roadway information system data*) equipment along the roadway to provide information such as basic safety rules and current traffic information to drivers. The Traffic Management Subsystem can monitor the status of this equipment (*roadway information system status*).

7. The equipment on or along the Roadway used for variable speed limits can be coordinated (*roadway equipment coordination*) with signs, signals and Field-Vehicle Communications equipment.

8. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

ATMS22: Variable Speed Limits



2.23 ATMS23: Dynamic Lane Management and Shoulder Use

This service package provides for active management of travel lanes along a roadway. The package includes the field equipment, physical overhead lane signs and associated control electronics that are used to manage and control specific lanes and/or the shoulders. This equipment can be used to change the lane configuration on the roadway according to traffic demand and lane destination along a typical roadway section or on approach to or access from a border crossing, multimodal crossing or intermodal freight depot. This package can be used to allow temporary or interim use of shoulders as travel lanes. The equipment can be used to electronically reconfigure intersections and interchanges and manage right-of-way dynamically including merges. Also, lanes can be designated for use by special vehicles only, such as buses, high occupancy vehicles (HOVs), vehicles attending a special event, etc. Prohibitions or restrictions of types of vehicles from using particular lanes can be implemented.

The lane management system can be centrally monitored and controlled by a traffic management center or it can be autonomous. This service also can include automated enforcement equipment that notifies the enforcement agency of violators of the lane controls.

Dynamic lane management and shoulder use is an Active Traffic Management (ATM) strategy and is typically used in conjunction with other ATM strategies (such as ATMS22-Variable Speed Limits and ATMS24-Dynamic Roadway Warning).

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

Equipment on the Roadway is constantly monitoring traffic conditions (*traffic characteristics*) including volume, speed, density, etc. which are used to determine the appropriate lane usage and configuration.

1. The current weather and roadway conditions (*environmental conditions*), which can impact lane availability, are also monitored.

2. The Traffic Management Subsystem can receive request from Border Inspection Systems (*lane management inputs*) for specific lane management including the types of vehicles to allow in each lane.

3. Also, the Traffic Management Subsystem can receive request for specific lane management (*lane management inputs*) from Multimodal Crossings.

4. The Traffic Management Subsystem can receive request from Intermodal Freight Depot (*intermodal freight event information*) for specific lane management including the type of vehicles to allow in each lane. The Traffic Management Subsystem can respond to the Intermodal Freight Depot with confirmation (*intermodal freight traffic confirmation*) that the request was received

5. The Traffic Management Subsystem can receive request from Other Traffic Management (*device control request*) for specific lane management to allow coordination between jurisdictions.

6. To obtain information about traffic that can be used to make lane management decisions, the Traffic Management Subsystem can control (*traffic sensor control*) and monitor (*traffic flow*) sensors in or along the Roadway.

7. The Traffic Management Subsystem also may obtain information on traffic (*traffic images*) from video equipment. The equipment can be controlled (e.g. pan/tilt/zoom) (*video surveillance control*) by the Traffic Management Subsystem.

8. The Traffic Management Subsystem can configure, download messages and otherwise control (*lane management control*) equipment on or along the roadway to dynamically manage lane usage and configuration. The Traffic Management Subsystem can monitor the status of this equipment (*lane management information*).

9. The Traffic Management Subsystem can configure, download messages and otherwise control (*shoulder management control*) equipment on or along the roadway to dynamically manage usage of shoulders. The Traffic Management Subsystem can monitor the status of this equipment (*shoulder management information*).

10. Equipment on the Roadway notifies the Driver (*driver information*) of current lane usage restrictions and/or lane configuration changes. When a vehicle has violated a lane restriction, the equipment on the Roadway can identify the violating vehicle either by detecting the vehicle (*vehicle characteristics*) or by communicating with the Vehicle itself (*vehicle profile*).

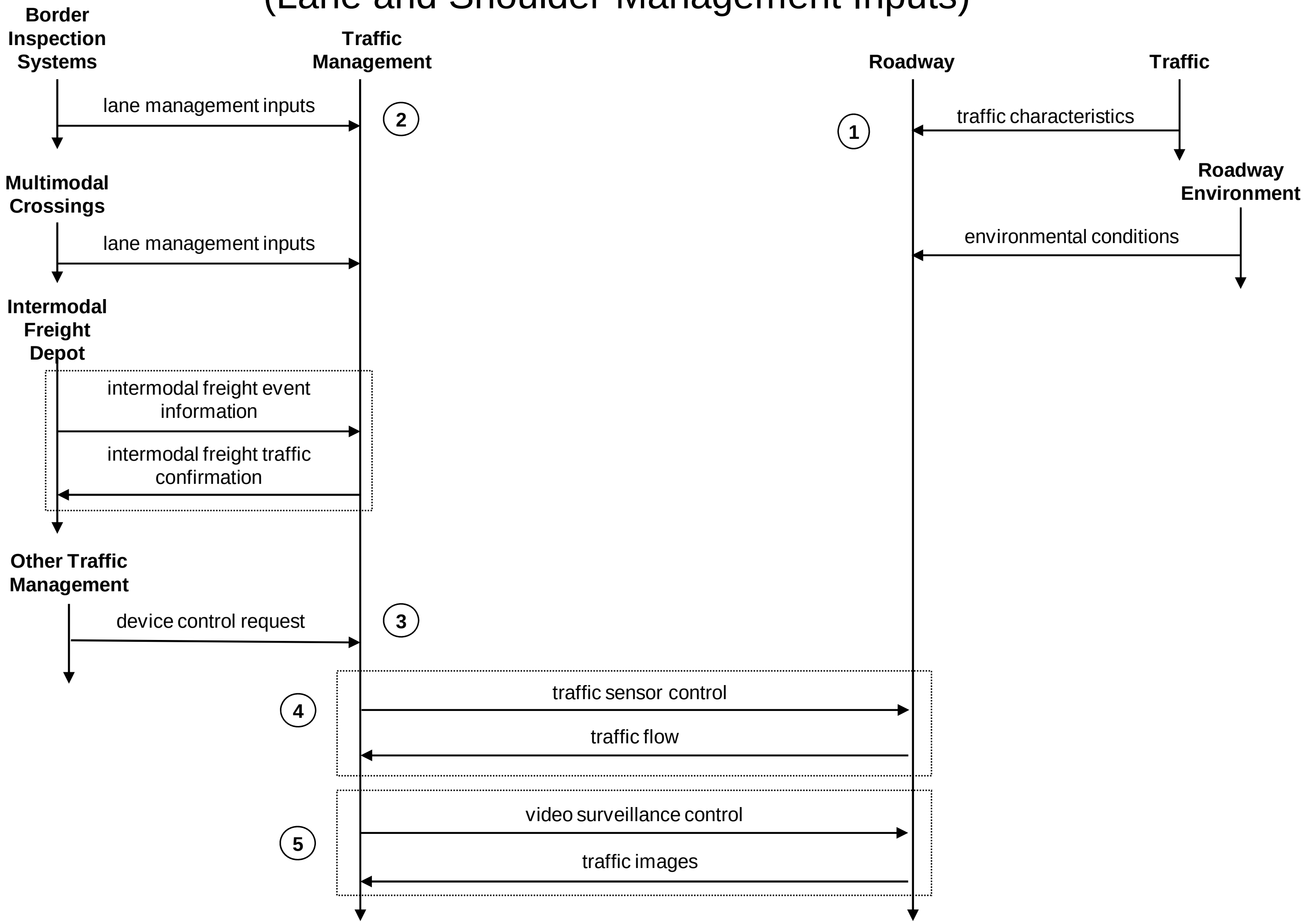
11. The Traffic Management Subsystem can request general enforcement of dynamically managed lanes (*request for enforcement*). Also, the Traffic Management Subsystem can notify (*request for enforcement*) an Enforcement Agency of a violation in a dynamically managed lane by a specific vehicle.

12. The Traffic Management Subsystem can request specific lane management from Other Traffic Management (*device control request*) to allow coordination between jurisdictions.

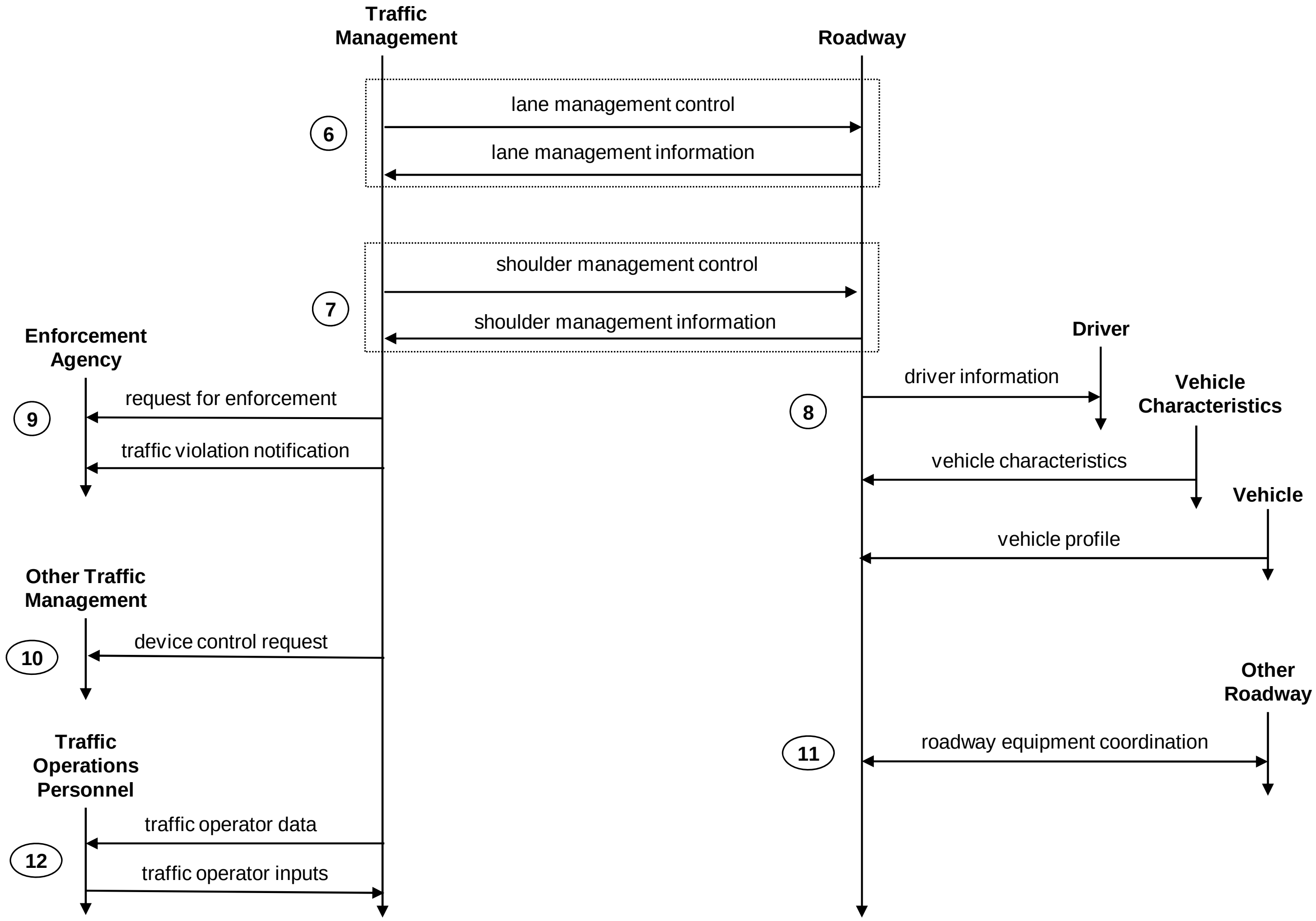
13. The equipment on or along the Roadway used for dynamic lane and shoulder management can be coordinated (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations.

14. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

ATMS23: Dynamic Lane Management and Shoulder Use (1 of 2) (Lane and Shoulder Management Inputs)



ATMS23: Dynamic Lane Management and Shoulder Use (2 of 2) (Lane and Shoulder Management)



2.24 ATMS24: Dynamic Roadway Warning

This service package includes systems that dynamically warn drivers approaching hazards on a roadway. Such hazards include roadway weather conditions, road surface conditions, traffic conditions including queues, obstacles or animals in the roadway and any other transient event that can be sensed. These dynamic roadway warning systems can alert approaching drivers via warning signs, flashing lights, in-vehicle messages, etc. Such systems can increase the safety of a roadway by reducing the occurrence of incidents. The system can be centrally monitored and controlled by a traffic management center or it can be autonomous.

Speed warnings that consider the limitations of a given vehicle for the geometry of the roadway (e.g., rollover risk for tall vehicles) are not included in this service package but are covered by the ATMS19 – Speed Warning and Enforcement service package.

Roadway warning systems, especially queue warning systems are an Active Traffic Management (ATM) strategy and are typically used in conjunction with other ATM strategies (such as ATMS22-Variable Speed Limits and ATMS23-Dynamic Lane Management and Shoulder Use).

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

Equipment on the Roadway is constantly monitoring traffic conditions (*traffic characteristics*) including the formation of queues.
The current weather and roadway conditions (*environmental conditions*) including icy patches and other obstacles are also monitored.
The roadway is constantly monitoring for the presence of obstacles (*physical presence*) including stalled vehicles, debris in the road or any other element which is in a potential path of a vehicle

1. To assist in identifying potential obstacles including queues, the equipment on the Roadway can identify specific vehicles and their characteristics (*vehicle characteristics*), (i.e. speed, acceleration, length, etc.)

2. To obtain information about traffic including queue formation, the Traffic Management Subsystem can control (*traffic sensor control*) and monitor (*traffic flow*) sensors in or along the Roadway.

3. The Traffic Management Subsystem can monitor video surveillance (*traffic images*) for the presence of potential obstacles. The equipment can be controlled (e.g. pan/tilt/zoom) (*video surveillance control*) by the Traffic Management Subsystem.

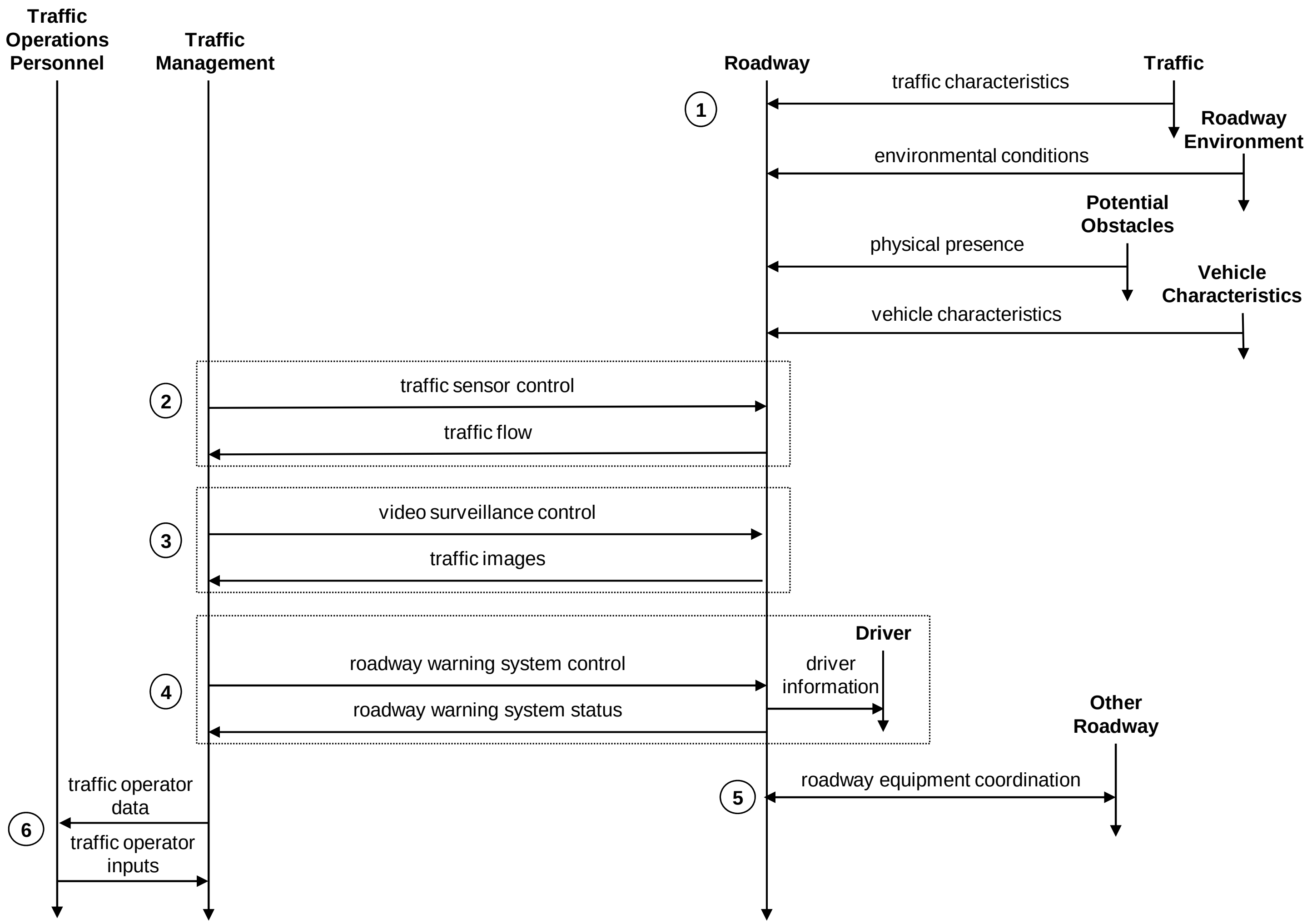
4. The Traffic Management Subsystem controls (*roadway warning system control*) the equipment on or along the roadway that monitors the roadway and displays warnings (*driver information*) to Drivers when they are approaching an obstacle.

5. The Traffic Management Subsystem can monitor the status of this equipment (*roadway warning system status*).

6. The equipment on or along the Roadway used for dynamic roadway warnings can be coordinated (*roadway equipment coordination*) with signs, signals or Field-Vehicle Communications equipment.

7. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.

ATMS24: Dynamic Roadway Warning



2.25 ATMS25: VMT Road User Payment

This service package facilitates charging fees to roadway vehicle owners for using specific roadways with potentially differential payment rates based on time-of-day, which specific roadway is used, and class of vehicle (a local policy decision by each roadway owner). Vehicle owners need only register with a single payment entity of their choice (a participating state, municipal, or regional DOT, an authority, or a private entity), and payments are reconciled by the entity receiving payment (and travel history) with all roadway owners that participate in the VMT payment scheme, which may also include the Federal government. Vehicle owners would pay nothing for distances traveled where there are no payments required (e.g. in jurisdictions that have not implemented a distance based payment or for roadway operators that collect payment using traditional tolls), although a Federal payment rate might cover some or all roadway operations (a Federal policy decision). Basic operation depends on the vehicle tracking its own location, and periodically reporting its travel history to the registered entity receiving payment using C-V communications. Roadway VMT Payment can duplicate the functions of current toll road payment schemes based on F-V communications, parking payment functions, as well as augment and/or replace federal and state gasoline taxes (which are otherwise ineffective for vehicles that don't use gasoline).

The payments per distance traveled can be structured to provide some amount of demand management by motivating vehicle owner travel choices to minimize payments. The use of this service package for demand management is a local policy decision by each roadway owner.

Alternatively, for vehicle owners that prefer a strictly odometer ("high privacy") based payment approach (that does not need to record and report specific locations and times of travel), then the payment amount may assume a payment rate corresponding to the most expensive roads at the most expensive times. Specific payment rates for this option are a local policy decision.

Odometer readings (from vehicle registration and periodic safety inspection events stored at the state DOT where the vehicle is registered) can be used as a back-office audit to detect gross vehicle equipment failures and fraud (e.g. disabling or dismounting vehicle equipment). In addition, vehicle equipment can be read by fixed or mobile roadside equipment using F-V communications for a more immediate audit of in-vehicle equipment and enforcement (for vehicle owners that have not chosen the odometer-only method of payment).

Payment can be made periodically through a normal bill/payment cycle that is part of the registration process a vehicle owner chooses, or using a vehicle mounted or entered payment instrument/information with vehicle operator or owner initiated payment points. This facilitates payment by vehicle operators (instead of owners) for various commercial operations such as rental vehicles, taxi operators.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Payment Administrator for each instance of the Payment Administration Subsystem (PAS) can initialize the payment rates for the region covered by the PAS with *payment administration requests* and report the current status with *payment information presentation*. Once the rates are correctly set they can be shared with all external entity ISPs in *VMT data for ISP* and with all vehicles that are registered with the PAS in *VMT cost data*. The information distributed can be augmented with cost data from Other Payment Administration subsystems using *VMT payment coordination* (see transaction set 8 for this service package described below). Once the Vehicle has the full set of cost data, then the vehicle can give the Driver *driver updates* which can inform the driver of expected or past VMT costs based on anticipated or past driving routes.

2. Vehicle owners can use either a PIAS or RTSS to setup an account with a selected PAS (*user VMT account setup*). During the account setup (or updates of the setup later), the owner can select the type of VMT payment scheme they will be charged under. Generally the schemes that give higher levels of privacy will also cost more (because they will assume travel on more costly roadways - since the actual roadway use will be unknown to the roadway owners). See the next transaction set paragraph for a discussion of the possible options.

3. Vehicle owners can use either a PIAS or RTSS to review account activity with the PAS where they have an account (*user VMT account reports*). Depending on how the user has setup the account, the PAS may be able to provide a full audit trail of how costs were calculated (identifying every roadway used, at what time, and what the VMT cost was to use that roadway at the time), or only a total of miles traveled on a reporting period and an average VMT cost, or just the total cost with no traceability to number of miles traveled or where, or a flat rate (that assumes a fixed VMT rate - probably a high rate) that ensures the highest level of privacy. Distance traveled at the highest level of privacy might be simply a report of the odometer reading by either the vehicle owner (audited periodically based on vehicle safety inspection reports).

4. The vehicle uses it's Location Data Source (*position fix*) to track the roadways used and the time they are used, calculating the VMT payment due and accumulating the travel history and cost in the Vehicle. Next, the Vehicle, at either periodic times (set by *VMT cost data* during initialization) or when queried by a Roadway Payment subsystem (RPS), the Vehicle issues a *VMT data* message to the registered PAS or to the nearby RPS. If the destination is an RPS, then the RPS relays the message to the appropriate PAS. RPS entities can be either fixed (at vehicle inspection stations or vehicle service stations or at roadside locations) or mobile. A mobile RPS (or a sequence of roadside RPSs) could read the same vehicle twice, after a short distance, and verify that the cost computed for the short (but known) distance is correct, verifying correct operation of the in vehicle equipment package (or conversely detecting faults in the equipment due to equipment failure or tampering).

5. Vehicle owners have two ways to pay for their VMT costs. First, using a PIAS or RTSS entity owners can see the costs they are liable to pay (see transaction set 3) and respond to a payment request (*traveler payment request*) with payment information *traveler payment information* using either a financial instrument (bank/credit/debit account) or reference to a positive cash balance account maintained by the PAS.

6. Second, drivers (may or may not be owners too) can pay their VMT costs from the vehicle using a payment instrument (or using account information entered here). In this scheme, the PAS send *vehicle payment request* to the VS either directly or via an RPS. This triggers a VS to Traveler Card *request for payment* and *payment* response, which sent to the PAS as *vehicle payment information* either directly or via the intermediary RPS. This payment mechanism is useful for vehicle operators that are responsible for VMT payments, but that don't own the vehicle such as vehicle renters or non-owner taxi drivers.

7. If a financial institution payment instrument is used in the prior steps, it is reconciled by the PAS through a transaction with the appropriate financial institution *payment request* and *transaction status*.

8. For VMT payments made for operations on the roadways of other PASs, a portion of the payment corresponding the VMT cost on the other PAS's roadways will be made via the *VMT payment coordination* message. This allows proper apportionment of payments based on actual usage of roadways outside the jurisdiction of the PAS with whom a vehicle owner has chosen to register.

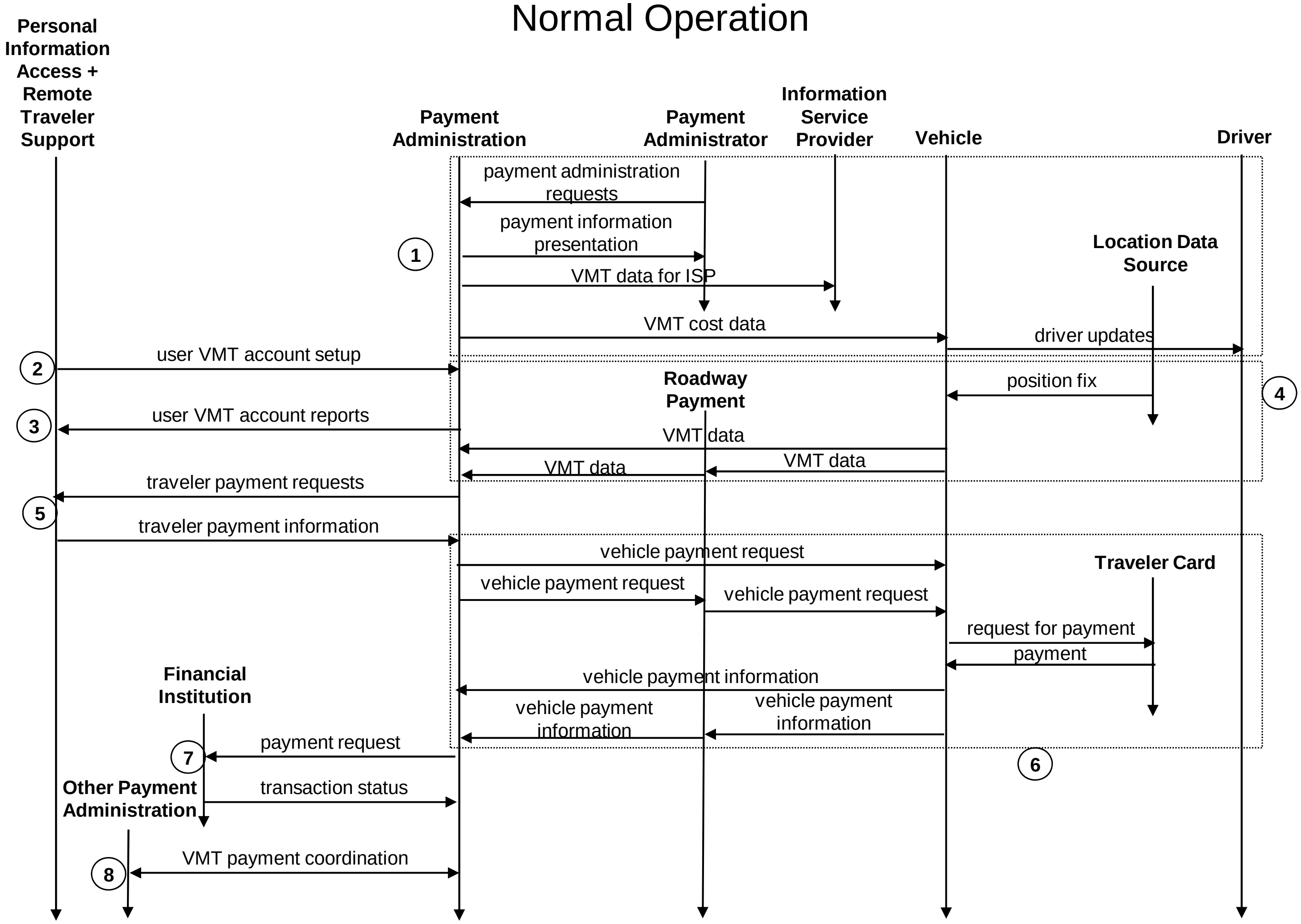
9. A crucial function of the VMT payment scheme is enforcement. The RPS subsystem can be either fixed or mobile in its enforcement role. The RPS will read the *vehicle characteristics* of the vehicle under "test". This should include estimating the class of vehicle (e.g. size and number of axles) relevant for the VMT scheme, and reading the vehicle registration license tag (e.g. optical character recognition or reading an electronic tag on the vehicle). At the same time, the *VMT equipment status* is read from the vehicle, which should provide a quick estimate of the proper functioning of the equipment, including the current estimated VMT cost that the vehicle has accumulated at the time that the status is read. Taking a second reading a short distance down the road should give a good verification of the proper functioning of the onboard equipment.

10. If a fault is detected on the VS equipment by the RPS, then the *VMT equipment fault* message is issued to the PAS identifying the vehicle, its license tag and the equipment status.

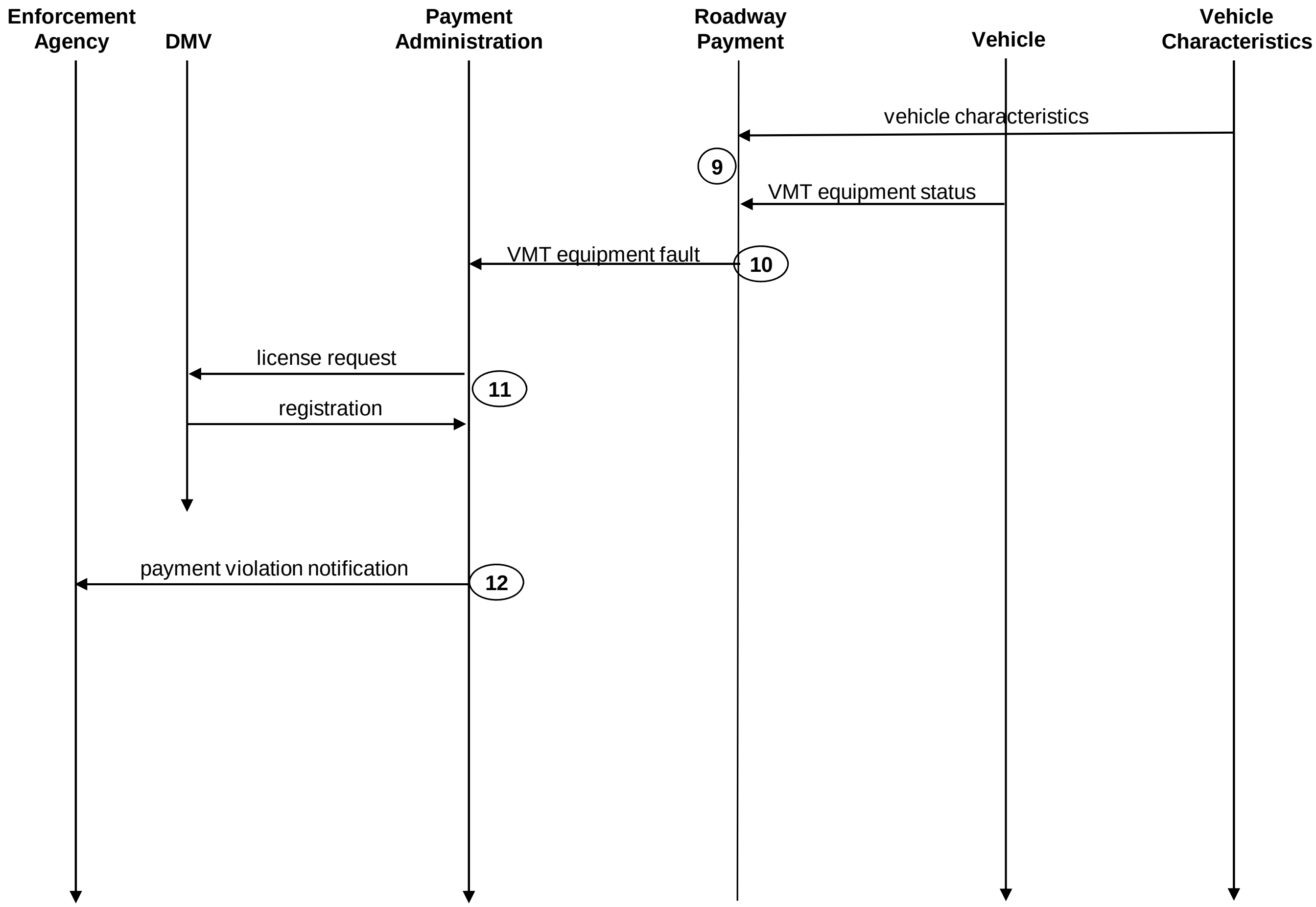
11. The PAS will transact with the DMV to resolve the vehicle owner from the license tag data by sending *license request* to the DMV and receiving *registration* in return. This information can be used to contact the vehicle owner to ask them to have the VS serviced to correct the fault within a period of time. This may or may not involve an additional administrative fee (since it's possible that the VS is using the roadways in a "free" mode).

12. In the event that a VS owner does not correct a detected fault when they have been notified by the PAS, or if they are a repeat offender, the PAS should follow a process that could result in a *payment violation notification* message being sent to the appropriate Enforcement Agency.

ATMS25: VMT Road User Payment (1 of 2) Normal Operation



ATMS25: VMT Road User Payment (2 of 2)
Enforcement Operation



2.26 ATMS26: Mixed Use Warning Systems

This service package supports the sensing and warning systems used to interact with pedestrians, bicyclists, and other vehicles that operate on the main vehicle roadways, or on pathways which intersect the main vehicle roadways. These systems could allow automated warning or active protection for this class of users.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

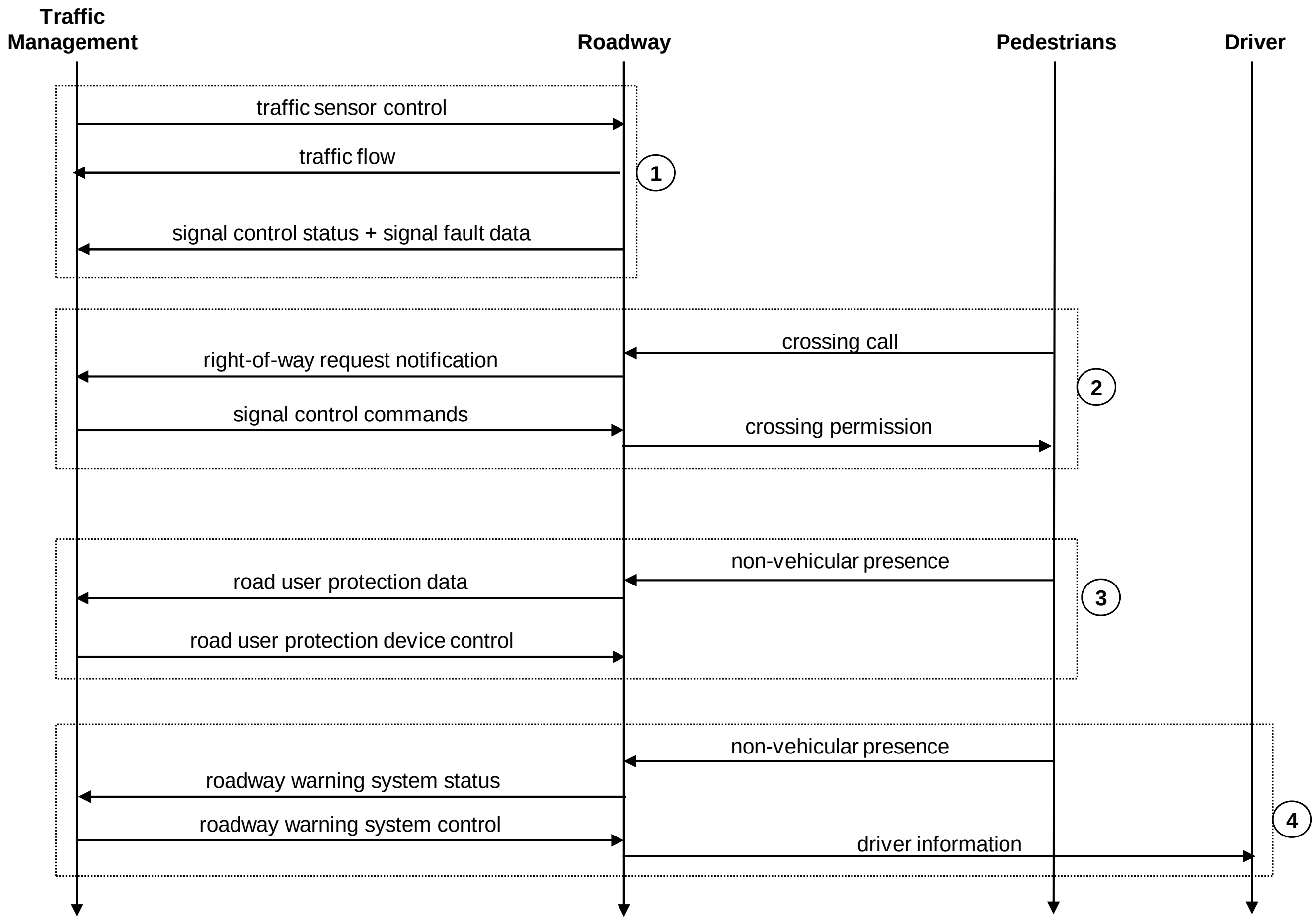
1. At mixed use signalized intersections, normal operations of *traffic sensor control* and *traffic flow*, as well as the monitoring functions of *signal control status* and *signal fault data* continue (as in ATMS03).

2. When a Pedestrian (e.g. walking or biking) makes a *crossing call* to the Roadway, the Roadway notifies the TMS (*right-of-way request notification*). The TMS sends the appropriate *signal control commands* to the RS to trigger the *crossing permission* indicator to the Pedestrian (at the appropriate point in the cycle).

3. If a Pedestrian *non-vehicular presence* is detected by the RS, then *road user protection data* can be sent to the TMS indicating the location, trajectory, mode (e.g. walking or biking) of the pedestrian. The TMS can then send *road user protection device control* to the RS to deploy the available and appropriate protection system for the pedestrian.

4. If a Pedestrian *non-vehicular presence* is detected by the RS, then *roadway warning system status* can be sent to the TMS, and an appropriate *roadway warning system control* can be sent to the RS, with an appropriate warning message or indicator sent to Drivers (*driver information*).

ATMS26: Mixed Use Warning Systems



3 Traveler Information

This section provides the Theory of Operations for the Traveler Information Service Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each service package section) to identify these service packages is ATIS—Advanced Traveler Information Systems.

3.1 ATIS01: Broadcast Traveler Information

This service package collects traffic conditions, advisories, general public transportation, toll and parking information, incident information, roadway maintenance and construction information, air quality and weather information, and broadcasts the information to travelers using technologies such as FM subcarrier, satellite radio, cellular data broadcasts, and Internet web casts. The information may be provided directly to travelers or provided to merchants and other traveler service providers so that they can better inform their customers of travel conditions. Different from the service package ATMS06 - Traffic Information Dissemination, which provides localized HAR and DMS information capabilities, ATIS01 provides a wide area digital broadcast service. Successful deployment of this service package relies on availability of real-time traveler information from roadway instrumentation, probe vehicles or other sources.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*ISP operations information presentation*) and control (*ISP operator inputs*) by the ISP Operator.

2. Concurrently and asynchronously, information is collected by the ISP from a variety of sources:

    - Traffic Management Subsystem (*road network conditions*, *traffic images* and *incident information*)
    - Transit Management Subsystem (*transit and fare schedules*), which includes static fare and schedule information, *transit schedule adherence information*, which includes real-time schedule performance information, and *transit incident information*, which includes real time incident information
    - Emergency Management Subsystem (*incident information*), including incidents arising from large-scale natural or human-caused disasters
    - Emissions Management Subsystem (*air quality information*)
    - Maintenance and Construction Management Subsystem (*current asset restrictions*), (*maint and constr work plans*), (*roadway maintenance status*), and (*work zone information*)
    - Parking Management Subsystem (*parking information*)
    - Payment Administration (*toll data*)

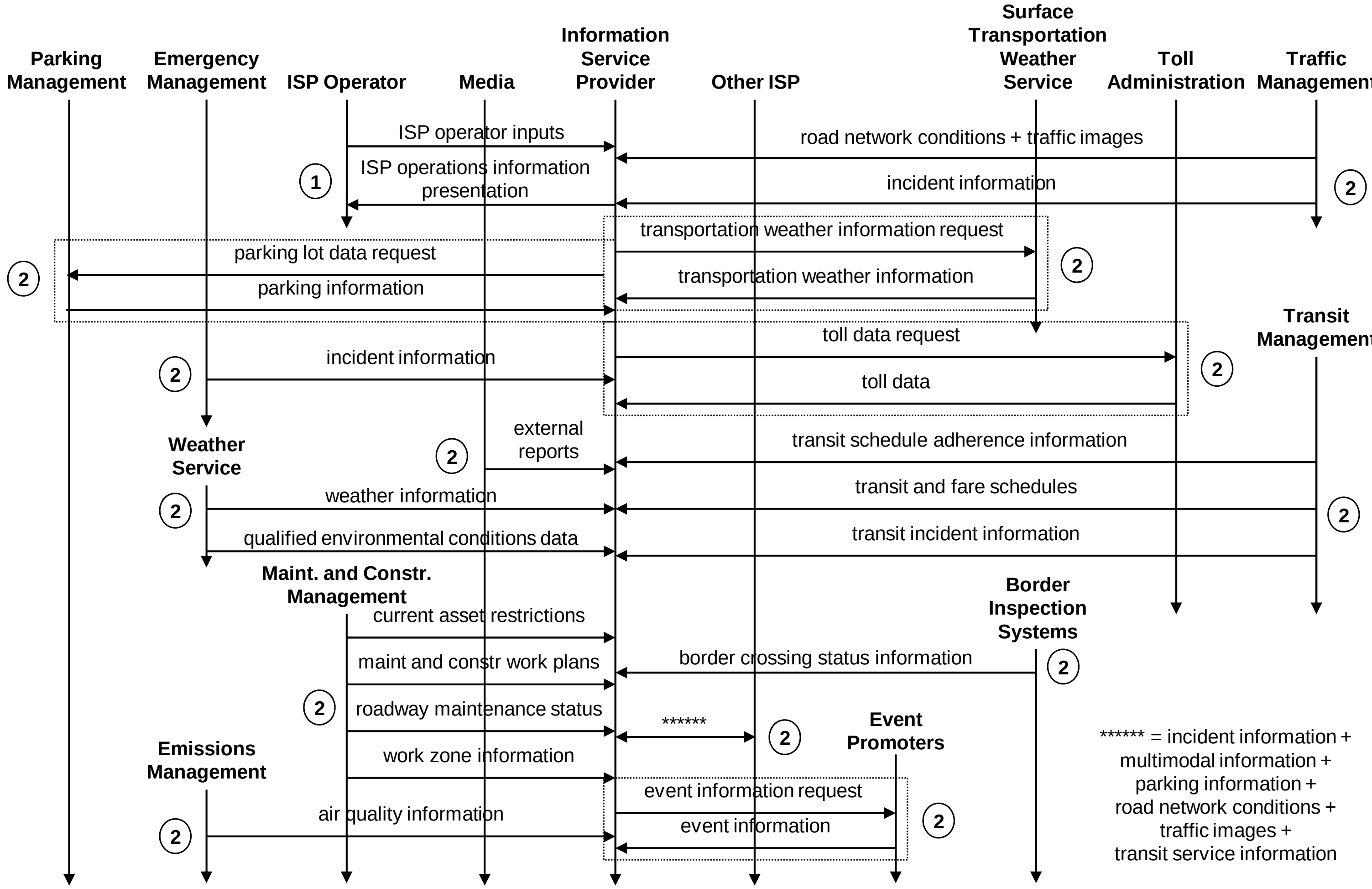
- Border Inspection Systems (*border crossing status information*)
- Event Promoters (*event information*)
- Media (*external reports*), which include traffic or incident information collected by the media
- Surface Transportation Weather Service (*transportation weather information*)
- Weather Service (*qualified environmental conditions data* and *weather information*)
- Other ISP (*incident information*, *multimodal information*, *parking information*, *road network conditions*, *traffic images*, and *transit service information*), which provides for multiple ISPs exchanging information from separate sources for purposes of augmenting the broadcast information or corroborating specific information items.

This information is often based upon exceptional conditions, such as an incident in traffic, a storm, or other special events.

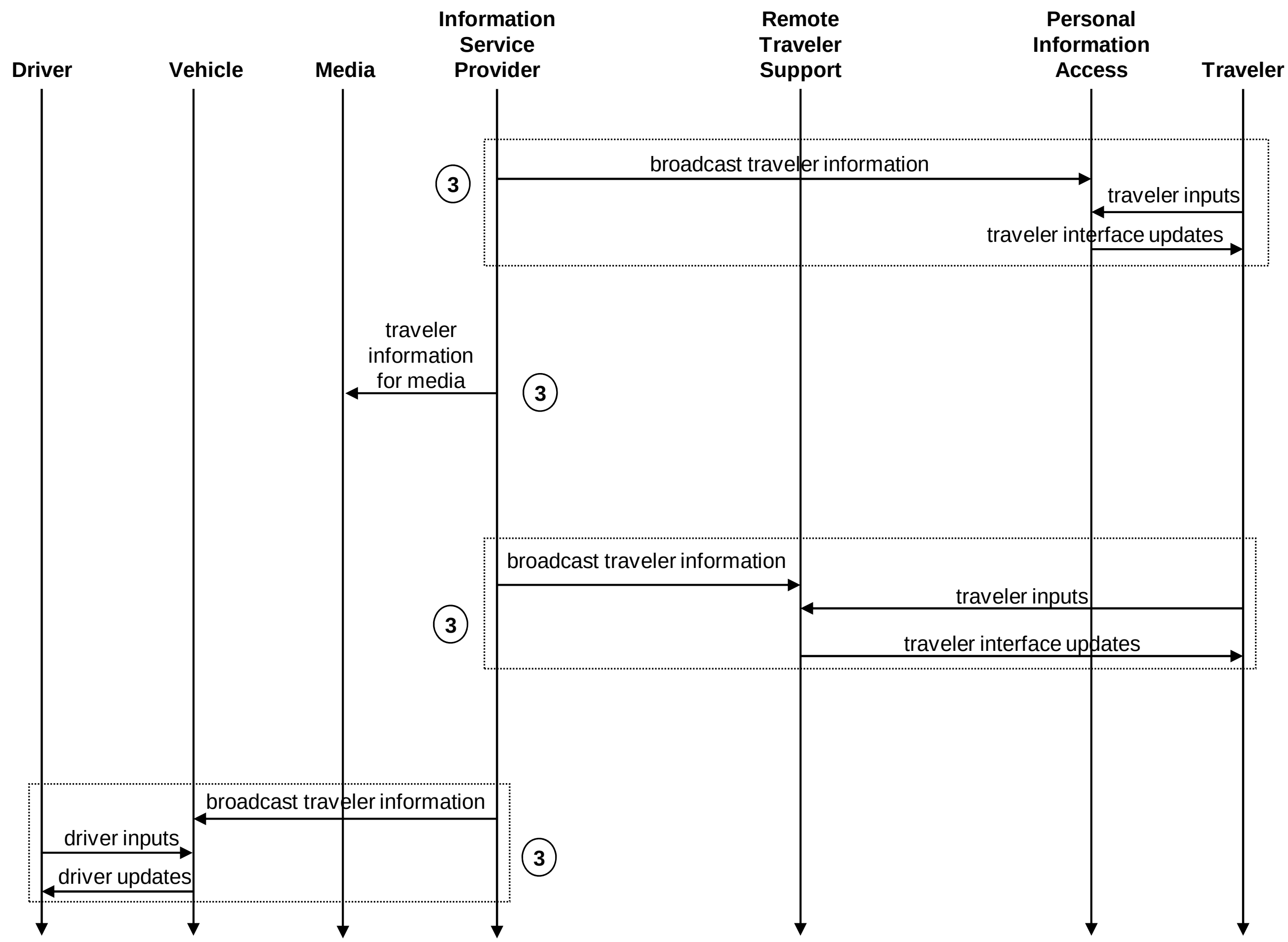
Information collected by the ISP from some sources may come as the result of a specific request or be obtained through subscriptions. Specific requests include (*parking lot data request*), (*toll data request*), (*event information request*), and (*transportation weather information request*). With subscriptions, providers usually send periodic updates on a scheduled basis.

3. ISPs broadcast information that contains link travel times, incidents, advisories, transit services and a myriad of other traveler information. The (*broadcast traveler information*) is provided via the Personal Information Access Subsystem (e.g. a personal computing device) and the Remote Traveler Support Subsystem (e.g. a kiosk) for Travelers and via the Vehicle Subsystem for Drivers. Travelers may make some selections (*traveler inputs*) about which part of the broadcast information they view. Similarly, Drivers can select which radio channels or telematics data channels they want via (*driver inputs*). Drivers are then provided (*driver updates*) and Travelers are provided (*traveler interface updates*). Similar information is sent to the Media (*traveler information for media*). Either raw data, processed data, or some combination of both may be provided by this architecture flow.

ATIS01: Broadcast Traveler Information (1 of 2) (Information Collection)



ATIS01: Broadcast Traveler Information (2 of 2) (Information Dissemination)



3.2 ATIS02: Interactive Traveler Information

This service package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, roadway maintenance and construction, transit services, ride share/ride match, parking management, detours and pricing information. Although the Internet is the predominate network used for traveler information dissemination, a range of two-way wide-area wireless and fixed-point to fixed-point communications systems may be used to support the required data communications between the traveler and Information Service Provider. A variety of interactive devices may be used by the traveler to access information prior to a trip or en route including phone via a 511-like portal and web pages via kiosk, personal digital assistant, personal computer, and a variety of in-vehicle devices. This service package also allows value-added resellers to collect transportation information that can be aggregated and be available to their personal devices or remote traveler systems to better inform their customers of transportation conditions. Successful deployment of this service package relies on availability of real-time transportation data from roadway instrumentation, transit, probe vehicles or other means. A traveler may also input personal preferences and identification information via a “traveler card” that can convey information to the system about the traveler as well as receive updates from the system so the card can be updated over time.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*ISP operations information presentation*) and control (*ISP operator inputs*) by the ISP Operator.

2. Concurrently and asynchronously, information is collected by the ISP from a variety of sources:

    - Traffic Management Subsystem (*road network conditions*, *traffic images* and *incident information*)
    - Transit Management Subsystem (*transit and fare schedules*), which includes static fare and schedule information, *transit schedule adherence information*, which includes real-time schedule performance information, and *transit incident information*, which includes real time incident information
    - Emergency Management Subsystem (*incident information*), including incidents arising from large-scale natural or human-caused disasters
    - Emissions Management Subsystem (*air quality information*)
    - Maintenance and Construction Management Subsystem (*current asset restrictions*), (*maint and constr work plans*), (*roadway maintenance status*), and (*work zone information*)
    - Parking Management Subsystem (*parking information*)
    - Payment Administration (*toll data*)

- Border Inspection Systems (*border crossing status information*)
- Event Promoters (*event information*)
- Media (*external reports*), which include traffic or incident information collected by the media
- Multimodal Transportation Service Providers (*multimodal information*), which includes information about other transportation modes such as train, airplane, and ferry
- Surface Transportation Weather Service (*transportation weather information*)
- Weather Service (*qualified environmental conditions data* and *weather information*)
- Other ISP (*incident information*, *multimodal information*, *parking information*, *road network conditions*, *traffic images*, and *transit service information*), which provides for multiple ISPs exchanging information from separate sources for purposes of augmenting the broadcast information or corroborating specific information items

This information is often based upon exceptional conditions, such as an incident in traffic, a storm, or other special events.

Information collected by the ISP from some sources may come as the result of a specific request or be obtained through subscriptions. Specific requests include *parking lot data request*, *toll data request*, *event information request*, *multimodal information request*, and *transportation weather information request*. With subscriptions, providers usually send periodic updates on a scheduled basis.

3. The ISP provides information to several centers or systems tailored to their requests or needs. It provides *traveler information for media* to the Media. In addition, data collected by the ISP can be associated with links and nodes of the transportation network. An interface to a Map Update Provider is available to keep this model of the transportation network current (*map update request*, *map updates*). The ISP also provides *voice-based traveler information* to 511 systems (i.e., Telecommunications System for Traveler Information) upon request (*voice-based traveler request*).

4. Periodically, possibly by subscription or maybe on a regular schedule, the Remote Traveler Support Subsystem, RTS (e.g. a kiosk), may request (*map update request*) and download *map updates*.

5. Asynchronously, and as often as desired, Travelers (who may later become Drivers) may enter requests for information (*traveler inputs*) into the Personal Information Access Subsystem, PIAS (e.g. personal computing device) or the RTS. These requests often take the form of a traveler profile which is stored in advance of its use (see box 7).

6. Asynchronously, whenever a Traveler uses a Traveler Card with the PIAS or RTS, user information will be retrieved from the card (*traveler card information*).

7. The core aspect of this service package is that travelers (or drivers) can make a request for personalized travel information. One method of requesting information is through the use of a *traveler profile*, which can be sent from the PIAS or from the Vehicle Subsystem to the ISP. This profile subscribes the user for a specific scope of travel information provided at specified intervals or times (e.g. incident information on a specific route provided every day at 5 PM). *Traveler alerts* are provided to the PIAS and Vehicle Subsystem per the traveler's profile.

8. Alternately the traveler profile may provide parameters specifying the type of device and preferences that are used whenever additional specific requests are made. The other mode of operation is for the Traveler to make a specific request (*traveler request*) that will elicit a specific response (*interactive traveler information*). Both alerts and interactive information are provided to the Traveler by the PIAS or RTS through visual or audio means (*traveler interface updates*). The cycle of request and response may be repeated as often as needed.

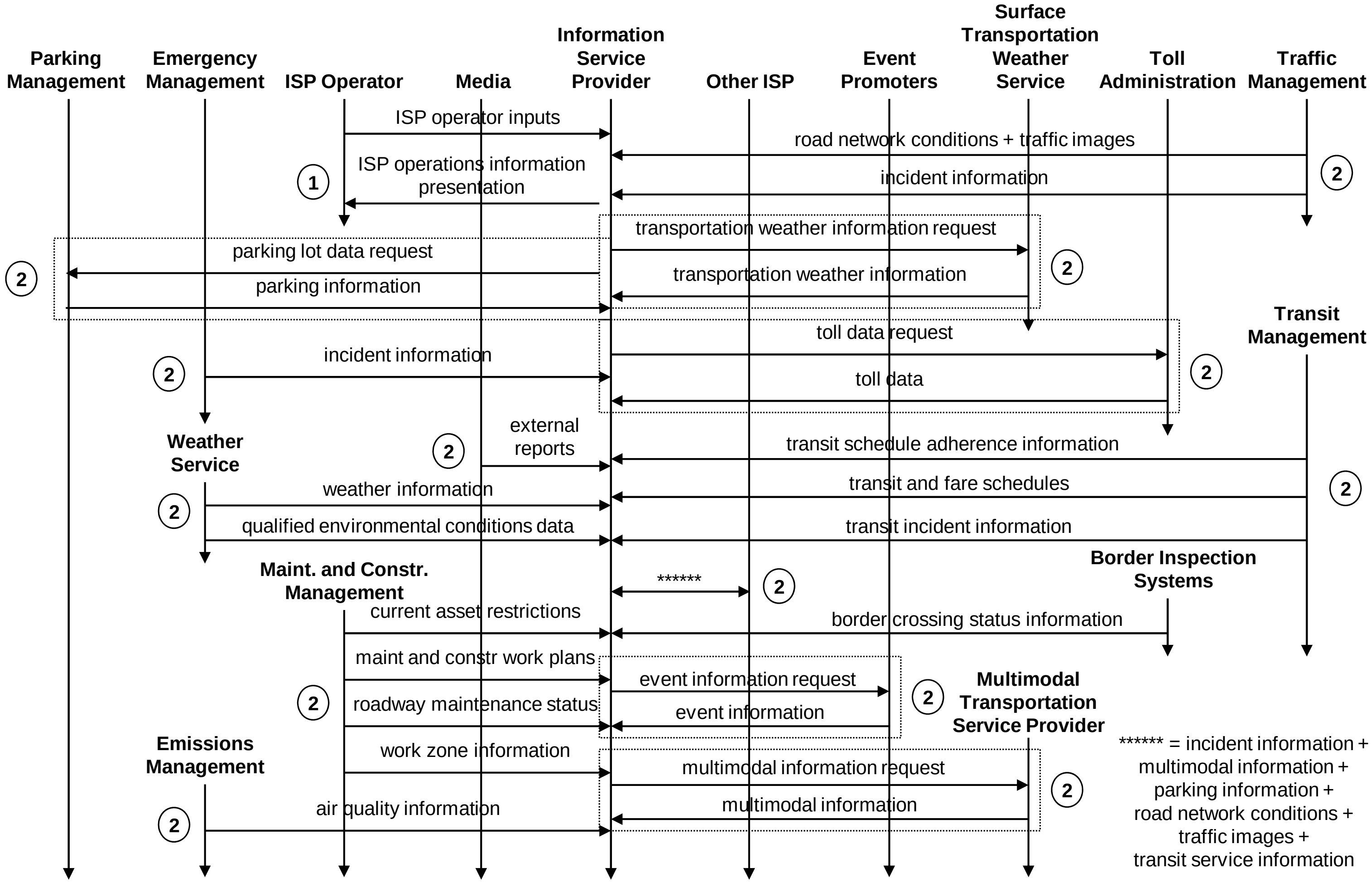
In a similar cyclical manner, Drivers may make information requests (*driver inputs*) and then traveler requests and corresponding traveler information may be exchanged between a Vehicle and an ISP, and the result (*driver updates*) returned to the Driver.

9. In between the time that a travel information request is sent to the ISP and the time that information is returned, the ISP may present a request for payment (*payment request*) and then receive *transaction status* on that request from a Financial Institution.

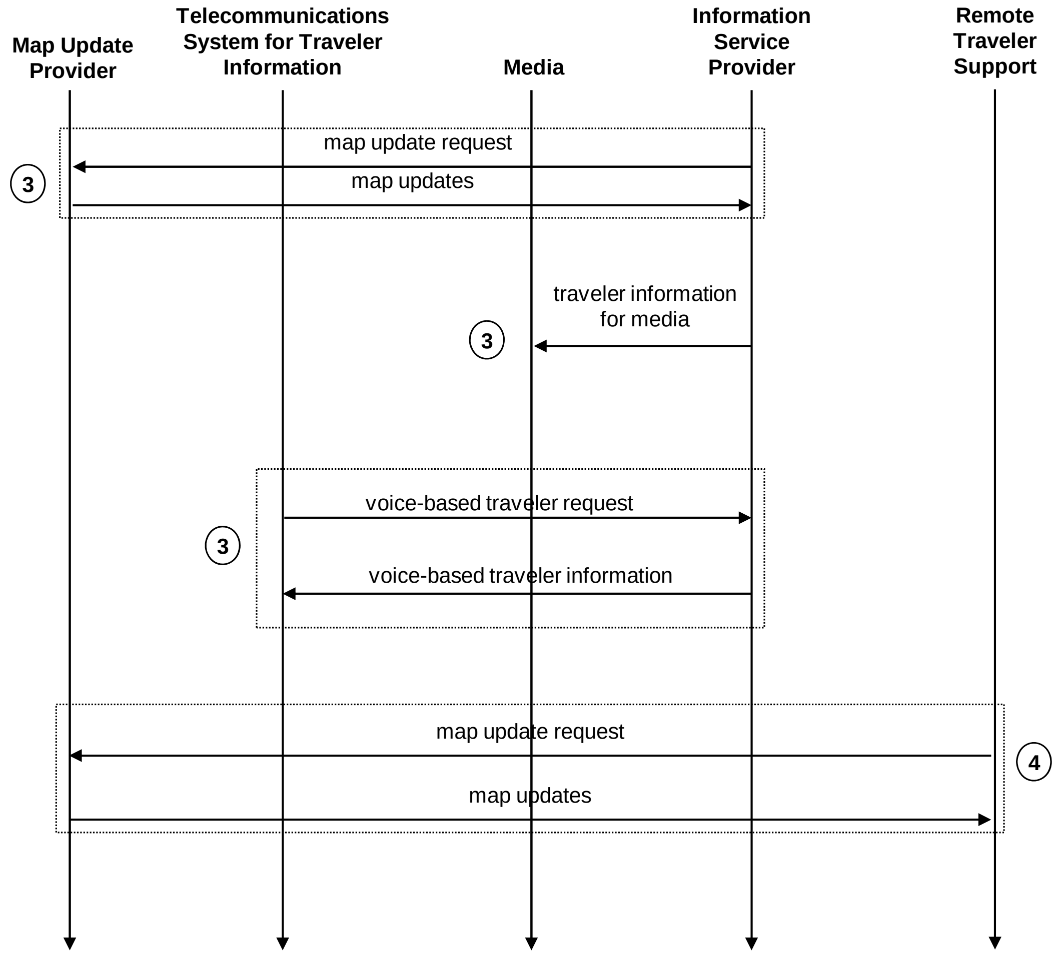
10. Optionally, in conjunction with the financial transaction with the Financial Institution, a similar *request for payment* and corresponding *payment* may be made using the Traveler Card. If payment is required for the information request, and the Traveler Card is capable of making the payment, the transaction with the Financial Institution may not occur.

11. Optionally, a *traveler card update* may be made to the Traveler Card by the PIAS or RTS. These would update the personal information on the Traveler Card based upon the traveler interaction with the PIAS or RTS.

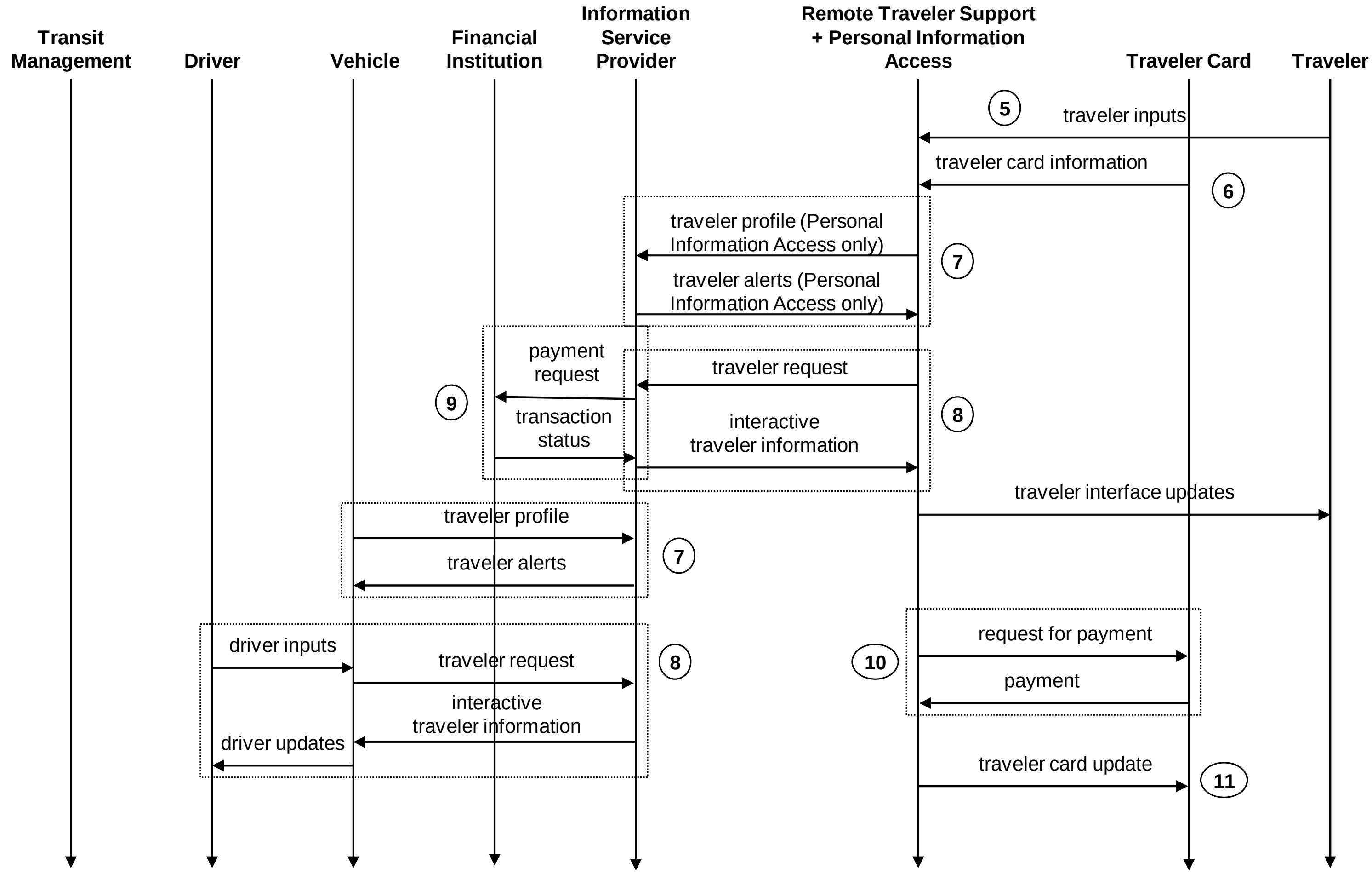
ATIS02: Interactive Traveler Information (1 of 3) (Information Collection)



ATIS02: Interactive Traveler Information (2 of 3)
(Center-to-Center Information Dissemination)



ATIS02: Interactive Traveler Information (3 of 3) (Driver/Personal Information Dissemination)



3.3 ATIS03: Autonomous Route Guidance

This service package relies on in-vehicle sensory, location determination, computational, map database, and interactive driver interface equipment to enable route planning and detailed route guidance based on static, stored information. No communication with the infrastructure is assumed or required. Identical capabilities are available to the traveler outside the vehicle by integrating a similar suite of equipment into portable devices.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Periodically, possibly by subscription or by regularly scheduled requests, vehicle systems and personal devices may request (*map update request*) and download *map updates* from a Map Update Provider. For autonomous route guidance, most likely this would come by way of some memory media (e.g., CD) and the vehicle or personal equipment would be updated accordingly.

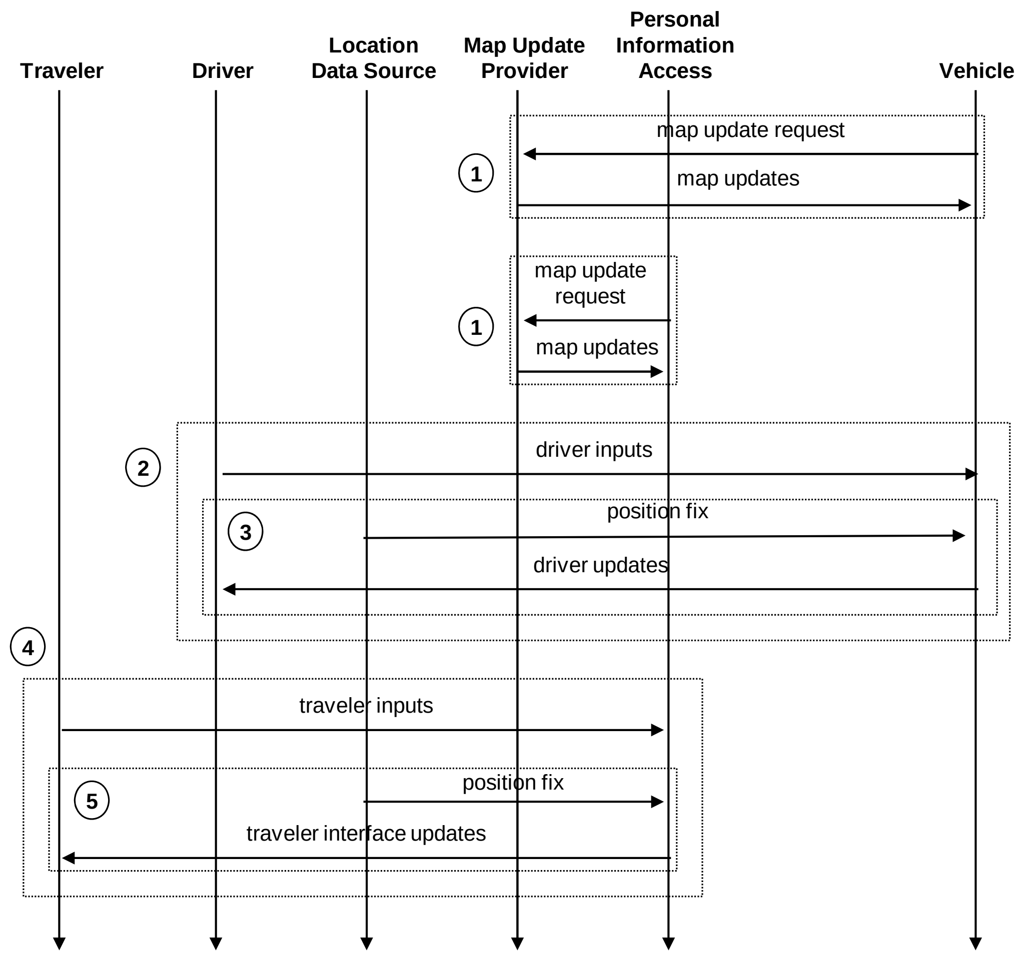
2. Optionally, asynchronously, and as often as desired, a driver may request (*driver inputs*) a route from the vehicle.

3. Once a route is requested by the driver (*driver inputs*), a continuous cycle occurs, consisting of these steps: the updated position of the driver (*position fix*) is obtained, real-time, the Vehicle Subsystem computes the best route from the current position to the destination, and then the next route guidance instructions (*driver updates*) is provided to the driver.

4. Optionally, asynchronously, and as often as desired, a traveler may request (*traveler inputs*) a route using a personal computing device (PDA, cell phone, or other mobile device).

5. Once a route is requested by the traveler, a continuous cycle occurs, consisting of these steps: the updated position of the traveler (*position fix*) is obtained, the Personal Information Access Subsystem computes the best route from the current position to the destination, and then the next route guidance instructions (*traveler interface updates*) is provided to the traveler.

ATIS03: Autonomous Route Guidance



3.4 ATIS04: Dynamic Route Guidance

This service package offers advanced route planning and guidance that is responsive to current conditions. The package combines the autonomous route guidance user equipment with a digital receiver capable of receiving real-time traffic, transit, and road condition information, which is considered by the user equipment in provision of route guidance.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*ISP operations information presentation*) and control (*ISP operator inputs*) by the ISP Operator.

2. Periodically, possibly by subscription or by regularly scheduled requests, vehicle systems and personal devices may request (*map update request*) and download *map updates* from a Map Update Provider.

3. All (or selected) collected *road network conditions*, *traffic images* and *incident information* can be provided by the Traffic Management Subsystem to Information Service Providers as either a direct response to requests or as subscription transactions. The information might also be pushed solely by the Traffic Management Subsystem according to a pre-arranged agreement.

4. All (or selected) *transit and fare schedules* and *transit schedule adherence information* can be received by Information Service Providers as either direct response to their requests or as subscription transactions. The schedules might also be pushed solely by the Transit Management Subsystem according to a pre-arranged agreement.

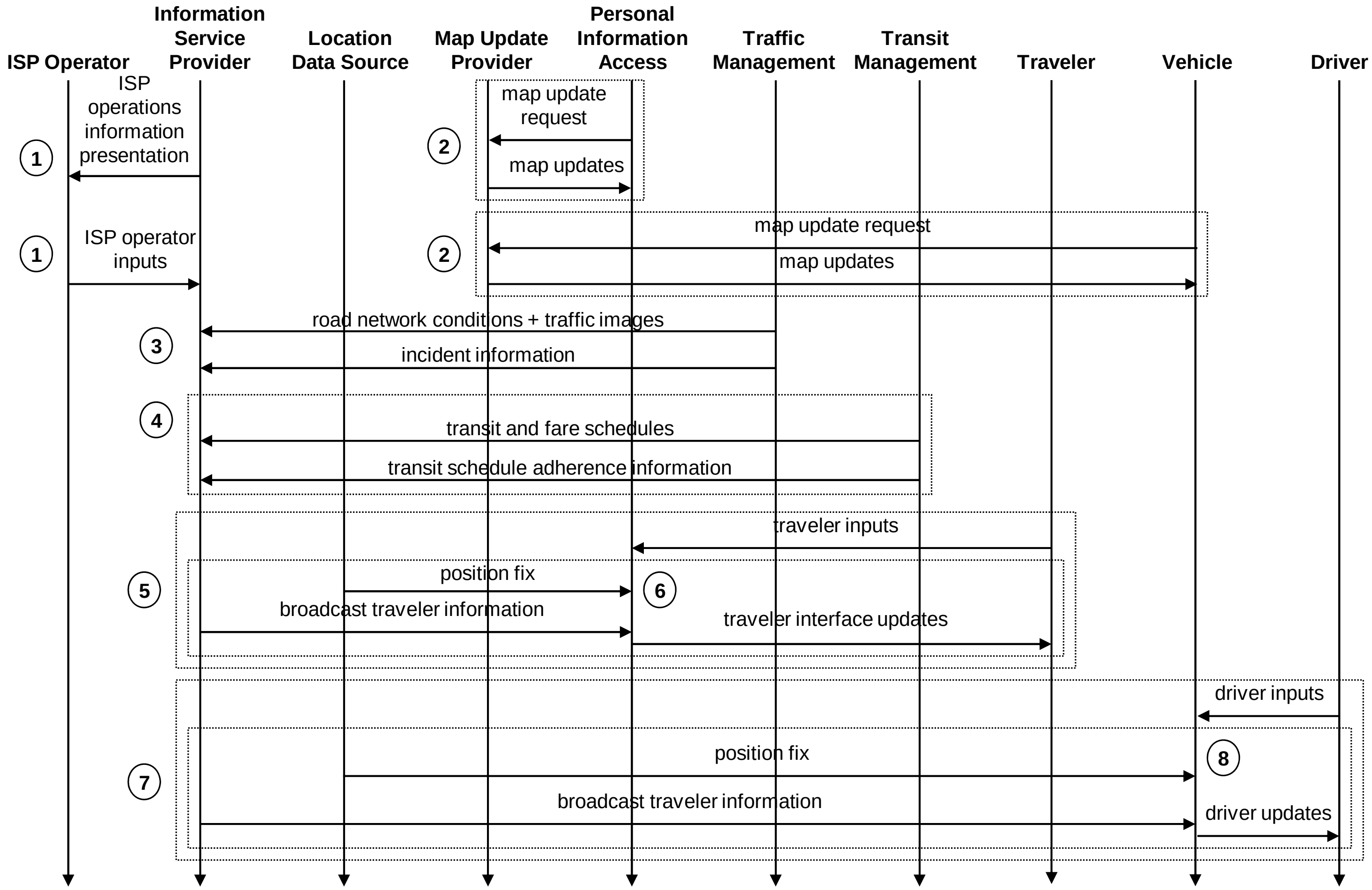
5. Optionally, asynchronously, and as often as desired, a traveler may request (*traveler inputs*) a route using a personal computing device (PDA, cell phone, or other mobile device).

6. Once a route is requested by the traveler, a continuous cycle occurs, consisting of these steps: the updated position of the traveler (*position fix*) is obtained, the Information Service Provider sends real-time, route-affecting information (*broadcast traveler information*), the Personal Information Access Subsystem computes the best route from the current position to the destination, and then the next route guidance instructions (*traveler interface updates*) is provided to the traveler.

7. Optionally, asynchronously, and as often as desired, a driver may request (*driver inputs*) a route from the vehicle.

8. Once a route is requested by the driver (*driver inputs*), a continuous cycle occurs, consisting of these steps: the updated position of the driver (*position fix*) is obtained, real-time, the Information Service Provider sends route-affecting information (*broadcast traveler information*), the Vehicle Subsystem computes the best route from the current position to the destination, and then the next route guidance instructions (*driver updates*) is provided to the driver.

ATIS04: Dynamic Route Guidance



3.5 ATIS05: ISP Based Trip Planning and Route Guidance

This service package offers the user trip planning and en-route guidance services. It generates a trip plan, including a multimodal route and associated service information (e.g., parking information), based on traveler preferences and constraints. Routes may be based on static information or reflect real time network conditions. Unlike ATIS3 and ATIS4, where the user equipment determines the route, the route determination functions are performed in the Information Service Provider Subsystem in this service package. The trip plan may be confirmed by the traveler and advanced payment and reservations for transit and alternate mode (e.g., airline, rail, and ferry) trip segments, and ancillary services (e.g., parking reservations) are accepted and processed. The confirmed trip plan may include specific routing information that can be supplied to the traveler as general directions or as turn-by-turn route guidance depending on the level of user equipment.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*ISP operations information presentation*) and control (*ISP operator inputs*) by the ISP Operator.

As part of the normal operation, ISPs may exchange information (*incident information*, *multimodal information*, *parking information*, *road network conditions*, *traffic images*, and *transit service information*) for a variety of reasons: contractual information access restrictions, proprietary data sources, economy of scale, cooperative agreements, etc. This ISP coordination is often in the form of a bulk data exchange. While necessary for route guidance, the information is not usually sent piecemeal for a specific route.

2. Periodically, possibly by subscription or by regularly scheduled requests, the Vehicle Subsystem and the Personal Information Access Subsystem (e.g. personal computing devices) may request (*map update request*) and download *map updates* from a Map Update Provider.

3. Schedule information for alternate mode transportation providers such as train, ferry, and air (*multimodal information*) are received by Information Service Providers as either direct response to their requests or as subscription transactions. The schedules might also be pushed solely by the Multimodal Transportation Service Provider according to a pre-arranged agreement (*multimodal information request*).

All (or selected) collected *road network conditions*, *traffic images* and *incident information* are provided by the Traffic Management Subsystem to Information Service Providers as either a direct response to requests or as subscription transactions. The information might also be pushed solely by the Traffic Management Subsystem according to a pre-arranged agreement.

All (or selected) *transit and fare schedules* and *transit schedule adherence information* are received from the Transit Management Subsystem by Information Service Providers as either direct response to their requests or as subscription transactions. Specific transit route recommendations and advanced fare payments may also be supported when explicitly requested by the Information Service Provider (*transit* *information request*). These requests for transit information or services are confirmed by the Transit Management Subsystem (*transit request confirmation*).

The Maintenance and Construction Management Subsystem provides *current asset restrictions* for the road network (e.g. height, weight, or width restrictions).

4. Prior to beginning the route request process, the traveler, using a PIAS, may submit a *traveler profile*, which will identify recurring trip characteristics, personal preferences, or equipment capabilities. To begin the route selection process a traveler may, asynchronously, and as often as desired, request (*traveler inputs*) a route through the Personal Information Access Subsystem, PIAS (e.g. a personal computing device such as a PDA, cell phone, PC, or other mobile device) or via the Remote Traveler Support Subsystem, RTS (e.g., a kiosk).

5. Once a route is requested by the traveler, a continuous cycle occurs, consisting of these steps:

    - The updated position of the traveler (*position fix*) may be obtained for the case of a mobile user making the route request via the PIAS.
    - The traveler's *trip request* is sent from the PIAS or RTS.
    - The Information Service Provider sends suggested route information (*trip plan*).
    - The PIAS or RTS presents the route/trip to the Traveler (*traveler interface updates*), and then the traveler either accepts the route (and the cycle stops) or asks for another route (and the cycle repeats).

6. Once the Traveler has accepted a route, a *trip confirmation* that the trip has been accepted is sent back to the ISP.

7. A similar set of flows can be used by a Driver to obtain route information. The driver may submit (through the Vehicle Subsystem) a *traveler profile*, which will identify recurring trip characteristics, personal preferences, or equipment capabilities. Then, asynchronously, and as often as desired, a driver may make a route request (*driver inputs*) to the Vehicle Subsystem.

8. Once a route is requested by the Driver (*driver inputs*), a continuous cycle occurs, consisting of these steps:

    - The updated position of the driver (*position fix*) is obtained.
    - The driver's *trip request* is sent from the Vehicle Subsystem to the ISP.
    - The ISP sends suggested route information (*trip plan*).
    - The Vehicle Subsystem presents the route/trip to the Driver (*driver updates*), and then the driver either accepts the route (and the cycle stops) or asks for another route (and the cycle repeats).

9. Once the Driver has accepted a route, a *trip confirmation* that the trip has been accepted is sent back to the ISP.

10. The ISP may provide specialized routing services for other types of clients. For example the Fleet and Freight Management Subsystem may request a route (*route request*) from the ISP. The

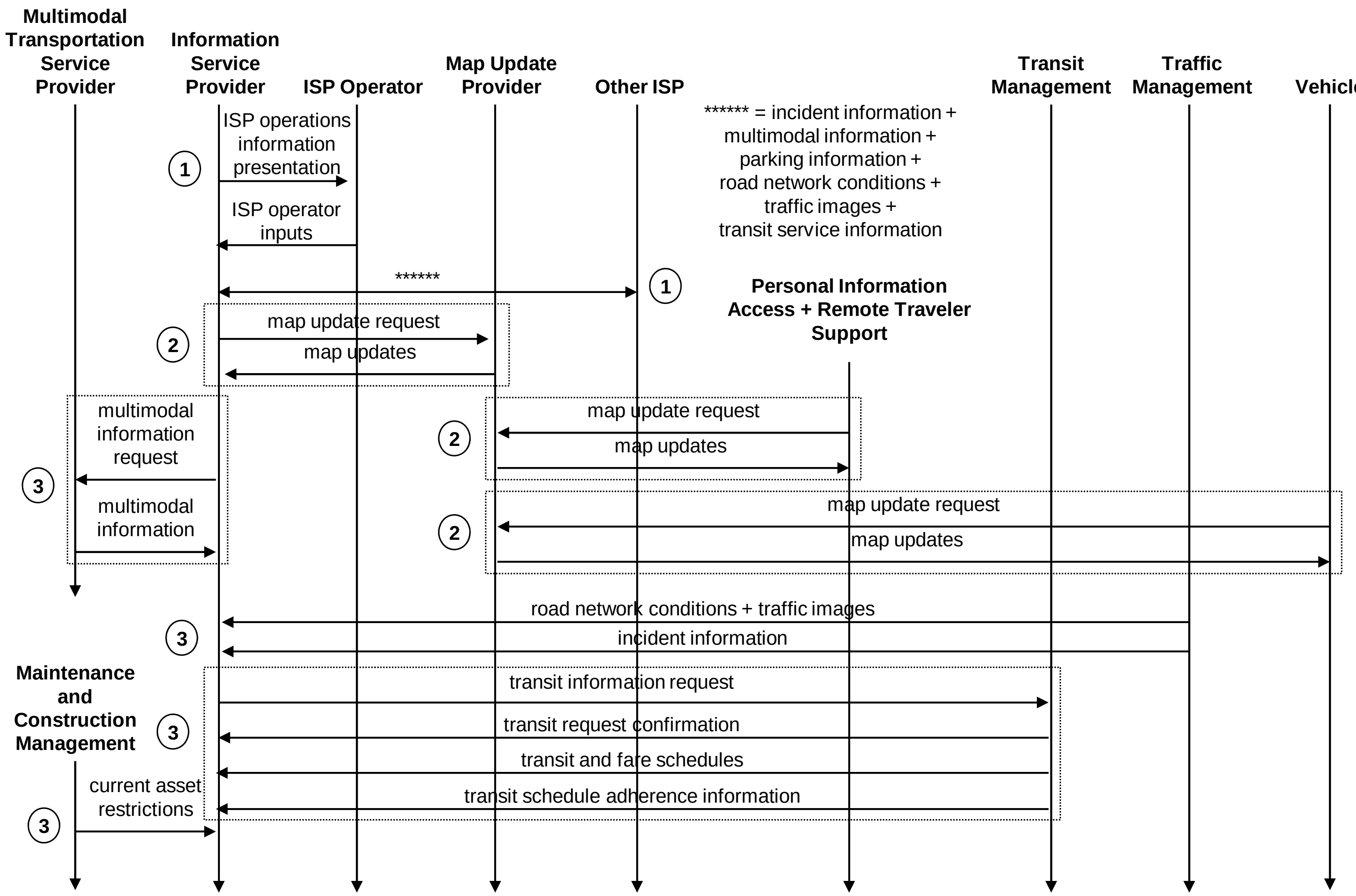
computed route is returned by the ISP (*route plan*). Prior to calculating routes, the ISP periodically and asynchronously receives *route restrictions* from the Commercial Vehicle Administration Subsystem. These could include hazmat route restrictions or other vehicle size and weight limitations.

11. The ISP may arrange for parking lot reservations by making a *parking reservations request* to the Parking Management Subsystem, which can respond with a *parking lot reservation confirmation*, confirming that the reservation has been made.

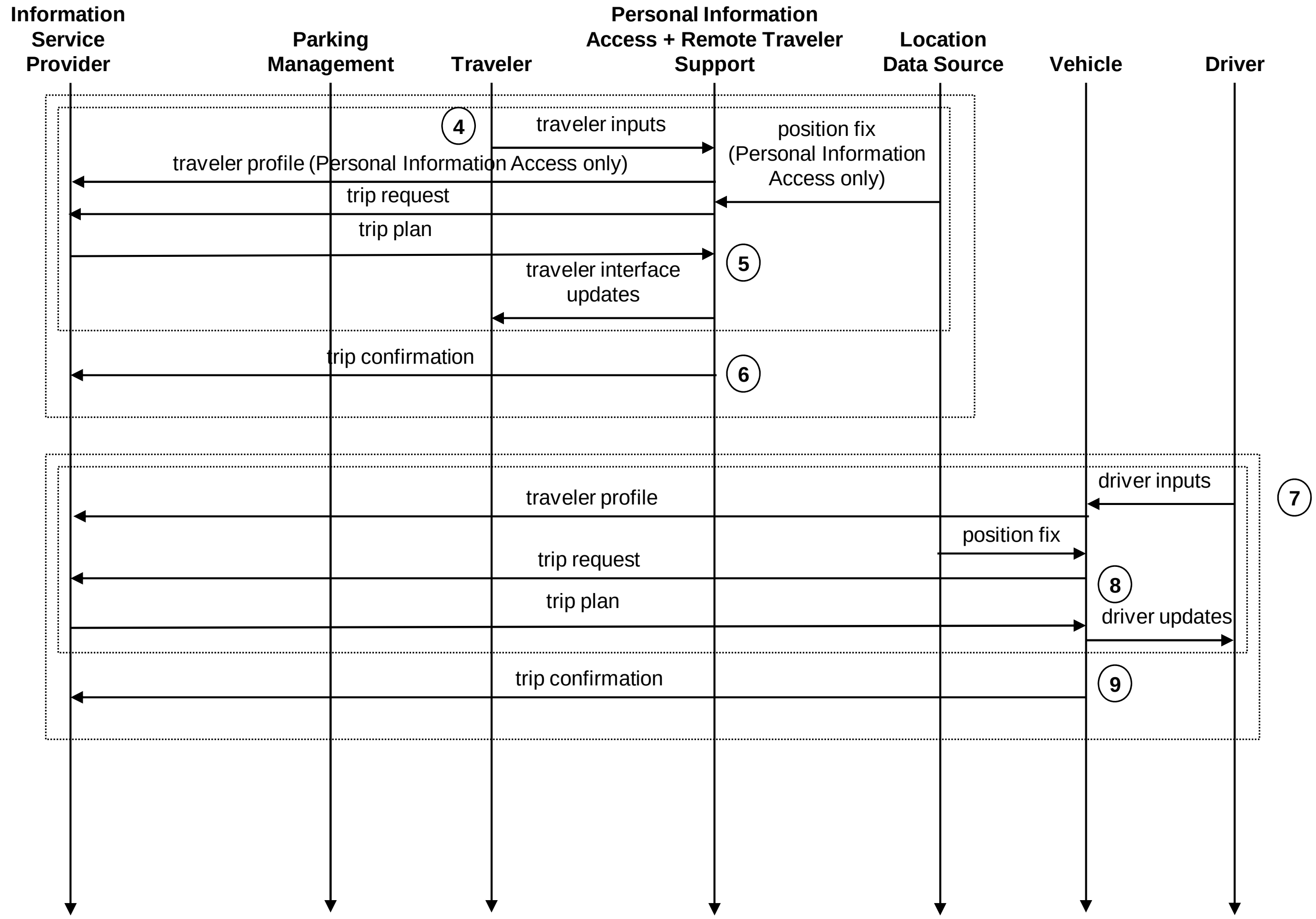
12. The Traffic Management Subsystem can be notified by the ISP of routes to be taken by guided vehicles (*logged vehicle routes*) that can be factored into adaptive traffic control strategies.

13. Additionally, the Transit Management Subsystem can be notified by the ISP of routes to be taken by guided vehicles for use in support of paratransit operations (*selected routes*).

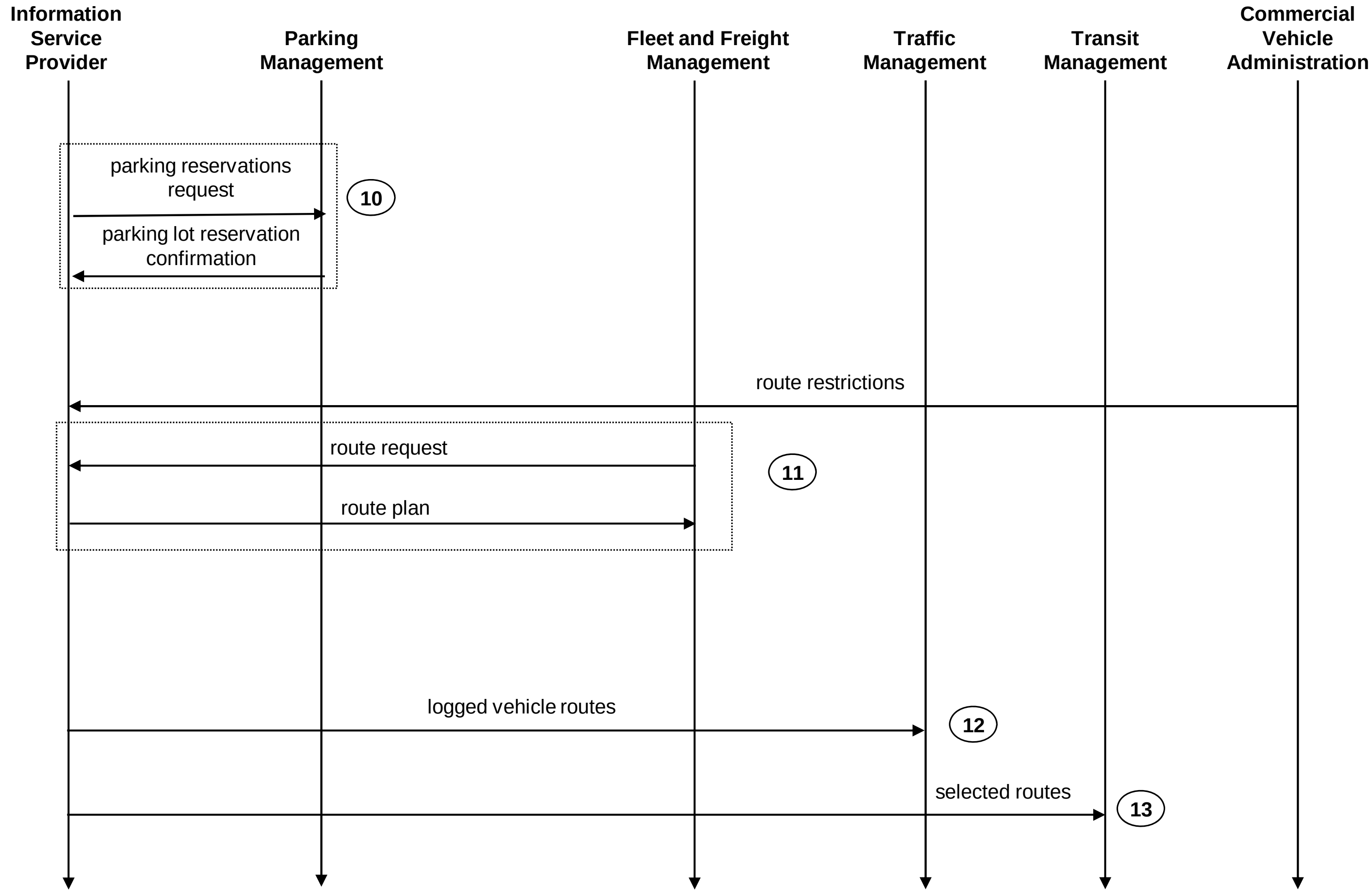
ATIS05: ISP Based Trip Planning and Route Guidance (1 of 3) (ISP Information Collection)



ATIS05: ISP Based Trip Planning and Route Guidance (2 of 3) (ISP Information Service 1)



ATIS05: ISP Based Trip Planning and Route Guidance (3 of 3) (ISP Information Service 2)



3.6 ATIS06: Transportation Operations Data Sharing

This service package makes real-time transportation operations data available to transportation system operators. The Information Service Provider collects, processes, and stores current information on traffic and travel conditions and other information about the current state of the transportation network and makes this information available to transportation system operators, facilitating the exchange of qualified, real-time information between agencies. Using the provided information, transportation system operators can manage their individual systems based on an overall view of the regional transportation system. The regional transportation operations data resource represented by the Information Service Provider may be implemented as a web application that provides a web-based access to system operators, an enterprise database that provides a network interface to remote center applications, or any implementation that supports regional sharing of real-time transportation operations data.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*ISP operations information presentation*) and control (*ISP operator inputs*) by the ISP Operator.

2. Concurrently and asynchronously, information is collected by the ISP from a variety of sources:

    - Traffic Management Subsystem (*road network conditions* and *traffic images*).
    - Transit Management Subsystem (*transit and fare schedules*), which includes static schedule and fare information and *transit schedule adherence information*, which includes real-time transit schedule performance information, and *transit incident information*.
    - Emergency Management Subsystem (*incident information*), including incidents arising from large-scale natural or human-caused disasters
    - Emissions Management Subsystem (*air quality information*)
    - Maintenance and Construction Management Subsystem (*current asset restrictions*), (*maint and constr work plans*), (*roadway maintenance status*), and (*work zone information*)
    - Parking Management Subsystem (*parking information*)
    - Payment Administration (*toll data*)
    - Border Inspection Systems (*border crossing status information*)
    - Event Promoters (*event information*)
    - Media (*external reports*), which include traffic or incident information collected by the media
    - Surface Transportation Weather Service (*transportation weather information*)
    - Weather Service (*qualified environmental conditions data* and *weather information*)

Other ISP (*incident information*, *multimodal information*, *parking information*, *road network conditions*, *traffic images*, and *transit service information*), which provides for multiple ISPs exchanging information from separate sources for purposes of augmenting the broadcast information or corroborating specific information items

This information is often based upon exceptional conditions, such as an incident in traffic, a storm, or other special events. Information collected by the ISP from some sources may come as the result of a specific request or be obtained through subscriptions. Specific requests include (*parking lot data request*), (*toll data request*), (*event information request*), and (*transportation weather information request*). With subscriptions, providers usually send periodic updates on a scheduled basis.

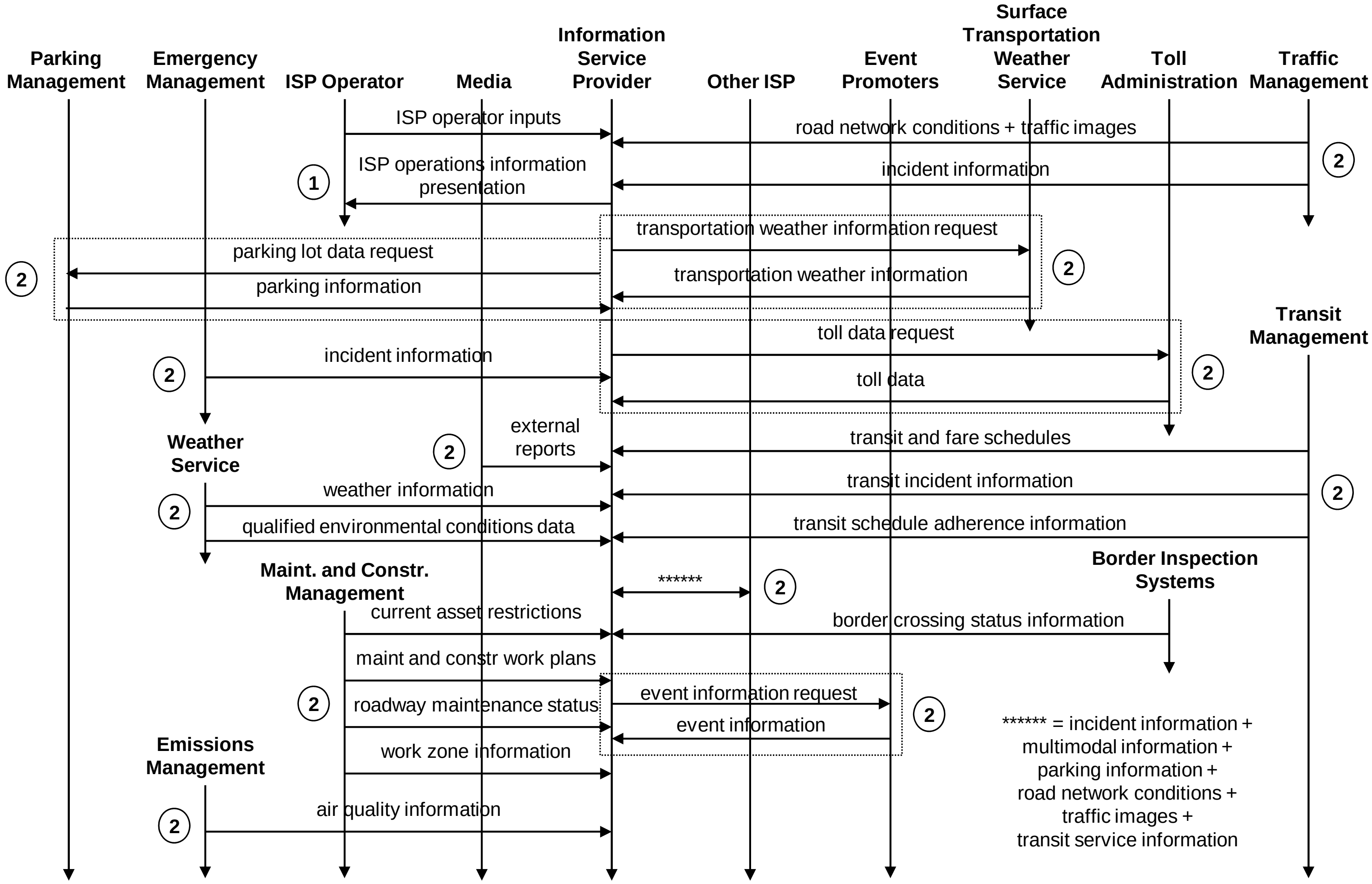
3. The ISP manages a real-time information repository that provides current information about the regional transportation system to transportation operators in the region. The information provided to each operator may be tailored based on individual requests or subscriptions (not shown in the architecture) or incremental real time updates could be pushed to operators as conditions change. The following transportation centers receive real-time transportation information:

    - Maintenance and Construction Management (*transportation information for operations*)
    - Traffic Management (*transportation information for operations*). For specific demand management applications, this subsystem may also receive *fare and price information* from the ISP (see ATMS09: Traffic Forecast and Demand Management).
    - Fleet and Freight Management (*road network conditions* and *incident information*). Commercial transportation operators in the region may also receive more focused regional transportation information suitable for commercial fleets.
    - Transit Management (*transportation information for operations*)
    - Emergency Management (*transportation information for operations*)

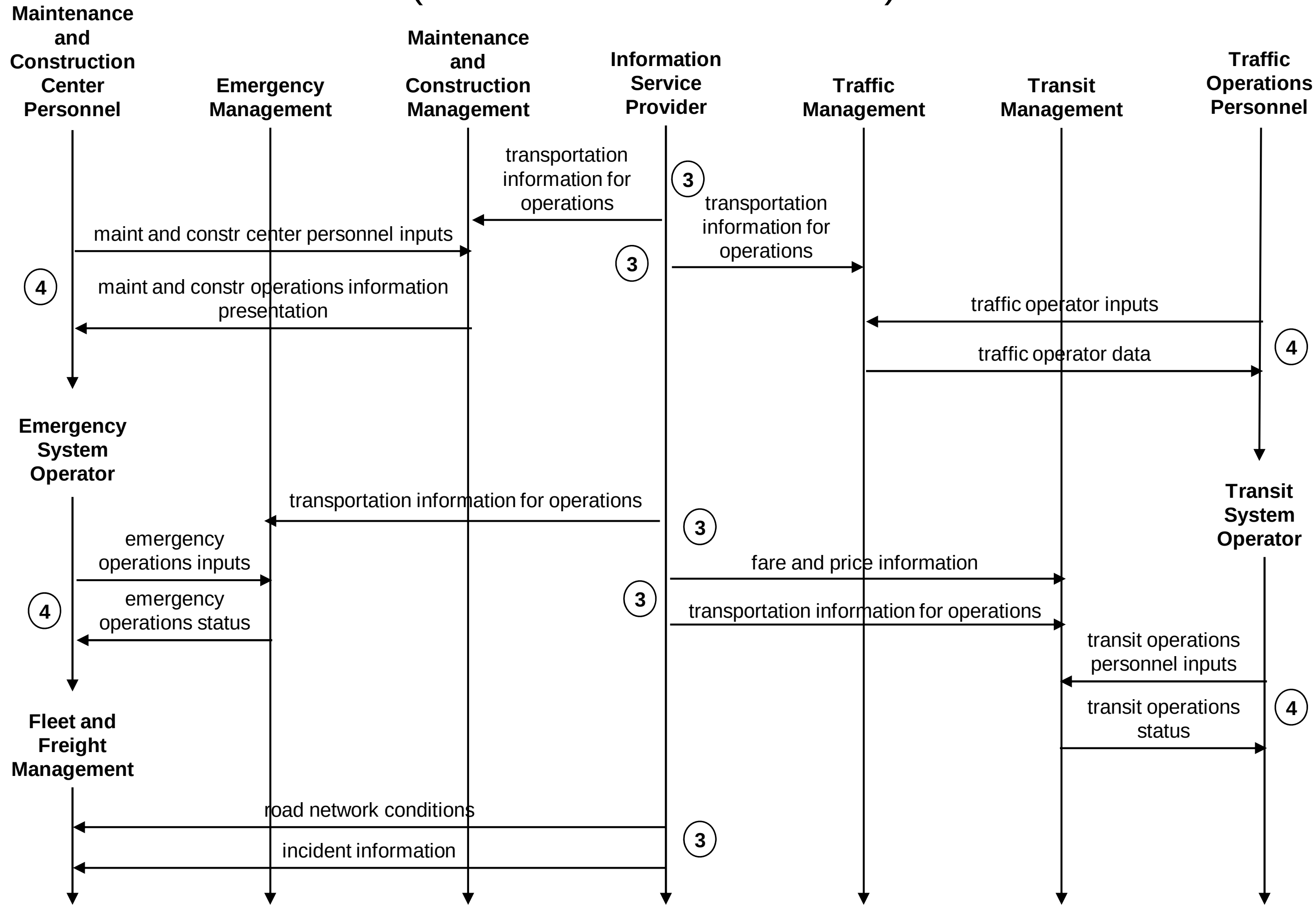
4. Operations personnel in each of the regional centers receive the operational data that was distributed by the Information Service Provider. Each of the receiving centers processes the received information and provides information as requested by the operator. Each operator may also provide commands that controls the information that is retrieved and presented:

    - Maintenance and Construction Center Personnel (*maint and constr center personnel inputs* and *maint and constr operations information presentation*)
    - Emergency System Operator (*emergency operations inputs* and *emergency operations status*)
    - Traffic Operations Personnel (*traffic operator inputs* and *traffic operator data*)
    - Transit System Operator (*transit operations personnel inputs* and *transit operations status*)

ATIS06: Transportation Operations Data Sharing (1 of 2) (Information Collection)



ATIS06: Transportation Operations Data Sharing (2 of 2)
(Information Dissemination)



3.7 ATIS07: Travel Services Information and Reservation

This service package provides travel information and reservation services to the user. These additional traveler services may be provided using the same basic user equipment used for Interactive Traveler Information. This service package provides multiple ways for accessing information either while en route in a vehicle using wide-area wireless communications or pre-trip via fixed-point to fixed-point connections.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*ISP operations information presentation*) and control (*ISP operator inputs*) by the ISP Operator.

2. Periodically, possibly by subscription or by regularly scheduled requests, Information Service Providers and kiosks (Remote Traveler Support) may request (*map update request*) and download *map updates* from a Map Update Provider.

3. The driver may submit (through the Vehicle Subsystem) a *traveler profile*, which will identify recurring trip characteristics, personal preferences, or equipment capabilities. Optionally, asynchronously, and as often as desired, a Driver may request (*driver inputs*) a yellow page information or reservations from an in-vehicle system.

4. Yellow page information requests or requests for reservations are passed from the in-vehicle system to the ISP (*travel services request*).

5. An ISP may present a request for payment (*payment request*) and then receive *transaction status* on that request from a Financial Institution.

6. A yellow pages and/or a *travel service information request* may be made by the Information Service Provider. When made, the *travel service information* is returned from Yellow Pages Service Providers. Upon receipt of the information, an Information Service Provider may make a *travel service reservation request*, and then the Yellow Pages Service Provider would return *travel service reservations*.

Yellow Pages requests, travel service requests and/or parking requests may be forwarded (*multimodal information*) to other Information Service Providers operating in conjunction with the primary ISP originating the request.

7. Once the information is collected, the ISP will send the *travel services information* back to the in-vehicle system.

8. The yellow pages information is sent to the driver (*driver updates*).

9. The Traveler may submit (through the Personal Information Access Subsystem) a *traveler profile*, which will identify recurring trip characteristics, personal preferences, or equipment capabilities.

Optionally, asynchronously, and as often as desired, a Traveler may request (*traveler inputs*) a yellow page information or reservations from a personal computing device or kiosk.

10. Optionally, in conjunction with the financial transaction with the Financial Institution (step 13 below), a *request for payment* and corresponding *payment* may be made using the Traveler Card. If payment is required for the information request, and the Traveler Card is capable of making the payment, the transaction with the Financial Institution may not occur. This Traveler Card payment may be a minimum charge merely required just to use a public device such as a kiosk, and a separate transaction charge may also be required, depending upon the service.

11. Yellow page information requests or requests for reservations are passed from the personal computing device or kiosk to the ISP (*travel services request*).

12. An ISP may present a request for payment (*payment request*) and then receive *transaction status* on that request from a Financial Institution.

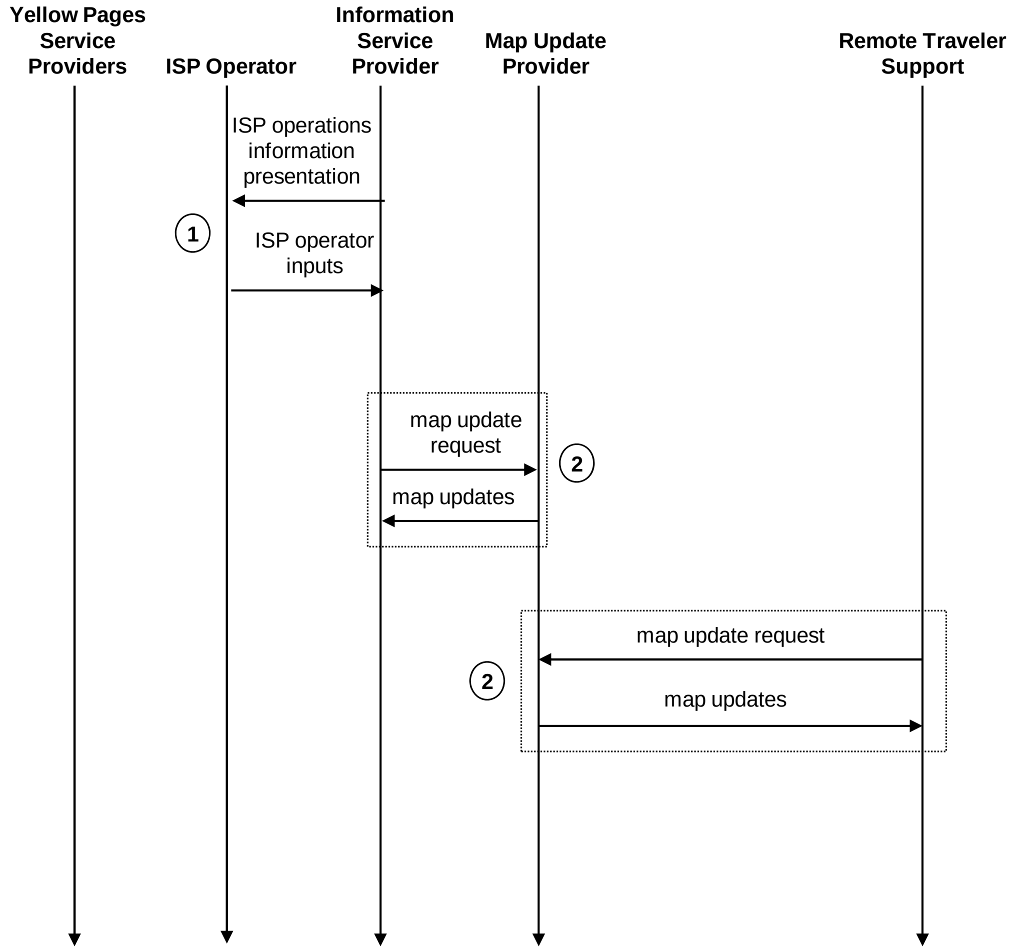
13. A yellow pages and/or a *travel service information request* may be made by the Information Service Provider. When made, the *travel service information* is returned from Yellow Pages Service Providers. Upon receipt of the information, an Information Service Provider may make a *travel service reservation request*, and then the Yellow Pages Service Provider would return *travel service reservations*.

Yellow Pages requests, travel service requests and/or parking requests may be forwarded (*multimodal information*) to other Information Service Providers operating in conjunction with the primary ISP originating the request.

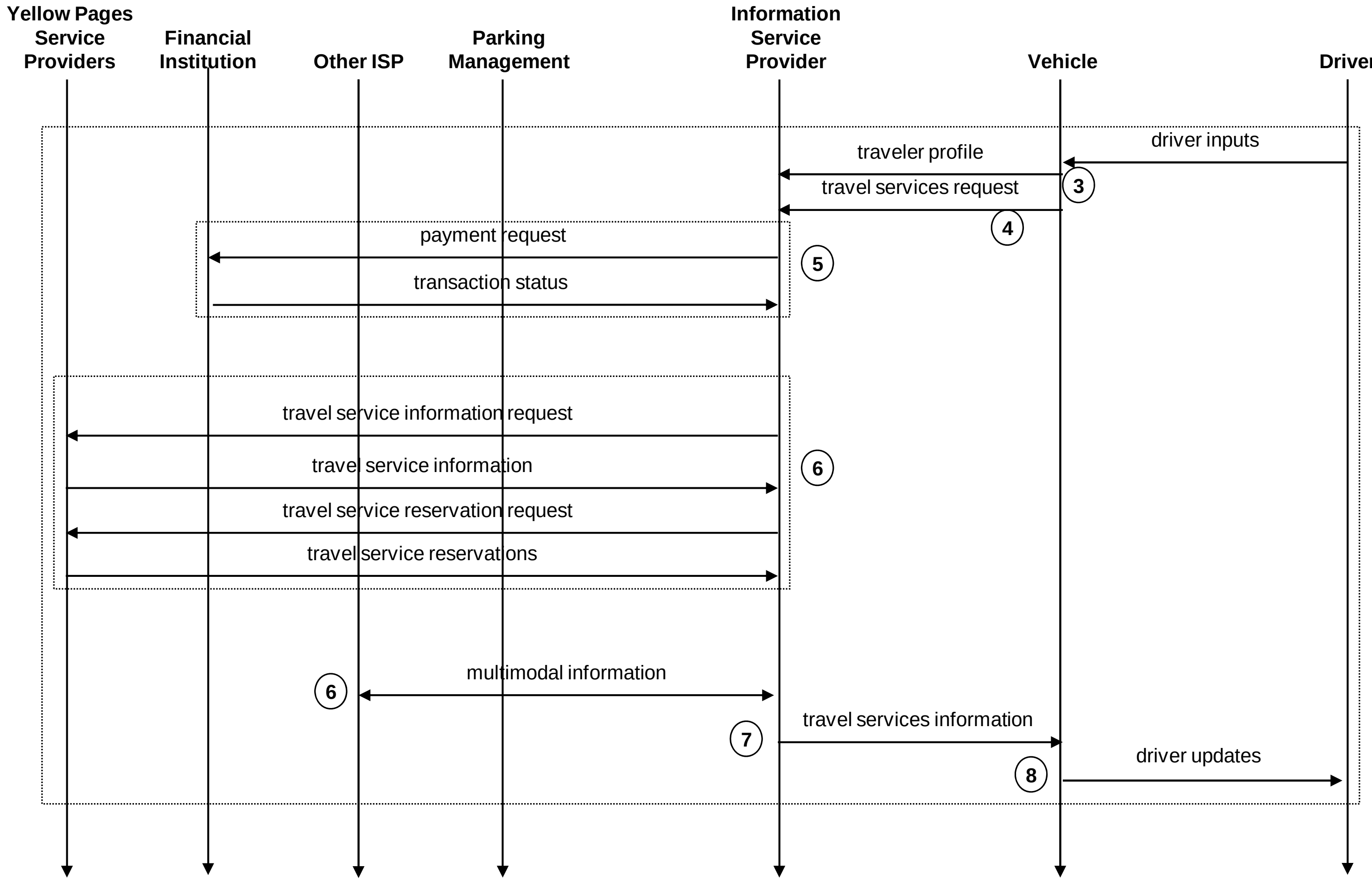
14. Once the information is collected, the ISP will send the *travel services information* back to the originating device (from Step 12).

15. The yellow pages information is sent to the Traveler (*traveler interface updates*).

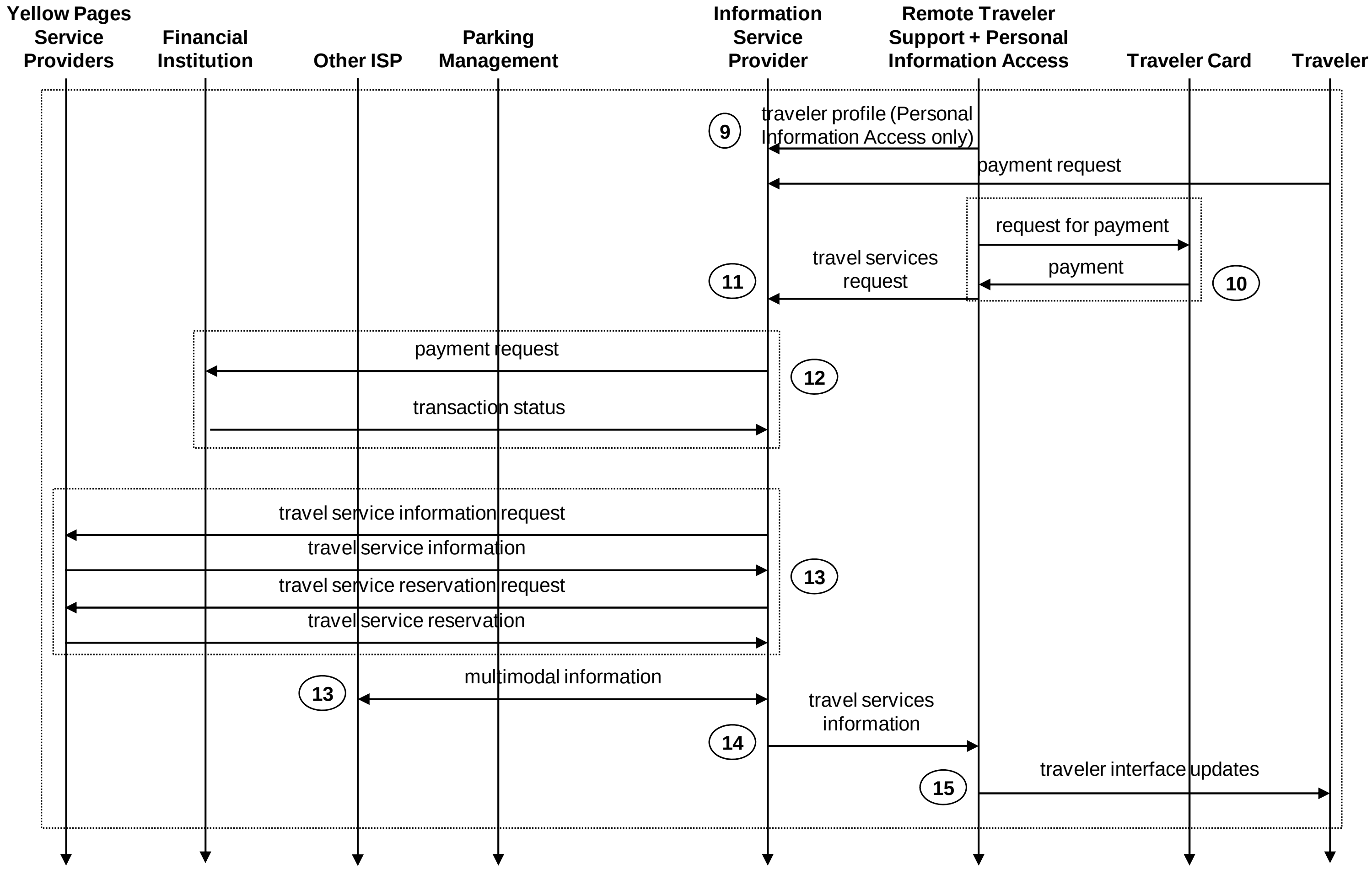
ATIS07: Travel Services Information and Reservation (1 of 3) (Initializations / Information Collection)



ATIS07: Travel Services Information and Reservation (2 of 3) (Operations for Vehicle)



ATIS07: Travel Services Information and Reservation (3 of 3)
(Operation for RTS and PIAS)



3.8 ATIS08: Dynamic Ridesharing

This service package provides dynamic ridesharing/ride matching services to travelers. This service could allow near real time ridesharing reservations to be made through the same basic user equipment used for Interactive Traveler Information. This ridesharing/ride matching capability also includes arranging connections to transit or other multimodal services.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*ISP operations information presentation*) and control (*ISP operator inputs*) by the ISP Operator.

2. Periodically, possibly by subscription or by regularly scheduled requests (*map update request*), Information Service Providers may request and download *map updates* from a Map Update Provider.

3. Schedule information for alternate mode transportation providers such as train, ferry, air and bus (*multimodal information*) can be received by Information Service Providers as either direct response to their *multimodal information request* or as subscription transactions.

4. Optionally, asynchronously, and as often as desired, a Driver may request (*driver inputs*) a ride match.

5. Once a route is requested by the Driver (*driver inputs*), a continuous cycle occurs (through Step 8), beginning with the driver's ride-match request being sent (*trip request*). The ride-match request the Driver enters may be on behalf of the passengers using his shuttle service or it may be his own individual trip.

6. The Information Service Provider sends a suggested ride-match and its associated information (*trip plan*) back to the Vehicle.

7. The Vehicle Subsystem presents the ride-match to the Driver (*driver updates*), and then the Driver either accepts the match (and the cycle stops) or asks for another match (and the cycle repeats – back to Step 5).

8. Once the Driver has accepted a ride-match, a confirmation that the match has been accepted is sent back to the ISP (*trip confirmation*).

9. An ISP may present a request for payment (*payment request*) and then receive *transaction status* on that request from a Financial Institution. This would depend upon whether there is a fee for the ride-matching service.

10. Optionally, asynchronously, and as often as desired, a Traveler (passenger) may request (*traveler inputs*) a ride-match via personal computing device or kiosk.

11. Once a ride-match is requested by the Traveler (*traveler inputs*), a continuous cycle occurs (through Step 16), beginning with the traveler's match request being sent (*trip request*).

12. One way a ride-match request can be satisfied is through paratransit or other demand responsive transit service. If this is acceptable to the Traveler, a *demand responsive transit request* is sent to the Transit Management Subsystem for a plan. If paratransit services can fulfill the ride request, then a *demand responsive transit plan* is returned to the ISP.

13. The Information Service Provider sends a suggested ride-match and its associated information (*trip plan*) back to the device that originated the ride-match request (Step 11).

14. The ride-match is then presented to the Traveler (*traveler interface updates*), and then the Driver either accepts the match (and the cycle stops) or asks for another match (and the cycle repeats – back to Step 11).

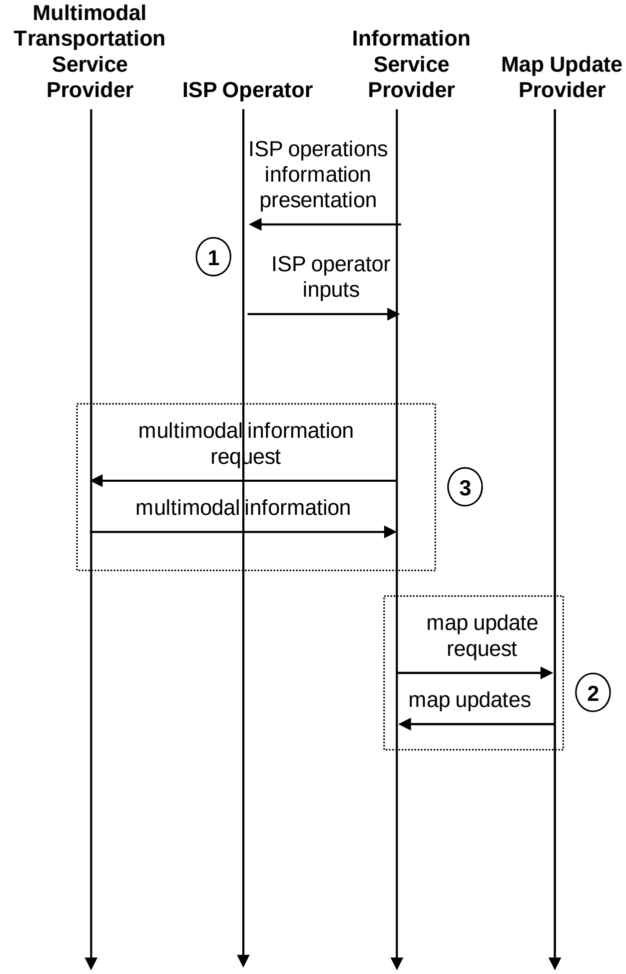
15. Optionally, in conjunction with the financial transaction with the Financial Institution (step 20 below), a *request for payment* and corresponding *payment* may be made using the Traveler Card. If payment is required for the information request, and the Traveler Card is capable of making the payment, the transaction with the Financial Institution may not occur. This Traveler Card payment may be a minimum charge merely required just to use a public device such as a kiosk, and a separate transaction charge may also be required, depending upon the service.

16. Once the Traveler has accepted a ride-match, a confirmation that the match has been accepted is sent back to the ISP (*trip confirmation*).

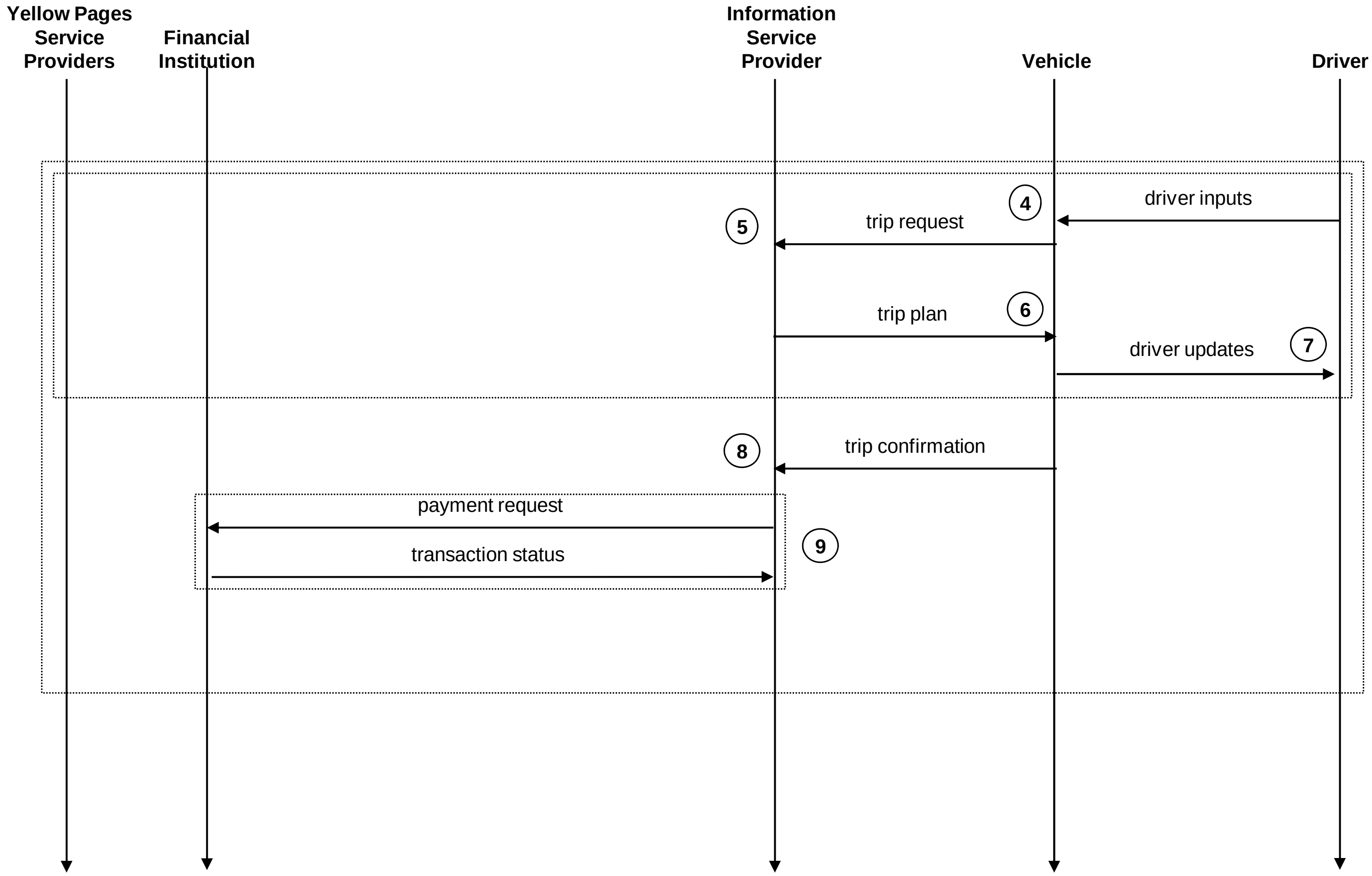
17. If the ride-match included the use of paratransit or other demand responsive transit (from Step 13), then notification is sent back to confirm that usage and a request to do the pick-up (*demand responsive transit request*).

18. An ISP may present a request for payment (*payment request*) and then receive *transaction status* on that request from a Financial Institution. This would depend upon whether there is a fee for the ride-matching service.

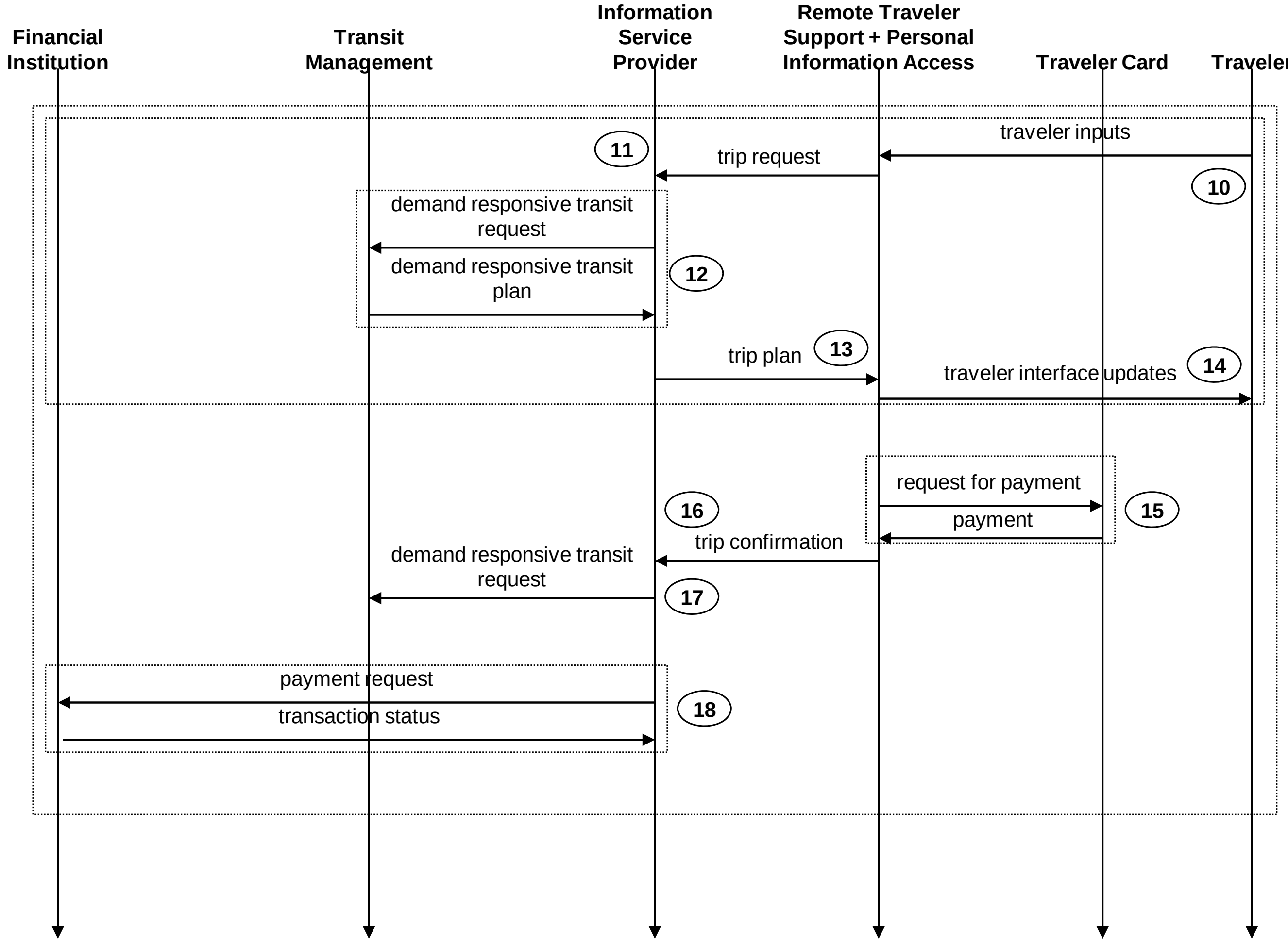
ATIS08: Dynamic Ridesharing (1 of 3) (Initializations / Information Collection)



ATIS08: Dynamic Ridesharing (2 of 3)
(Operations for Drivers)



ATIS08: Dynamic Ridesharing (3 of 3) (Operation for Passengers)



3.9 ATIS09: In Vehicle Signing

This service package augments regulatory, warning, and informational signs and signals by providing information directly to drivers through in-vehicle devices. The information provided would include static sign information (e.g., stop, curve warning, guide signs, service signs, and directional signs) and dynamic information (e.g., current signal states including highway intersection and highway-rail intersection status and local conditions warnings identified by local environmental sensors). It includes short range communications between field equipment and the vehicle and connections to the Traffic Management Subsystem for monitoring and control. This service package also includes the capability for maintenance and construction, transit, and emergency vehicles to transmit sign information to vehicles in the vicinity so that in vehicle signing can be used without fixed infrastructure in work zones, around incidents, and in areas where transit operations impacts traffic.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Traffic Operations Personnel manage in-vehicle signing, providing inputs (*traffic operator inputs*) that control the information that is provided to passing vehicles.

2. The Traffic Management Subsystem remotely controls short range communications equipment in the Roadway Subsystem that performs in vehicle signing, providing *vehicle signage data* to field equipment based on input from Traffic Operations Personnel.

3. Signage data that is provided to vehicles may also include information from local environmental sensors, current signal control states from signal controllers, and other data provided by local field equipment (*roadway equipment coordination*).

4. *Vehicle signage data* is provided to passing vehicles by short range communications equipment in the Roadway Subsystem.

5. *Short range communications status* is sent back to the Traffic Management Subsystem, allowing remote monitoring of in vehicle signing equipment.

6. Traffic Operations Personnel are kept appraised of in vehicle signing equipment status (*traffic operator data*).

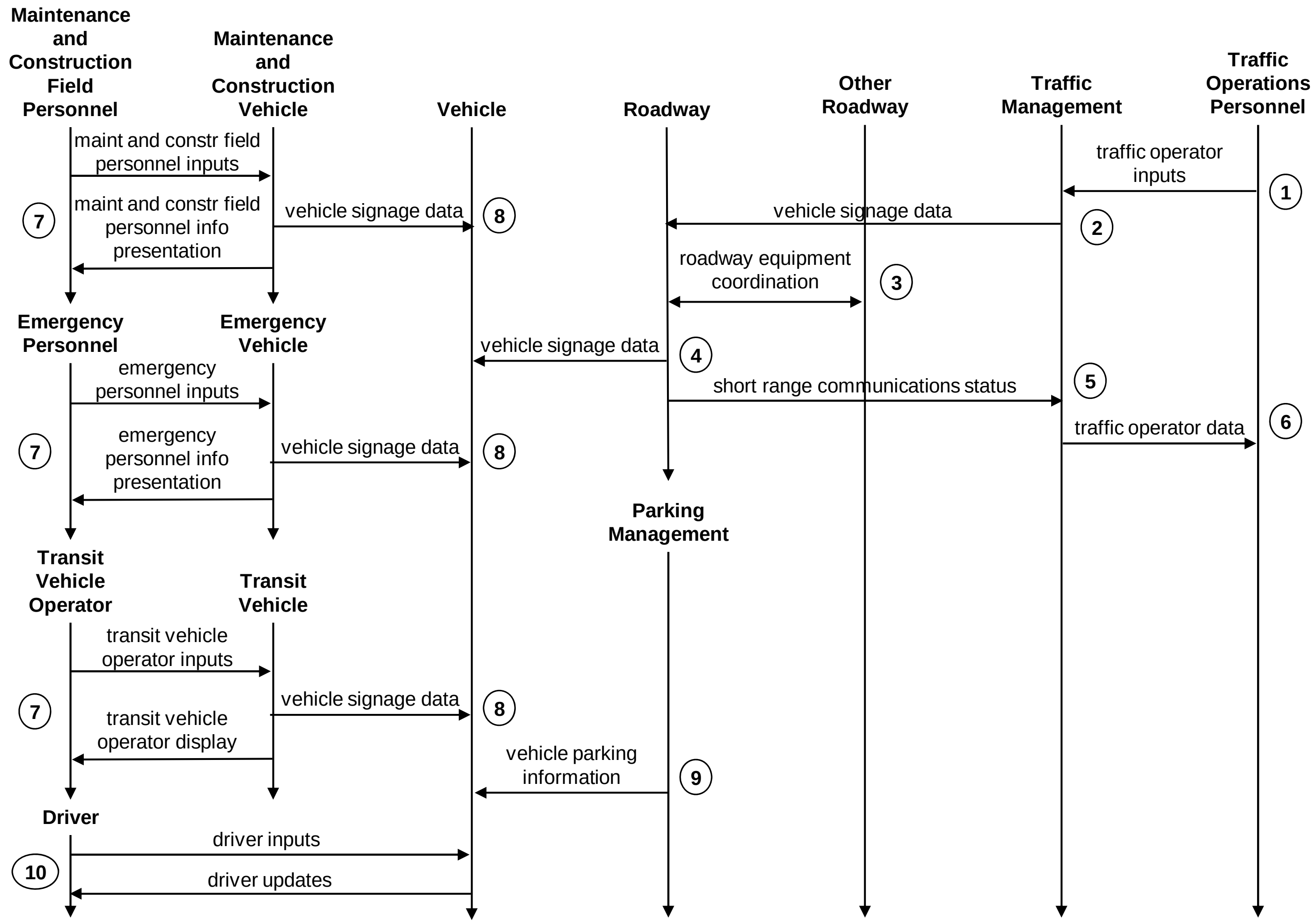
7. Alternatively, vehicle signing can be implemented using Vehicle - Vehicle Communications so that maintenance, emergency, and transit vehicles can warn drivers in the vicinity of potential hazards. In each case, the vehicle operator controls and monitors the in-vehicle signing capability, activating the system, controlling the messages that are sent, and monitoring system operation.

    - Maintenance and Construction Field Personnel control and monitor vehicle signage systems in maintenance vehicles (*maint and constr field personnel inputs* and *maint and constr field personnel information presentation*)

- Emergency Personnel control and monitor vehicle signage systems in emergency vehicles (*emergency personnel inputs* and *emergency personnel information presentation*)
- Transit Vehicle Operators control and monitor vehicle signage systems in transit vehicles (*transit vehicle operator inputs* and *transit vehicle operator display*)

8. *Vehicle signage data* is communicated to passing vehicles by maintenance, emergency, and transit vehicles:
    - Maintenance and Construction Vehicles warn drivers prior to work zones.
    - Emergency Vehicles warn drivers approaching an incident.
    - Transit Vehicles warn drivers as the transit vehicle merges into traffic or when loading/offloading passengers.
9. *Vehicle parking information* may also be provided direct to vehicles by the Parking Management Subsystem, representing vehicle signage data that may be provided by equipped parking facilities.
10. The vehicle signage data is presented to the driver by the vehicle (*driver updates*). The Driver controls data that is presented, providing *driver inputs* that may filter or prioritize the information that is presented and the way that the vehicle signage data is presented.

ATIS09: In Vehicle Signing



3.10 ATIS10: Short Range Communications Traveler Information

This service package provides location-specific or situation-relevant information to travelers in vehicles using Dedicated Short Range Communications (DSRC) infrastructure supporting mobility applications for connected vehicles. DSRC is used to deliver real-time traveler information including travel times, incident information, road conditions, and emergency traveler information to vehicles as they pass DSRC roadside equipment along their route. This service package provides public information that is available to all equipped vehicles in the vicinity of the roadside equipment.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*ISP operations information presentation*) and control (*ISP operator inputs*) by the ISP Operator.

2. Concurrently and asynchronously, information is collected by the ISP from a variety of sources:

    - Traffic Management Subsystem (*road network conditions*, *traffic images* and *incident information*)
    - Transit Management Subsystem (*transit and fare schedules*), which include static schedule and fare information, *transit schedule adherence information* which provides real-time performance information, and *transit incident information*, which includes real time incident information
    - Emergency Management Subsystem (*incident information*, *alert notification*, *evacuation information*, *transportation system status*), including incidents arising from large-scale natural or human-caused disasters
    - Emissions Management Subsystem (*air quality information*)
    - Maintenance and Construction Management Subsystem (*current asset restrictions*), (*maint and constr work plans*), (*roadway maintenance status*), and (*work zone information*)
    - Parking Management Subsystem (*parking information*)
    - Payment Administration (*toll data*)
    - Border Inspection Systems (*border crossing status information*)
    - Event Promoters (*event information*)
    - Media (*external reports*), which include traffic or incident information collected by the media
    - Surface Transportation Weather Service (*transportation weather information*)
    - Weather Service (*qualified environmental conditions data* and *weather information*)
    - Other (*incident information*, *multimodal information*, *parking information*, *road network conditions*, *traffic images*, *transit service information*), which provides for multiple ISPs

exchanging information from separate sources for purposes of augmenting the broadcast information or corroborating specific information items

This information is often based upon exceptional conditions, such as an incident in traffic, a storm, or other special events.

Information collected by the ISP from some sources may come as the result of a specific request or be obtained through subscriptions. Specific requests include (*parking lot data request*), (*toll data request*), (*event information request*), and (*transportation weather information request*). With subscriptions, providers usually send periodic updates on a scheduled basis.

3. The ISP sends traveler information (*broadcast traveler information* and *emergency traveler information*) to short range communications equipment in the Roadway Subsystem.

4. The Roadway Subsystem uses short range communications to send the traveler information (*broadcast traveler information* and *emergency traveler information*) to passing vehicles.

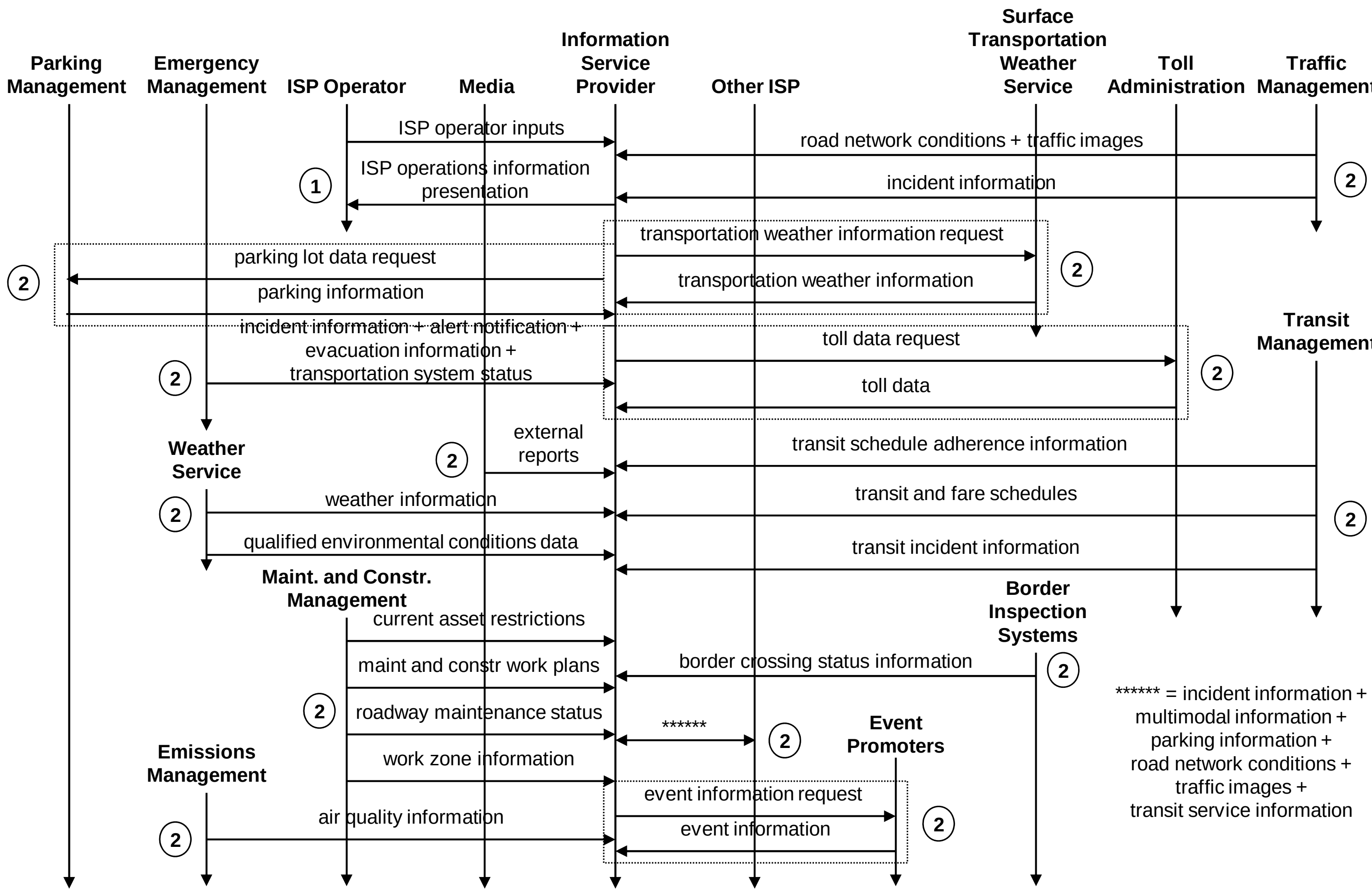
5. Vehicle equipment presents the traveler information to the driver (*driver updates*). The driver controls the information that is presented (*driver inputs*).

6. *Short range communications status* is sent to the ISP, allowing remote monitoring of short range communications equipment.

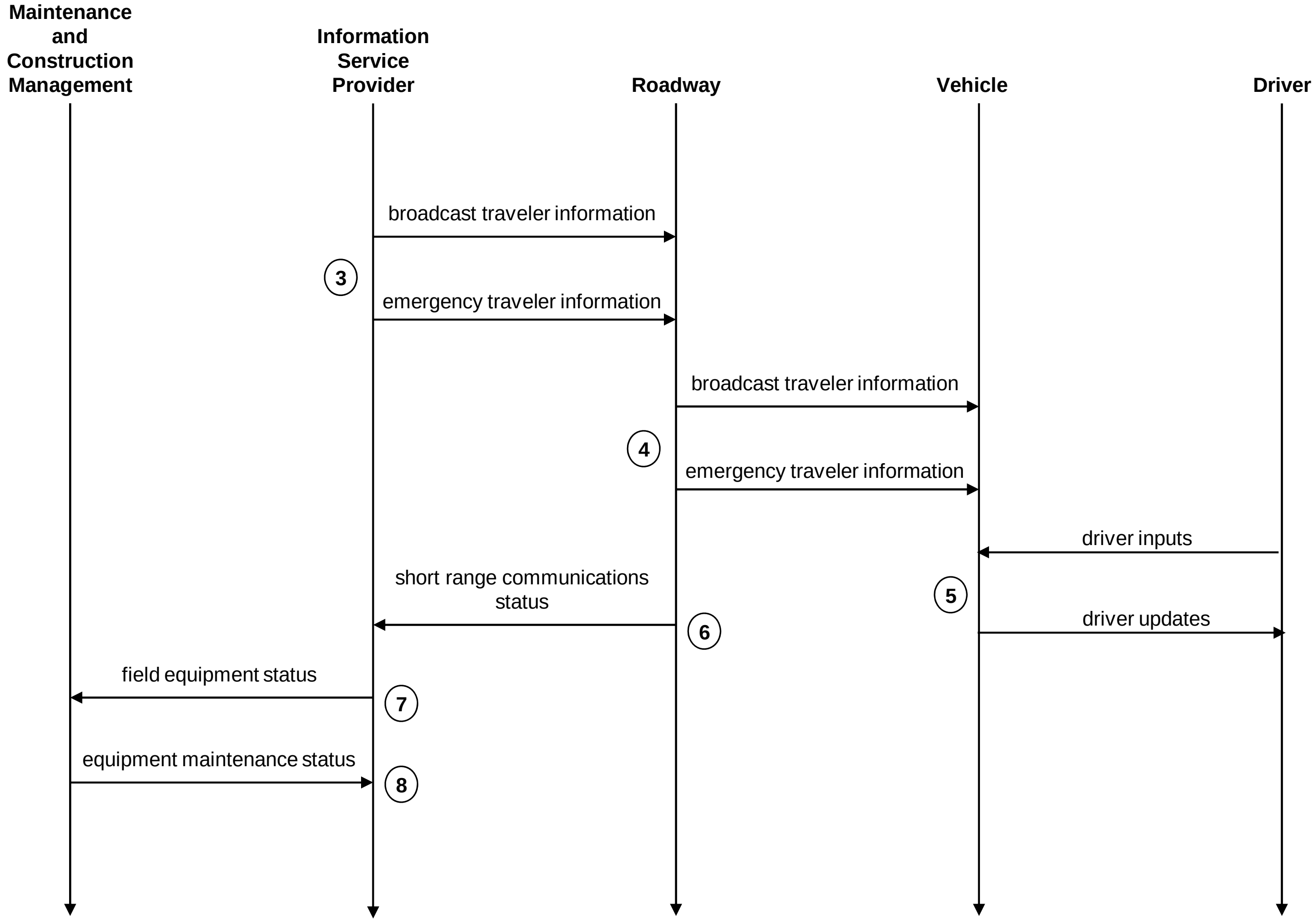
7. The ISP notifies the Maintenance and Construction Management Subsystem (MCMS) of the current operation and fault status of the short range communications equipment (*field equipment status*).

8. In case of maintenance actions, *equipment maintenance status* is sent from the MCMS to the ISP, notifying the ISP when the operational status of short range communications equipment changes.

ATIS10: Short Range Communications Traveler Information (1 of 2) (Information Collection)



ATIS10: Short Range Communications Traveler Information (2 of 2) (Information Dissemination)



4 Transit Management

This section provides the Theory of Operations for the Transit Management Service Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each service package section) to identify these service packages is APTS—Advanced Public Transportation Systems.

4.1 APTS01: Transit Vehicle Tracking

This service package monitors current transit vehicle location using an Automated Vehicle Location System. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real-time. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Transit Management Subsystem is used for relaying vehicle position and control measures. Fixed route transit systems may also employ beacons along the route to enable position determination and facilitate communications with each vehicle at fixed intervals. The Transit Management Subsystem processes this information, updates the transit schedule and makes real-time schedule information available to the Information Service Provider.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

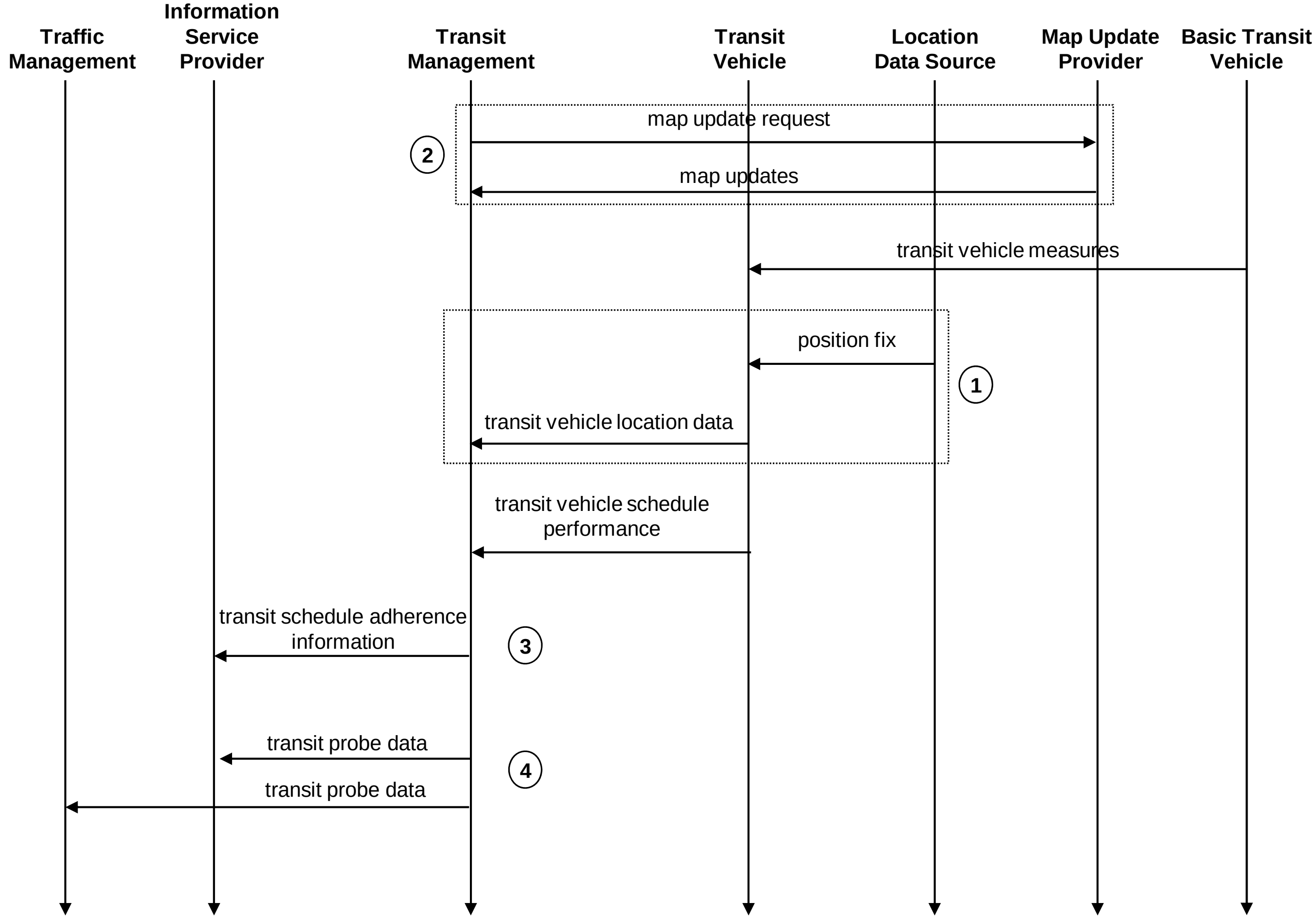
1. The entity Location Data Source sends the flow *position fix* to the Transit Vehicle Subsystem (TRVS). The location information is passed along to the Transit Management Subsystem (TRMS) via the architecture flow *transit vehicle location data*. This architecture flow also contains automated vehicle mileage and fuel usage reporting, which are collected in the TRVS through the flow *transit vehicle measures* from the Basic Transit Vehicle. Finally, the estimated times of arrival and anticipated schedule deviations are sent from the TRVS to the TRMS in the flow *transit vehicle schedule performance*.

2. As part of vehicle tracking the TRMS will convert the location data received from the TRVS into some map-based representation. An interface to a Map Update Provider is available to keep this map-based representation of the transportation network current. The implied operation of this interface is for the TRMS to request a map update (*map update request*), and the Map Update Provider to electronically provide the update (*map updates*).

3. Information about transit vehicle location and schedule adherence is provided as part of the flow *transit schedule adherence information*. This information may be requested by the ISP or provided periodically or as needed by the TRMS.

4. It is also possible to use the location and tracking services on equipped transit vehicles equipped as probes. The Transit Management Subsystem can provide the Traffic Management Subsystem and/or an Information Service Provider with information on probe vehicles (*transit probe data*).

APTS01: Transit Vehicle Tracking



4.2 APTS02: Transit Fixed-Route Operations

This service package performs automated dispatch and system monitoring for fixed-route and flexible-route transit services. This service performs scheduling activities including the creation of schedules, blocks and runs, as well as operator assignment. This service determines the transit vehicle trip performance against the schedule using AVL data and provides information displays at the Transit Management Subsystem. Static and real time transit data is exchanged with Information Service Providers where it is integrated with that from other transportation modes (e.g. rail, ferry, air) to provide the public with integrated and personalized dynamic schedules.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

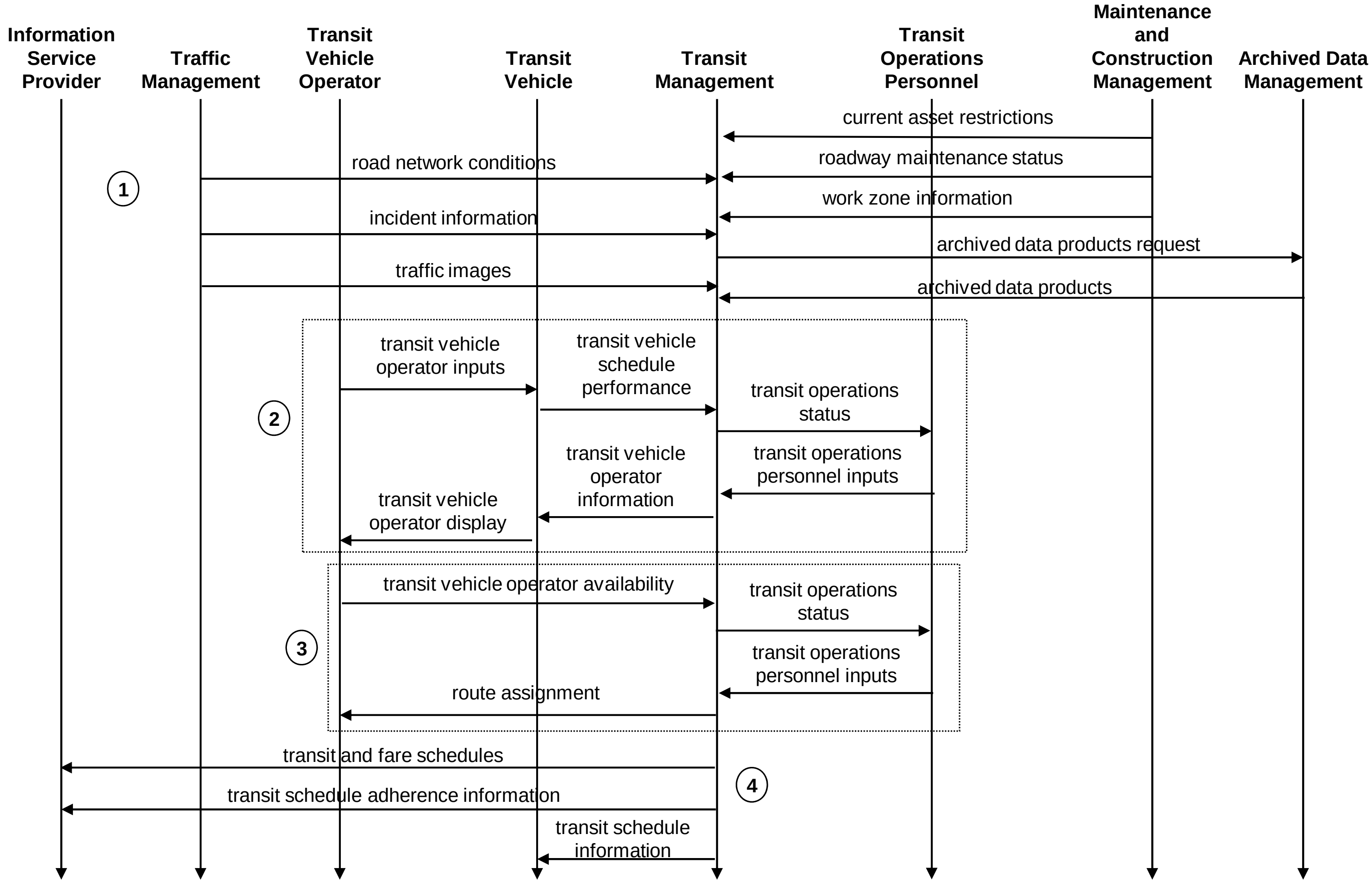
1. In order to assess the impact on its operations, the Transit Management Subsystem (TRMS) collects data on the transportation network used by its fleet of transit vehicles. This data includes current traffic video images, current and forecasted traffic information, road and weather conditions, and incident information obtained from the Traffic Management Subsystem (*traffic images*, *road network conditions* and *incident information*). The data also includes *current asset restrictions* (e.g., width, height and weight restrictions), *roadway maintenance status* (e.g. a summary of maintenance activities in the area relevant to the transit fleet), and *work zone information* (e.g., work zone activities affecting the road network including the nature of the maintenance or construction activity, location, impact to the roadway, expected time(s) and duration of impact, anticipated delays, alternate routes, and suggested speed limits) from the Maintenance and Construction Management Subsystem. Upon request (*archived data product requests*) an Archived Data Management Subsystem (ADMS) can provide TRMS with *archived data products* that contain historical data used to assist with the planning portion of a transit management operation.

2. One of the key functions of the fixed route operations is to assess the performance of the fleet vehicles and provide corrective actions if needed. The Transit Vehicle Operator can provide an input on the vehicle's schedule status (*transit vehicle operator inputs*). This plus anticipated schedule deviations and estimated arrival information is passed from the Transit Vehicle Subsystem (TRVS) to the TRMS (*transit vehicle schedule performance*). This information is provided to the Transit Operations Personnel (*transit operations status*), who can create corrective actions (*transit operations personnel inputs*). This information is sent to the TRVS (*transit vehicle operator information*), and then presented to the Transit Vehicle Operator (*transit vehicle operator display*). An alternate operational concept is to use the information flows of APTS01 Transit Vehicle Tracking to identify at the TRMS the location and schedule performance of the vehicle.

3. Another function of the fixed route transit operations is to assign transit vehicle operators to routes. To initiate this activity, the Transit Vehicle Operator provides their availability to the TRMS (*transit vehicle operator availability*). This information is passed to the Transit Operations Personnel (*transit operations status*), who inputs vehicle operator assignments (*transit operations personnel inputs*). The assignment information is provided to the Transit Vehicle Operator as a *route assignment*.

4. The TRMS manages the fixed route fleet, and its real time knowledge of the fleet status is a valuable source of information for travelers. The TRMS provides the information as *transit and fare schedules*, *transit schedule adherence information*, and *transit schedule information*.

APTS02: Transit Fixed-Route Operations



4.3 APTS03: Demand Response Transit Operations

This service package performs automated dispatch and system monitoring for demand responsive transit services. This service performs scheduling activities as well as operator assignment. In addition, this service package performs similar functions to support dynamic features of flexible-route transit services. This package monitors the current status of the transit fleet and supports allocation of these fleet resources to service incoming requests for transit service while also considering traffic conditions. The Transit Management Subsystem provides the necessary data processing and information display to assist the transit operator in making optimal use of the transit fleet. This service includes the capability for a traveler request for personalized transit services to be made through the Information Service Provider (ISP) Subsystem. The ISP may either be operated by a transit management center or be independently owned and operated by a separate service provider. In the first scenario, the traveler makes a direct request to a specific paratransit service. In the second scenario, a third party service provider determines that the paratransit service is a viable means of satisfying a traveler request and makes a reservation for the traveler.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. In order to assess the impact on its operations, the Transit Management Subsystem (TRMS) collects data on the transportation network used by its fleet of demand responsive transit vehicles. This data includes traffic images, current and forecasted traffic information, road and weather conditions, and incident information obtained from the Traffic Management Subsystem (*road network conditions* and *incident information*). The data also includes *current asset restrictions* (e.g., width, height and weight restrictions), *roadway maintenance status* (e.g., a summary of maintenance activities in the area relevant to the transit fleet), and *work zone information* (e.g., work zone activities affecting the road network including the nature of the maintenance or construction activity, location, impact to the roadway, expected time(s) and duration of impact, anticipated delays, alternate routes, and suggested speed limits) from the Maintenance and Construction Management Subsystem.

2. One of the key functions of the demand responsive transit operations is to dispatch and route its vehicles. The Transit Vehicle Operator can provide an input on the vehicle's status (*transit vehicle operator inputs*). This, plus information on availability and passenger usage determined by sensors on-board the vehicle is passed from the Transit Vehicle Subsystem (TRVS) to the TRMS (*demand response passenger and use data*). This information is provided to the Transit Operations Personnel as part of *transit operations status*. Transit Operations Personnel can input dispatch, pickup, and routing information as part of *transit operations personnel inputs*. The information input by the Transit Operations Personnel, or information generated by TRMS software systems is transmitted to the Transit Vehicle Subsystem (TRVS) in *transit vehicle operator information*. This information is provided to the Transit Vehicle Operator by the flow *transit vehicle operator display*.

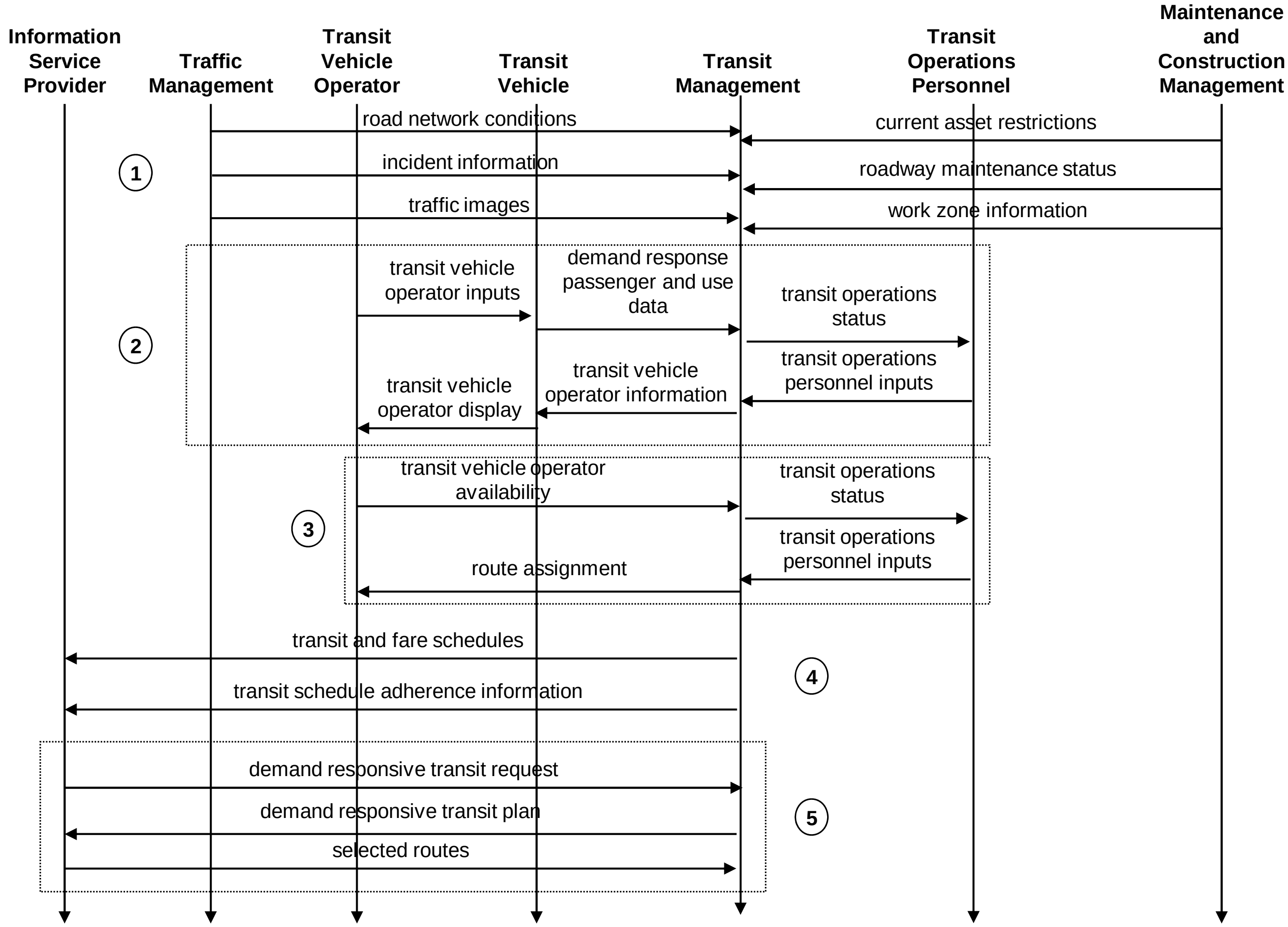
3. Another function of the fixed route transit operations is to assign vehicle operators to routes. To initiate this activity, the Transit Vehicle Operator provides their availability to the TRMS (*transit*

vehicle operator availability). This information is passed to the Transit Operations Personnel (*transit operations status*), who inputs vehicle operator assignments (*transit operations personnel inputs*). The assignment information is provided to the Transit Vehicle Operator as a *route assignment*.

4. The TRMS manages the demand responsive transit fleet, and its real time knowledge of the fleet status is a valuable source of information for travelers. The TRMS provides the information to the Information Service Provider as *transit and fare schedules* and *transit schedule adherence information*.

5. In addition the ISP can make, on behalf of its customers, a specific *demand responsive transit request* to the TRMS, which would respond with a *demand responsive transit plan* for the customer. If the ISP's customer chooses to accept this assignment to the demand responsive service, the ISP will respond to the TRMS with an indication of the demand responsive services being contracted for by the ISP's customer (*selected routes*).

APTS03: Demand Response Transit Operations



4.4 APTS04: Transit Fare Collection Management

This service package manages transit fare collection on-board transit vehicles and at transit stops using electronic means. It allows transit users to use a traveler card or other electronic payment device. Readers located either in the infrastructure or on-board the transit vehicles enable electronic fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Subsystem. Two other service packages, ATMS10: Electronic Toll Collection and ATMS16: Parking Facility Management, also provide electronic payment services. These three service packages in combination provide an integrated electronic payment system for transportation services.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. At roadside locations (e.g. a transit stop with a kiosk), a Traveler makes a request for a fare transaction (*traveler inputs*), which would include the desired destination, to the Remote Traveler Support Subsystem (RTS). The RTS forwards the request (as part of *transit fare and passenger status*) to the Transit Management Subsystem (TRMS). At this point there are two possible operational concepts. In the first the *payment request* is forwarded to a Financial Institution, who in real time provides a *transaction status* indicating if the transaction is approved (it could be either a credit transaction or a debit transaction). The TRMS would forward the *transit fare information* back to the RTS, which would provide an indication to the Traveler (as part of *traveler interface updates*) whether their request was successful and possibly provide a ticket or other form of receipt. Alternatively, the request from the RTS is processed by the TRMS in real time and the response sent back to the RTS. The interface to the Financial Institution is a periodic, batch type update. A third concept supported in the diagram is for the Traveler to make the initial request (*traveler inputs*), but use a Traveler Card for the payment media. In this case the RTS sends a *request for payment* to the Traveler Card, which responds with the *payment* information.

2. Another electronic fare payment concept is for customers of an Information Service Provider (ISP) to request an advanced fare payment (i.e. request a future transit service, such as a demand responsive transit pickup, that could be paid for in advance) through the ISP, who makes the request to the TRMS (a part of the flow *transit information request*). The TRMS responds with the *transit request confirmation*.

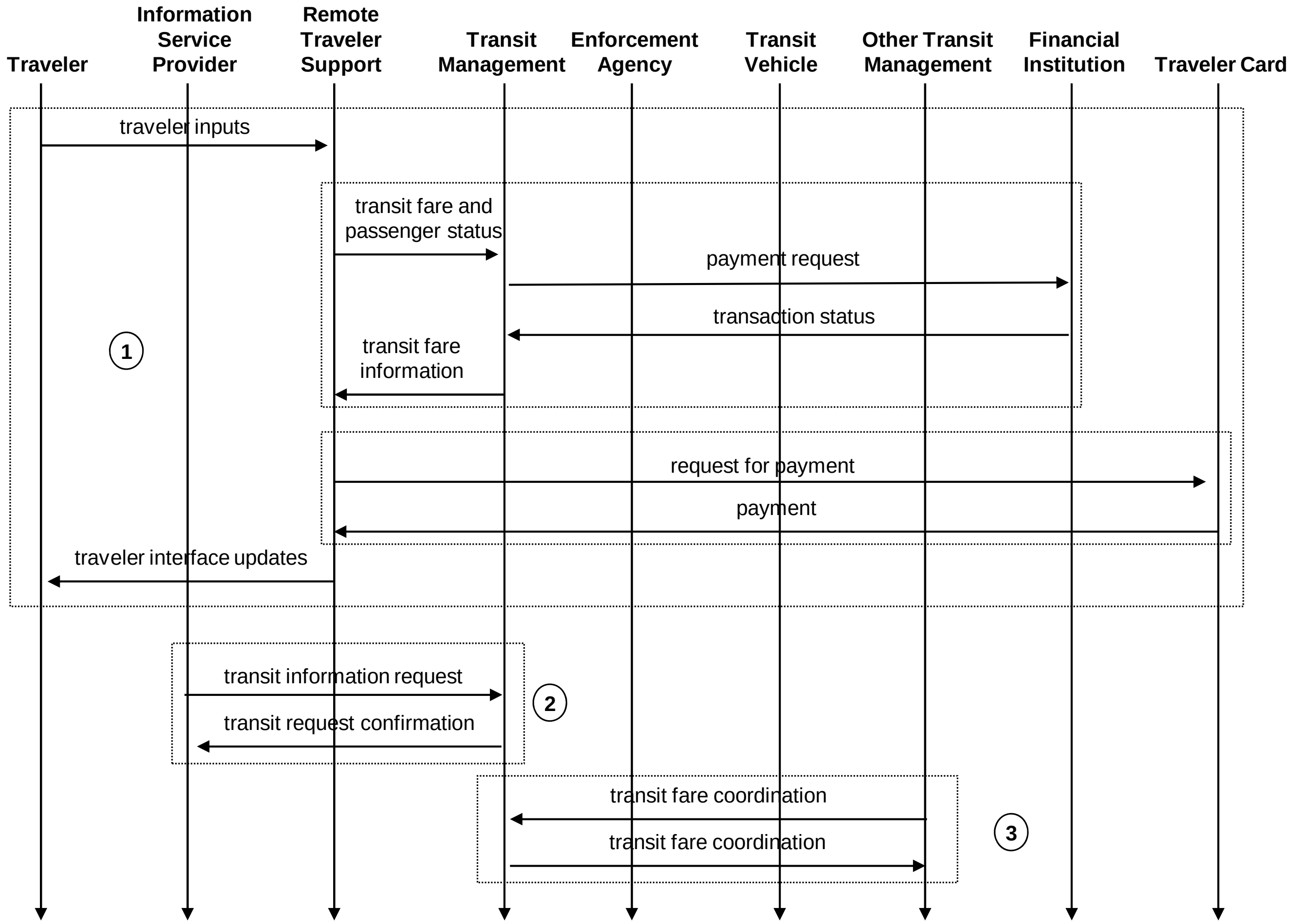
3. Electronic fare payment systems may operate within a single agency, or they may be regional in nature. For the latter case agencies provide a form of payment reconciliation where they inform each other of the transactions within their system using cards issued by the other system. The National ITS Architecture represents this as the flows *transit fare coordination* between TRMS and Other Transit Management. The entity Other Transit Management could also represent a regional reciprocity authority that coordinates fare payments among multiple agencies in a region.

4. Fare management onboard a transit vehicle is handled slightly differently. One possible fare management concept on a transit vehicle is to carry a list of the invalid fare cards that would be updated at some interval (possibly daily). To obtain this updated list, the Transit Vehicle Subsystem

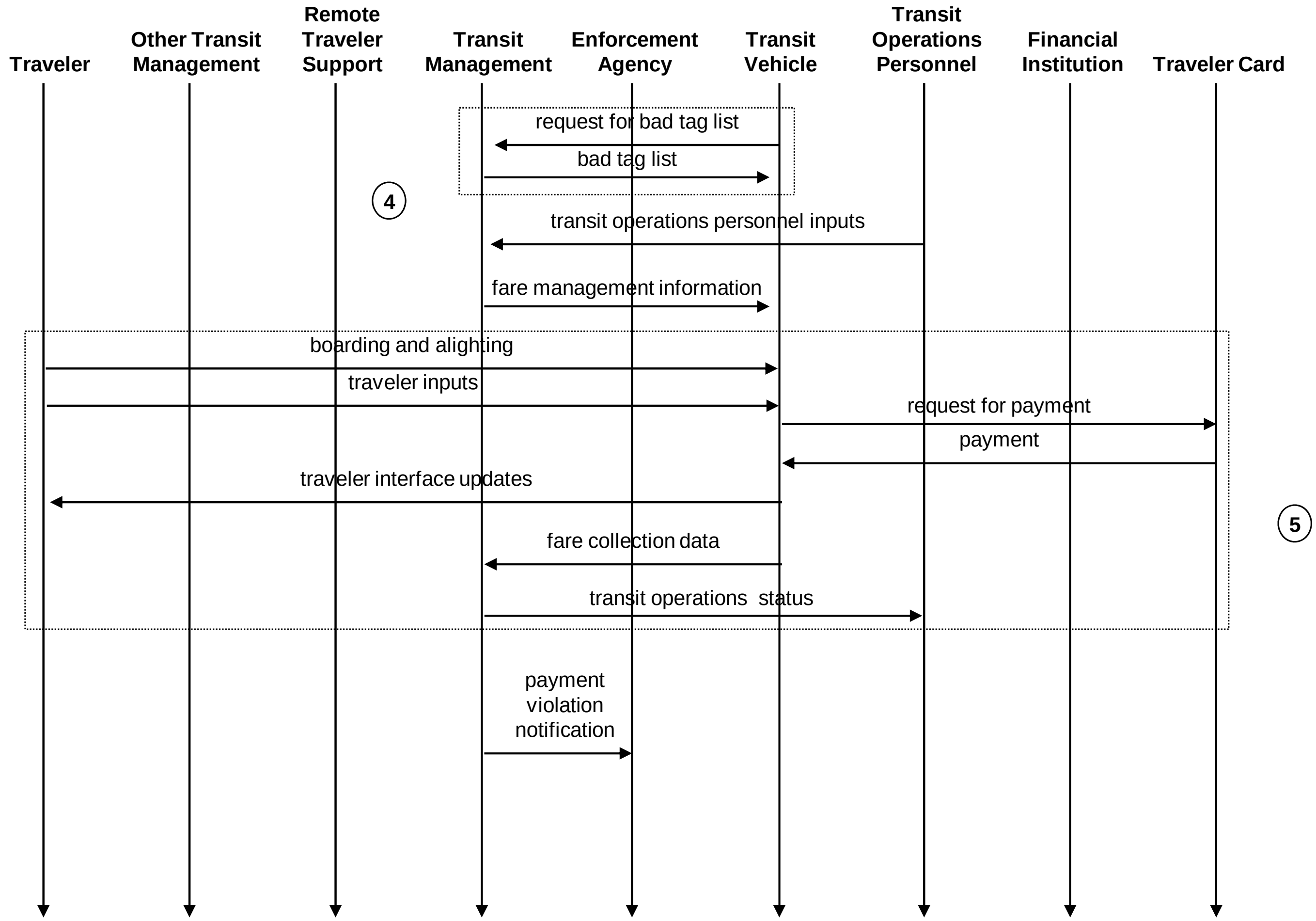
(TRVS) sends the request (*request for bad tag list*) to the TRMS, which responds with the updated list (*bad tag list*). As part of managing the fare collection on-board transit vehicles, Transit Operations Personnel can initiate adjustments to the fares charged on various routes (as part of *transit operations personnel inputs*). This might occur through the changing of a fare scheme (e.g. putting a weekend fare scheme into place during some special weekday event), or through adjustments of individual fares. The TRMS provides this *fare management information* to the TRVS.

5. Another supported on-board electronic fare concept supported is to use a Traveler Card for the payment media. In this case the TRVS detects the *boarding and alighting* of a passenger and sends a *request for payment* to the Traveler Card, which responds with the *payment* information. The Traveler may input information to the TRVS about their intended trip such as the destination (*traveler inputs*). The TRVS then informs the Traveler of the status of the transaction (*traveler interface updates*). The Traveler Card could be a stored value type card that requires no outside verification, or it could be a credit/debit card that is checked via the invalid tag list discussed above. The TRVS also provides information to the TRMS regarding the on-board fare system (*fare collection data*). This information includes system status (i.e. the health of the system), transaction status, and even video images associated with fare violations. An alternate operational concept is for the *fare collection data* to be a periodic, batch type transmission. The information on the fare system is passed along to the Transit Operations Personnel as part of *transit operations status*. If fare violations are collected, then *payment violation notification* is sent to the Enforcement Agency.

APTS04: Transit Fare Collection Management (1 of 2) (Non-Mobile Transactions)



APTS04: Transit Fare Collection Management (2 of 2) (Transit Vehicle Transactions)



4.5 APTS05: Transit Security

This service package provides for the physical security of transit passengers and transit vehicle operators. On-board equipment is deployed to perform surveillance and sensor monitoring in order to warn of potentially hazardous situations. The surveillance equipment includes video (e.g., CCTV cameras), audio systems and/or event recorder systems. The sensor equipment includes threat sensors (e.g., chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors) and object detection sensors (e.g., metal detectors). Transit user or transit vehicle operator activated alarms are provided on-board. Public areas (e.g., transit stops, park and ride lots, stations) are also monitored with similar surveillance and sensor equipment and provided with transit user activated alarms. In addition this service package provides surveillance and sensor monitoring of non-public areas of transit facilities (e.g., transit yards) and transit infrastructure such as bridges, tunnels, and transit railways or bus rapid transit (BRT) guideways. The surveillance equipment includes video and/or audio systems. The sensor equipment includes threat sensors and object detection sensors as described above as well as, intrusion or motion detection sensors and infrastructure integrity monitoring (e.g., rail track continuity checking or bridge structural integrity monitoring).

The surveillance and sensor information is transmitted to the Emergency Management Subsystem, as are transit user activated alarms in public secure areas. On-board alarms, activated by transit users or transit vehicle operators are transmitted to both the Emergency Management Subsystem and the Transit Management Subsystem, indicating two possible approaches to implementing this service package.

In addition the service package supports remote transit vehicle disabling by the Transit Management Subsystem and transit vehicle operator authentication.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. A Traveler initiates a silent or audible security alarm (*traveler inputs*) at a transit public area (e.g. stops, park and ride lots, stations). This may occur by pushing a “panic button”, or some other mechanism. The Remote Traveler Support Subsystem (RTS) sends an *alarm notification* to the Emergency Management Subsystem (EM). Here the EM represents either the public safety part of the transit agency (e.g. transit police) or other non-transit public safety agencies. The Emergency System Operator is made aware of the security alarm (as part of *emergency operations status*), and inputs an acknowledgement of the alarm (*emergency operations inputs*). The EM provides an *alarm acknowledge* to the RTS, which provides an acknowledgement to the Traveler who initiated the request for help (*traveler interface updates*).

2. Similarly, a security alarm on-board a transit vehicle is initiated by a Traveler (*traveler inputs*) or by the Transit Vehicle Operator (*transit vehicle operator inputs*). This could be a silent alarm or an audible alarm. The flow *alarm notification* is sent by the Transit Vehicle Subsystem (TRVS) to the EM. Here the EM represents either the public safety part of the transit agency (e.g. transit police) or

other non-transit public safety agencies. The Emergency System Operator is made aware of the security alarm (*emergency operations status*), and inputs an acknowledgement of the alarm (*emergency operations inputs*). The EM provides an *alarm acknowledge* to the TRVS, which provides an acknowledgement to either the Traveler (*traveler interface updates*) or to the Transit Vehicle Operator (*transit vehicle operator display*). The EM may also provide the status of the response to the alarm to the TRMS as *incident response status*.

3. An additional operational concept for security alarms on-board a transit vehicle is for the vehicle to interface with the Transit Management Subsystem (TRMS) rather than with the EM. This represents the case where a transit agency has automated the link from dispatch function to transit vehicle but does not have a separate link to transit police or other public safety agency. In this case the following operational concept applies. A security alarm on-board a transit vehicle is initiated by a Traveler (*traveler inputs*) or by the Transit Vehicle Operator (*transit vehicle operator inputs*). This could be a silent alarm or an audible alarm. The flows *alarm notification* and *transit vehicle location data* are sent by the TRVS to the TRMS, which represents the transit system dispatch function. Transit Operations Personnel are made aware of the security alarm (*transit operations status*), and inputs an acknowledgement of the alarm (*transit operations personnel inputs*). The TRMS provides an *alarm acknowledge* to the TRVS, which provides an acknowledgement to either the Traveler (*traveler interface updates*) or to the Transit Vehicle Operator (*transit vehicle operator display*). The TRMS may also inform a public safety entity (either the transit police if one exists, or local police) about the alarm via *transit emergency data*.

4. In addition to a user initiated security alarm, the transit public areas (represented by the RTS) as well as transit facilities and infrastructure (represented by the Security Monitoring Subsystem, SMS) may also be under video or audio surveillance. The input to the surveillance equipment is represented in the architecture by the flow *secure area characteristics* coming from the Secure Area Environment. The video and/ or audio equipment is controlled and configured by the EM (*secure area surveillance control*), with inputs from the Emergency System Operator (*emergency operations inputs*). The video images and/or audio are sent from the RTS or the SMS to the EM via *secure area surveillance data*. The RTS or SMS systems may include processing prior to sending *secure area surveillance data* to the EM. Once at the EM, the surveillance information may undergo additional processing before it is passed to the Emergency System Operator as part of *emergency operations status*. One type of processing that the image data may undergo is biometric analysis, which uses video image analysis technologies to identify persons who may represent a threat to the transit system.

5. Threat sensors (e.g., thermal, acoustic, radiological, chemical), object, motion and intrusion detection sensors are used to detect threats to transportation infrastructure. The flow *secure area characteristics* represents the environment that is sensed. The sensor equipment, located in transit public areas (represented by the RTS) as well as transit facilities and infrastructure (represented by the SMS), is controlled and configured by the EM (*secure area sensor control*), with inputs from the Emergency System Operator (*emergency operations inputs*). The sensor outputs (either raw or processed at the sensor location) are sent from the RTS or the SMS to the EM via *secure area sensor data*. The sensor information is passed to the Emergency System Operator as part of *emergency operations status*.

6. Sensors are also used to monitor the condition of transit infrastructure (which is represented by the SMS). The flow *secure area characteristics* represents the environment that is sensed. The sensor equipment is controlled and configured by the EM (*infrastructure monitoring sensor control*), with

inputs from the Emergency System Operator (*emergency operations inputs*). The sensor outputs (either raw or processed at the sensor location) are sent from the SMS to the EM via *infrastructure monitoring sensor data*. The sensor information is passed to the Emergency System Operator as part of *emergency operations status*.

7. Video and/or audio surveillance can also be performed on-board a transit vehicle. The flow *secure area characteristics* represents the environment on-board the vehicle that is sensed. The video and/or audio equipment is controlled and configured by the EM (*secure area surveillance control*), with inputs from the Emergency System Operator (*emergency operations inputs*). The video images and/or audio are sent from the TRVS to the EM via *secure area surveillance data*. The EM also receives *transit vehicle location data* from the TRVS so it can identify where the location of the TRVS is that is supplying the surveillance data. The surveillance information (and vehicle location information) is passed to the Emergency System Operator as part of *emergency operations status*. An alternative operational concept is for the Transit Vehicle Operator to have control of the on-board surveillance equipment (*transit vehicle operator inputs*) and for the video and/or audio to be presented to the transit vehicle operator (*transit vehicle operator display*).

8. Threat sensors (e.g., thermal, acoustic, biological, explosives, radiological, chemical) and object sensors may also be placed on a transit vehicle. The flow *secure area characteristics* represents the environment on-board the vehicle that is sensed. The sensor equipment is controlled and configured by the EM (*secure area sensor control*), with inputs from the Emergency System Operator (*emergency operations inputs*). The sensor outputs (either raw or processed at the sensor location) are sent from the TRVS to the EM via *secure area sensor data* (which contains the transit vehicle location so it can identify where the transit vehicle TRVS is that is supplying the sensor data). The sensor information (and vehicle location) is passed to the Emergency System Operator as part of *emergency operations status*.

9. Another security function involves performing Transit Vehicle Operator authentication prior to operating a transit vehicle. This authentication is begun by the Transit Vehicle Operator entering authentication information while logging onto the vehicle (*transit vehicle operator inputs*). There are two operational concepts supported by the service package. In the first the authentication occurs in the TRVS, with a report of the authentication results being passed from the TRVS to the TRMS (*transit vehicle operator authentication information*), and then to the Transit Operations Personnel (*transit operations status*). This implies an on-board authentication database, which can be queried or updated from the TRMS (as part of *transit vehicle operator authentication update*). This query is originated by the Transit Operations Personnel (*transit operations personnel inputs*). An alternate operational concept is for the authentication database to reside in the TRMS, in which case the operator authentication information is passed from the TRVS to the TRMS (*transit vehicle operator authentication information*), the authentication occurs in the TRMS, and the results of the authentication are passed to the TRVS (*transit vehicle operator authentication update*). Unsuccessful authentication could result in a disabling of the Basic Transit Vehicle (via *basic transit vehicle controls*).

10. An additional security function is the capability to identify when a transit vehicle has deviated from its planned route and schedule. The TRMS tracks the location of the transit vehicle (*transit vehicle location data*), and can compare the actual location to the planned route and schedule. Any unexpected deviation can be reported to the Transit Operations Personnel (*transit operations status*), who can report the possible emergency to the Transit Police or other public safety agency

(*transit operations personnel inputs* from Transit Operations Personnel to TRMS and then *transit emergency data* sent to the EM).

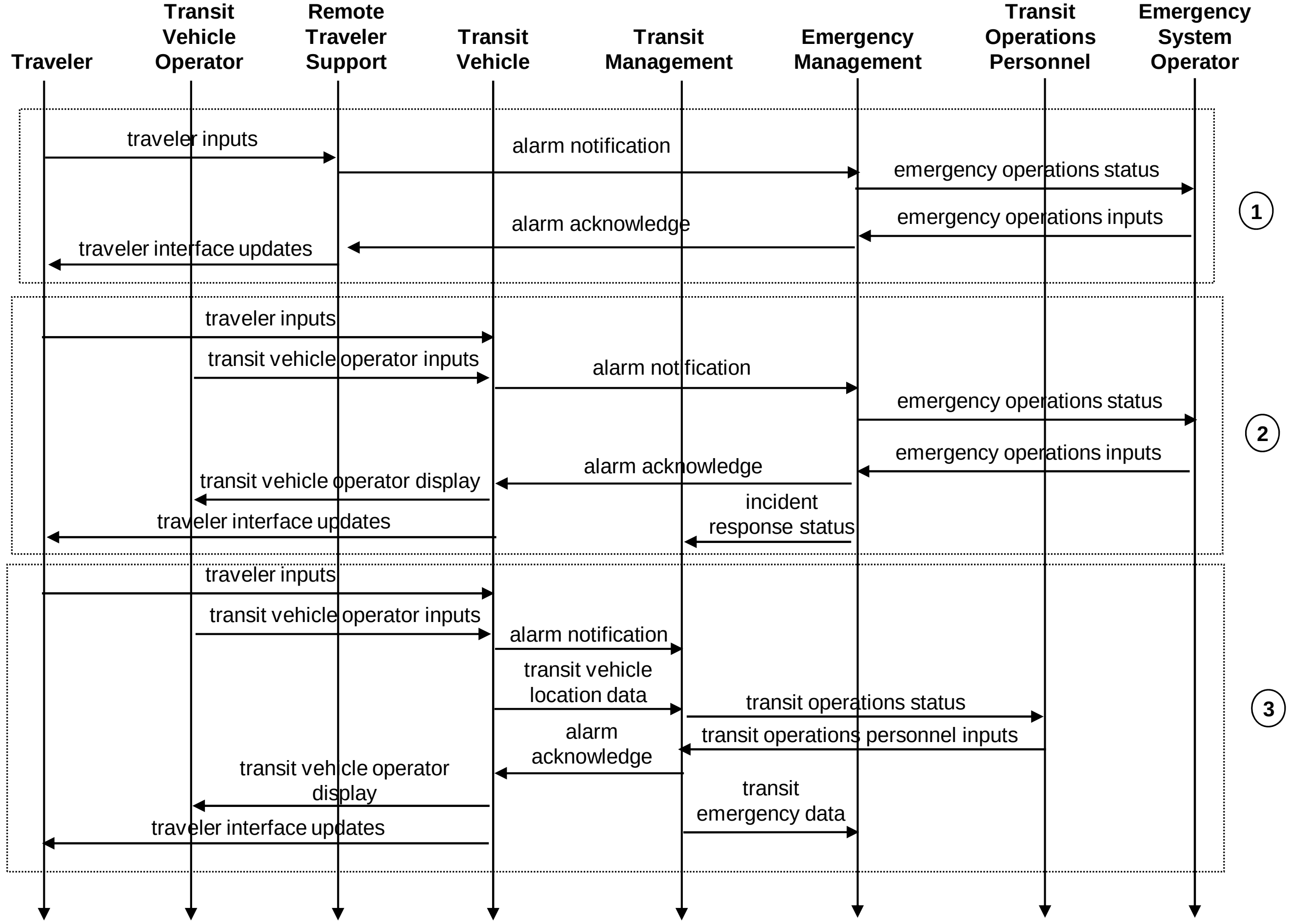
11. Under certain emergency conditions (e.g. the hijacking of a transit vehicle) it is possible for the TRMS to remotely disable a transit vehicle. This action is initiated by the Transit Operations Personnel (as part of *transit operations personnel inputs*). The TRMS sends *remote vehicle disable* to the TRVS, which results in the disabling of the Basic Transit Vehicle (via *basic transit vehicle controls*). An indication of whether the Basic Transit Vehicle is disabled is obtained by the TRVS from *transit vehicle measures* and reported to the TRMS (as a part of *transit vehicle conditions*). The information is passed to the Transit Operations Personnel as part of *transit operations status*. Transit Operations Personnel have the capability to cancel the disable command (issued from the TRMS to the TRVS as part of *remote vehicle disable*).

12. The results of surveillance monitoring (and analysis) and sensor monitoring (and analysis) are reported to Alerting and Advisory Systems (*threat information*). In some cases the EM will request support from the Alerting and Advisory Systems in analysis of surveillance or sensor outputs (*threat data for analysis*). This might include results of preliminary biometric analysis, sent for further analysis. The results of this analysis are returned as *threat support data*. *Threat information* may also be provided to Rail Operations, for threats that may impact the infrastructure shared with freight rail systems.

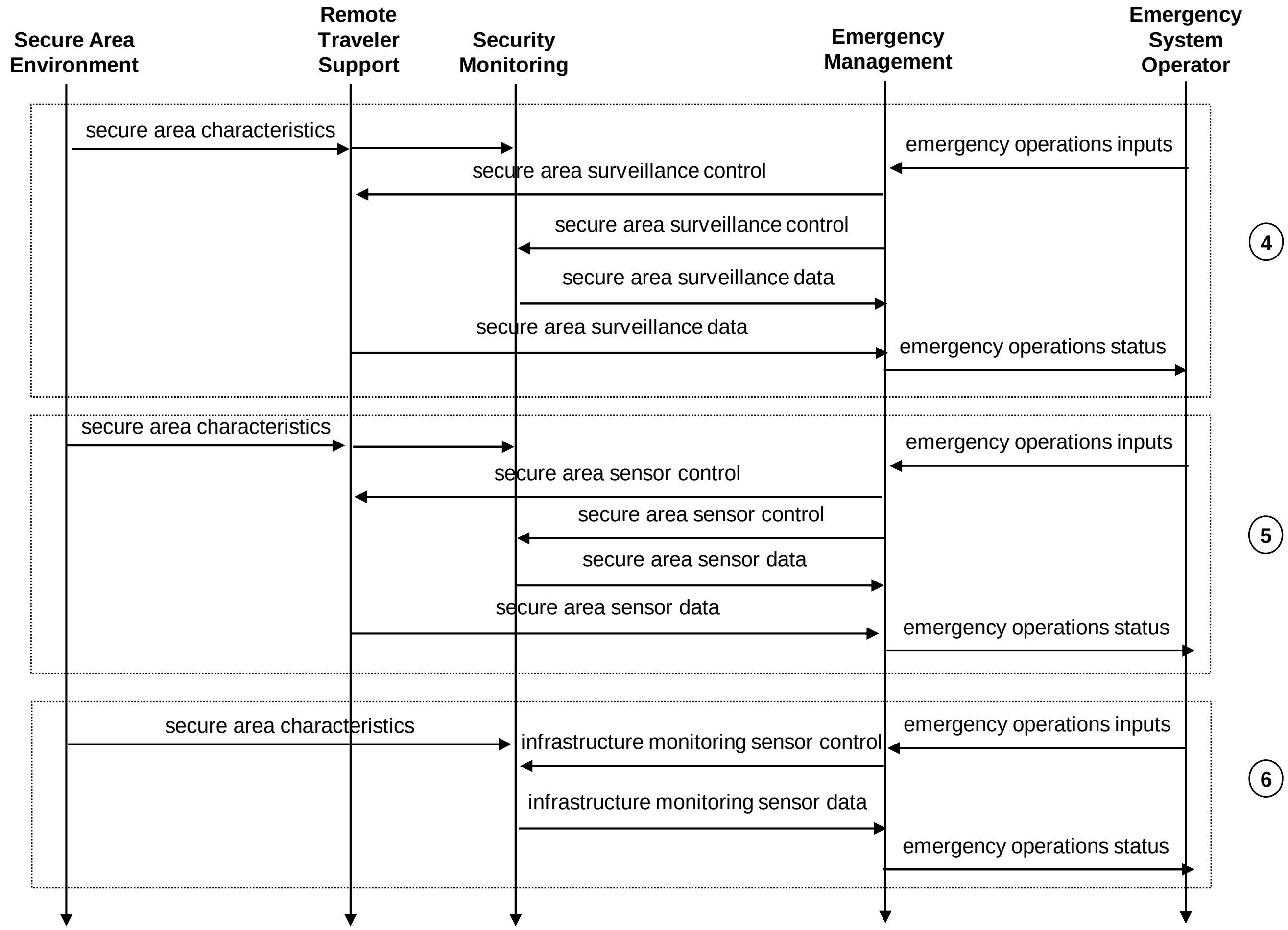
13. In the case of a threat or incident, EM coordinates (*threat information coordination* and *incident report*) with Other Emergency Management. This also includes the exchange of sensor and surveillance information for coordinated analysis.

14. The TRMS makes selected information relative to transit security available to the Media (*transit incidents for media*) and to the Information Service Provider for distribution to its customers (*transit incident information*).

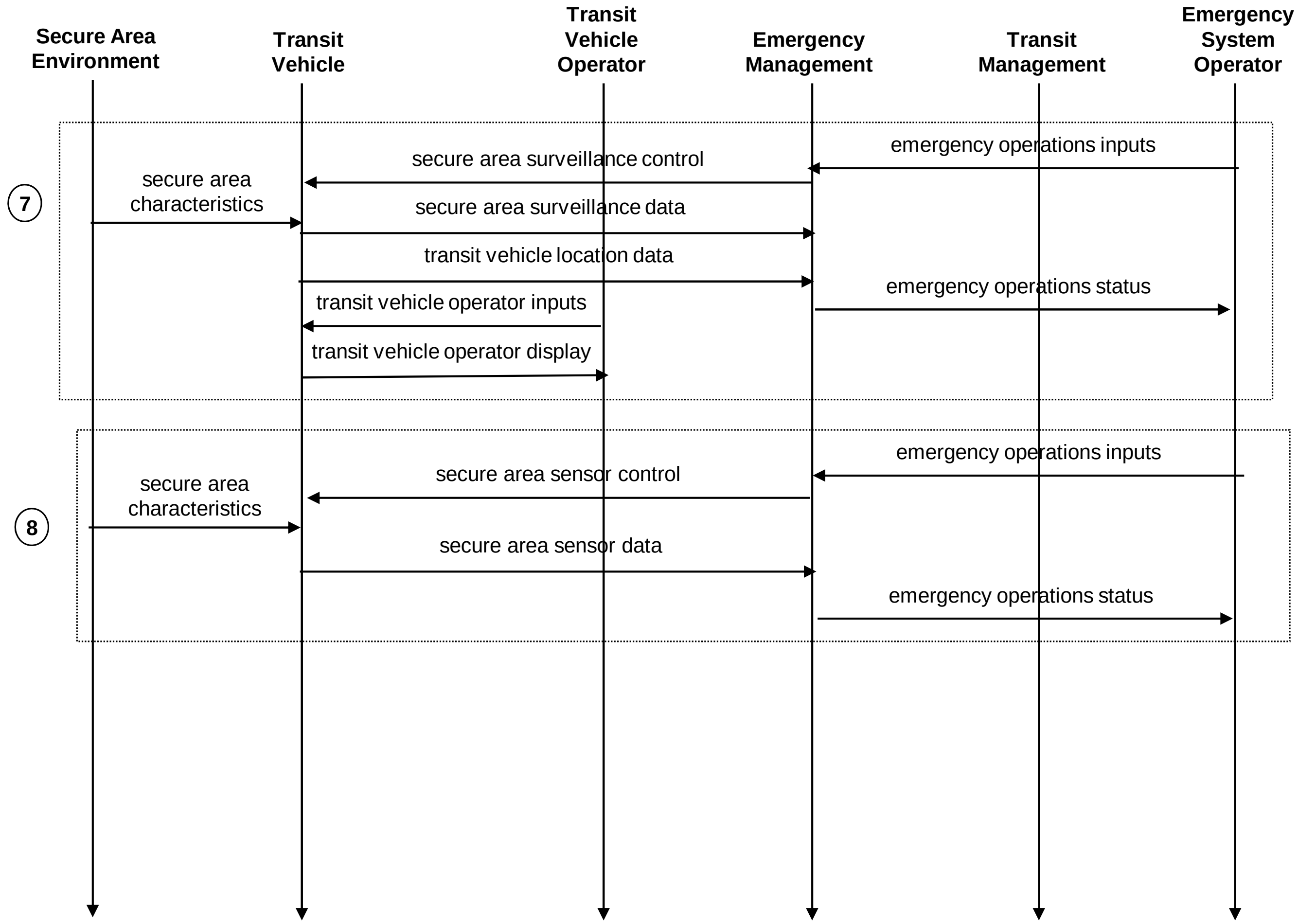
APTS05: Transit Security (1 of 5) (Alarms)



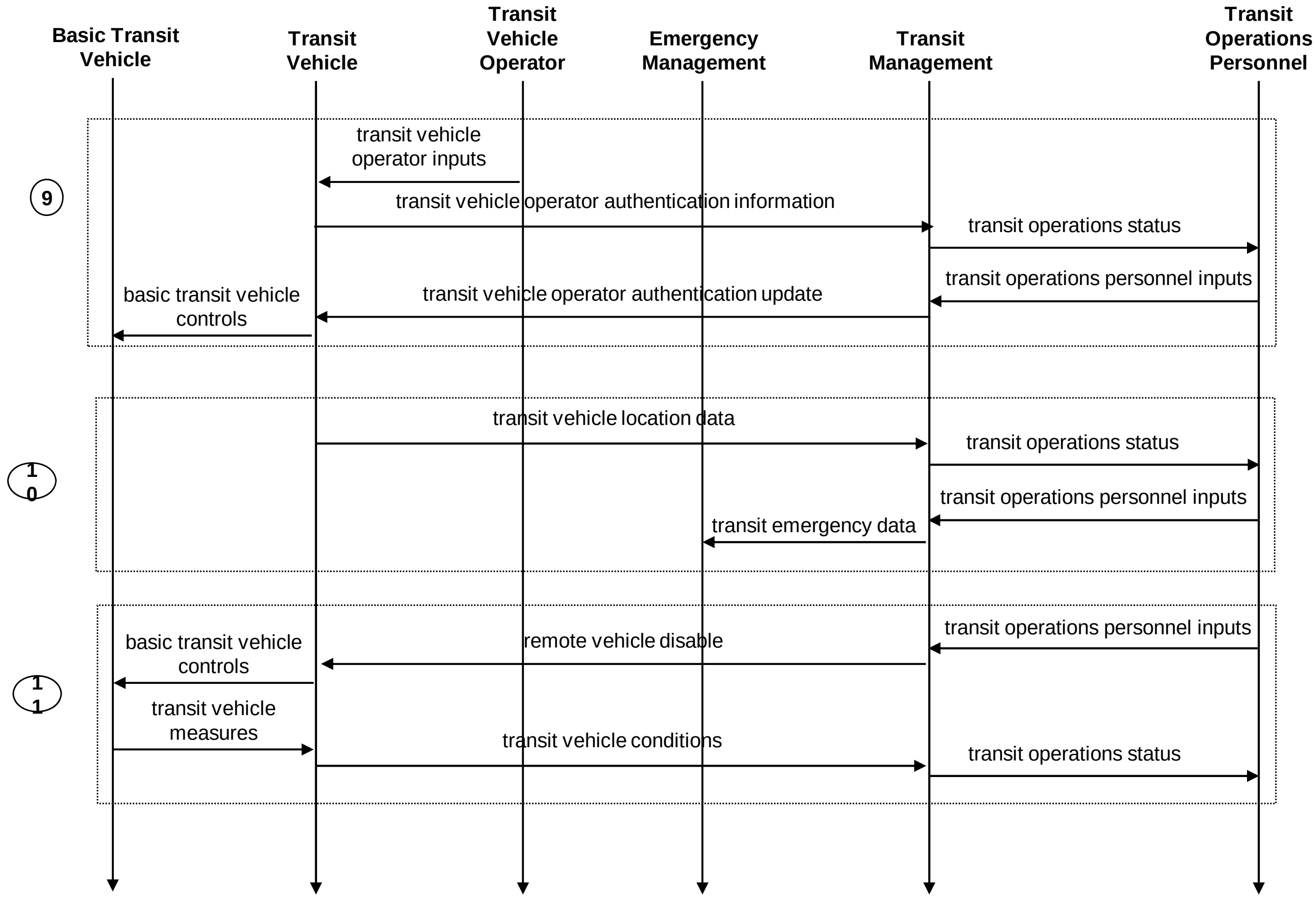
APTS05: Transit Security (2 of 5) (Non-mobile Transactions)



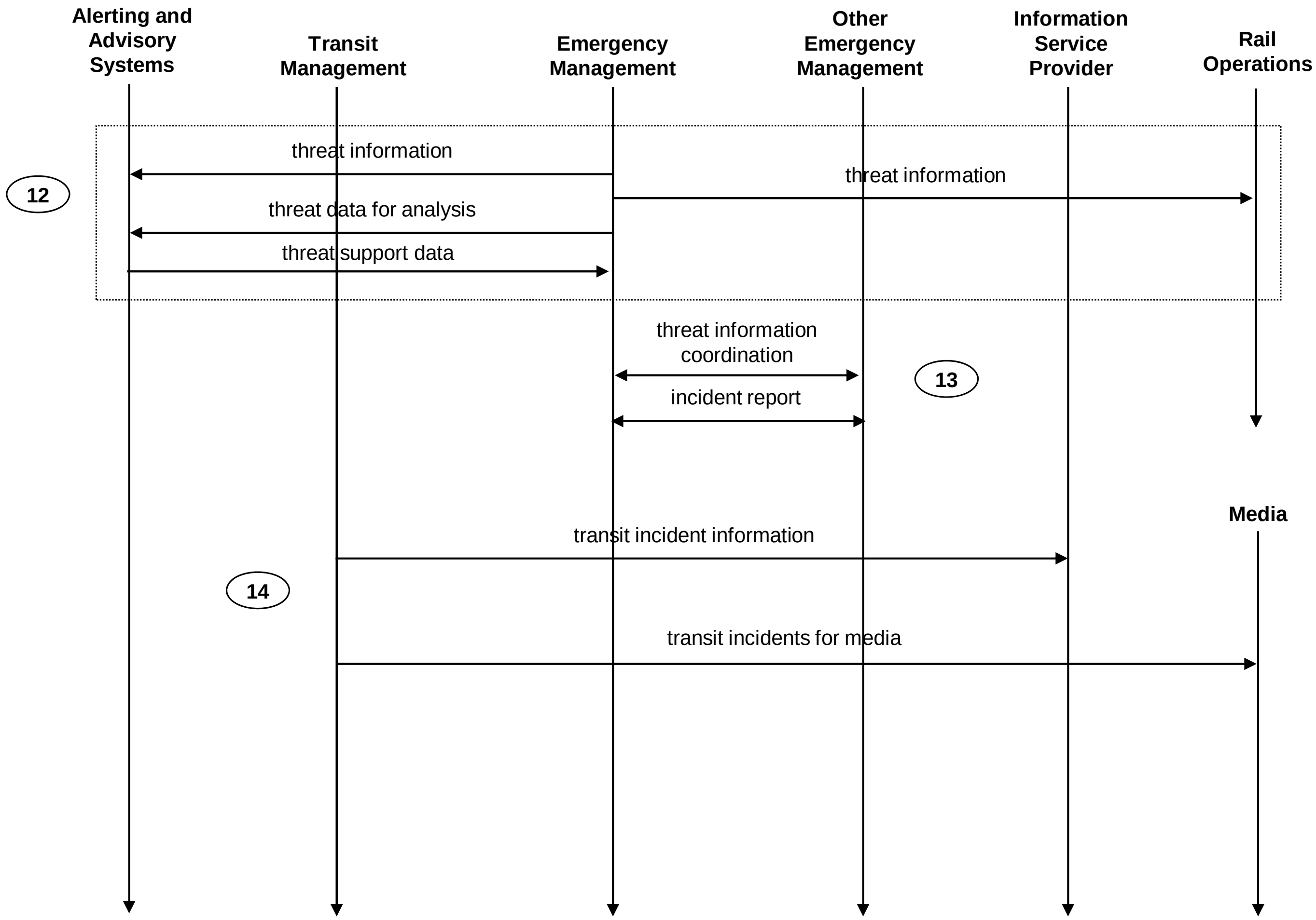
APTS05: Transit Security (3 of 5)
(Mobile Transactions)



APTS05: Transit Security (4 of 5) (Mobile Transactions)



APTS05: Transit Security (5 of 5)
(Center and System Transactions)



4.6 APTS06: Transit Fleet Management

This service package supports automatic transit maintenance scheduling and monitoring. On-board condition sensors monitor system status and transmit critical status information to the Transit Management Subsystem. Hardware and software in the Transit Management Subsystem processes this data and schedules preventative and corrective maintenance. The service package also supports the day to day management of the transit fleet inventory, including the assignment of specific transit vehicles to blocks.

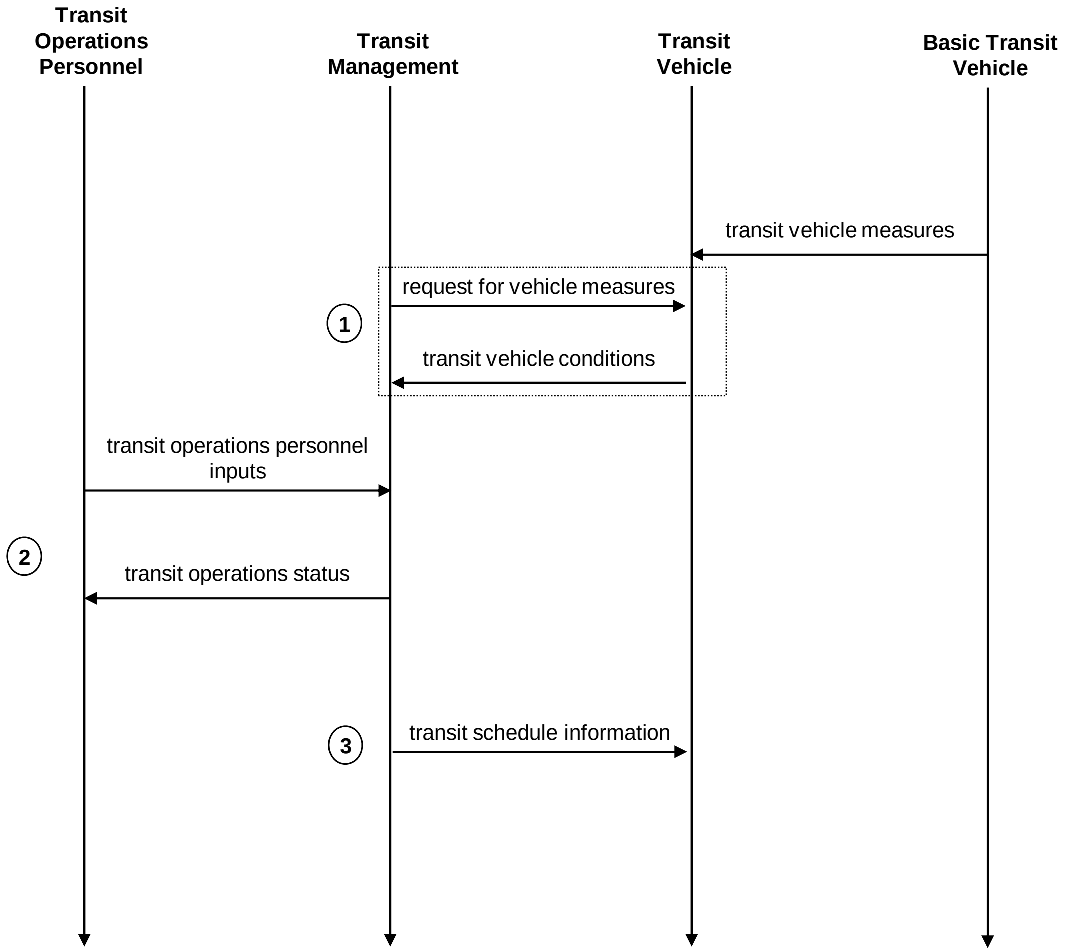
The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. To automate the maintenance of the transit vehicles, the TRMS sends a request to the Transit Vehicle Subsystem (TRVS) for vehicle performance and maintenance data collected by on-board sensors (*request for vehicle measures*). The TRVS responds with data containing vehicle performance and maintenance data collected by onboard sensors (*transit vehicle conditions*). Some of this data is obtained from sensors or systems in the Basic Transit Vehicle (the non-ITS portion of the transit vehicle) as *transit vehicle measures*.

2. Transit Operations Personnel manage the overall process of transit vehicle management, inputting transit maintenance requirements, requested maintenance actions, as well as initializing and updating a vehicle assignment (as part of *transit operations personnel inputs*) to the Transit Management Subsystem (TRMS). The overall status of vehicle's activities as well as status of individual vehicle maintenance would be presented to the Transit Operations Personnel (as a part of *transit operations status*).

3. At the beginning of a work day or shift, TRMS will send the *transit schedule information* to the TRVS in order to initialize the transit vehicle with a vehicle assignment to a particular block, monitor schedule performance, and develop corrective actions on-board.

APTS06: Transit Fleet Management



4.7 APTS07: Multi-modal Coordination

This service package establishes two way communications between multiple transit and traffic agencies to improve service coordination. Multimodal coordination between transit agencies can increase traveler convenience at transit transfer points and clusters (a collection of stops, stations, or terminals where transfers can be made conveniently) and also improve operating efficiency. Transit transfer information is shared between Multimodal Transportation Service Providers and Transit Agencies.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The TRMS provides transit schedule information to the Multimodal Transportation Service Provider for coordination at modal interchange points (*transit multimodal information*). The Multimodal Transportation Service Provider (who represents the operators of non-roadway transportation systems such as airlines, ferry services, and passenger carrying heavy rail) returns multimodal transportation schedules and service information (*multimodal service data*).

2. TRMS coordinates with the Parking Management Systems (PMS). The TRMS requests static or dynamic parking information (*parking lot data request*). In response, the PMS sends to the TRMS *parking information*.

3. TRMS coordinates transit service for special events with Event Promoters. Event Promoters send *event plans* that are used to plan transit service adjustments for the special event and TRMS returns *event confirmation* acknowledging transit service support for the event.

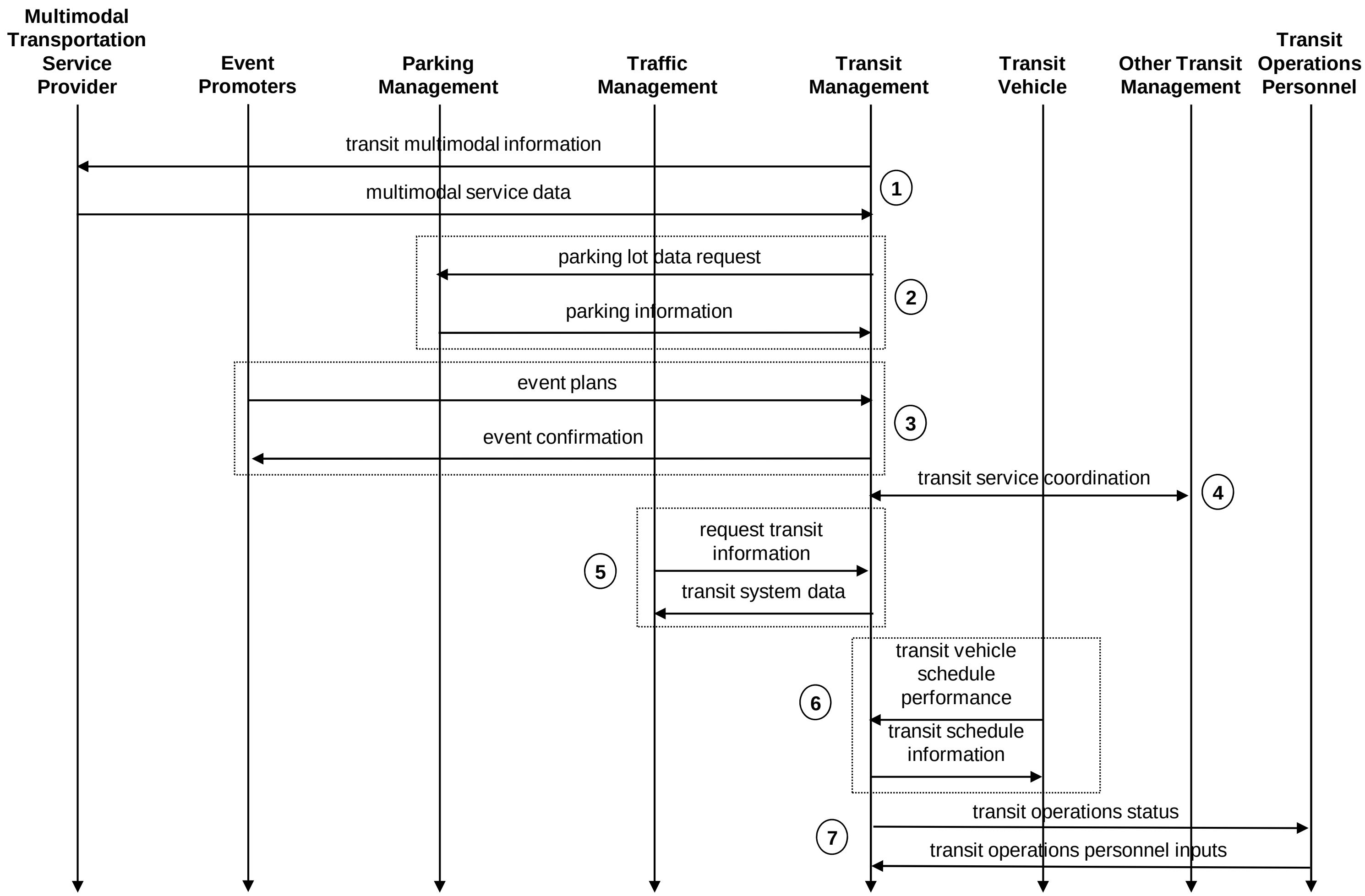
4. Another key coordination function is from one transit agency to another, represented in this service package by the *transit service coordination* flow that goes both ways between TRMS and Other Transit Management. The coordination between agencies might be on route transfer points and clusters, schedule, on-time information, incident information, and ridership.

5. Coordination with a TMS takes the form of a *request transit information* flow from the TMS to the TRMS, with the response (*transit system data*) including current transit system operations information indicating current transit routes, the level of service on each route, and the progress of individual vehicles along their routes for use in forecasting demand and estimating current transportation network performance.

6. The TRMS collects estimated times of arrival and anticipated schedule deviations from its fleet of transit vehicles (*transit vehicle schedule performance*) and returns *transit schedule information* to the transit vehicle to aid in corrective action.

7. TRMS will support an interface with Transit Operations Personnel to provide *transit operations status* and use the *transit operations personnel inputs* to support the multimodal coordination functionality.

APTS07: Multi-modal Coordination



4.8 APTS08: Transit Traveler Information

This service package provides transit users at transit stops and on-board transit vehicles with ready access to transit information. The information services include transit stop annunciation, imminent arrival signs, and real-time transit schedule displays that are of general interest to transit users. Systems that provide custom transit trip itineraries and other tailored transit information services are also represented by this service package.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

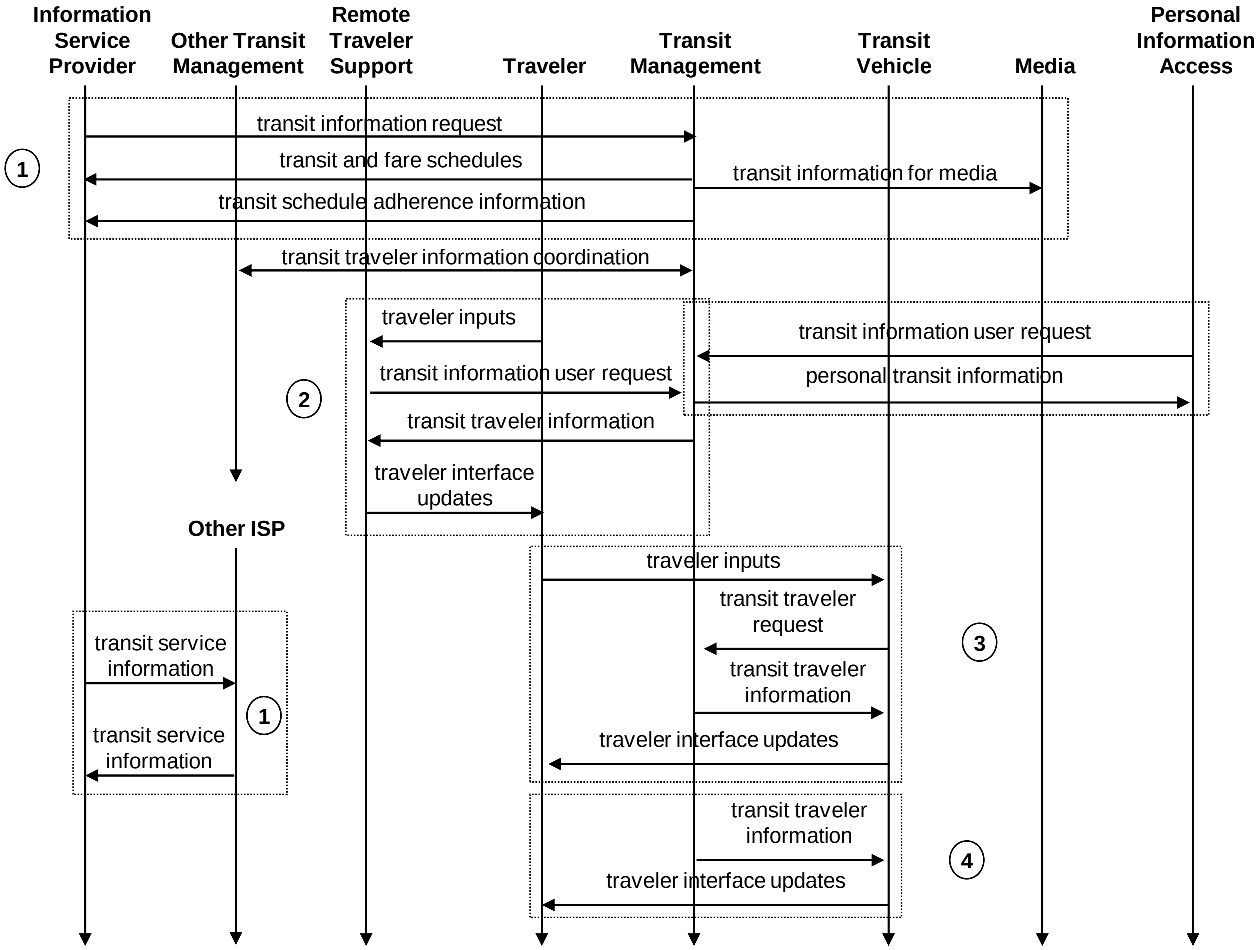
1. The Information Service Provider Subsystem makes a *transit information request* to the Transit Management Subsystem (TRMS) or gets from Other ISPs *transit service information* on behalf of its clients. These information collection activities could be for specific transit routes for a specific client or for the reservation of an advanced service. TRMS responds with the *transit and fare schedules* and *transit schedule adherence information*. The Media also can receive transit information such as schedule changes or routes where service is behind schedule, which is provided by the TRMS (*transit information for media*). In addition TRMS systems can exchange transit traveler information with Other Transit Management systems (*transit traveler information coordination*).

2. There are two ways for Travelers to request transit traveler information prior to boarding a transit vehicle. The Traveler can provide inputs (*traveler inputs*) to a Remote Traveler Support Subsystem (typically a kiosk). The kiosk may have some information available locally, or it forwards the *transit information user request* to the TRMS. The request might be for real time schedule information, or special routing information. The TRMS responds with the requested information (*transit traveler information*), which is given to the Traveler (part of *traveler interface updates*). Alternatively, a Traveler makes a *transit information user request* from a Personal Information Access Subsystem (which could be a personal computer, or a handheld computer) to the TRMS. The TRMS responds with *personal transit information*.

3. On-board a Transit Vehicle Subsystem (TRVS) a Traveler may also provide *traveler inputs* to a traveler information device inside the TRVS. The TRVS device will forward the *transit traveler request* to the TRMS if the information is not resident in the device, and receive the *transit traveler information* response from the TRMS. The information requested is then provided to the Traveler (*traveler interface updates*).

4. This service package also supports a simpler operational concept where information is “pushed” to the TRVS by the TRMS (*transit traveler information*) and provided as a broadcast message to the Travelers as part of *traveler interface updates* (possibly as stop annunciation or message signs within the TRVS).

APTS08: Transit Traveler Information



4.9 APTS09: Transit Signal Priority

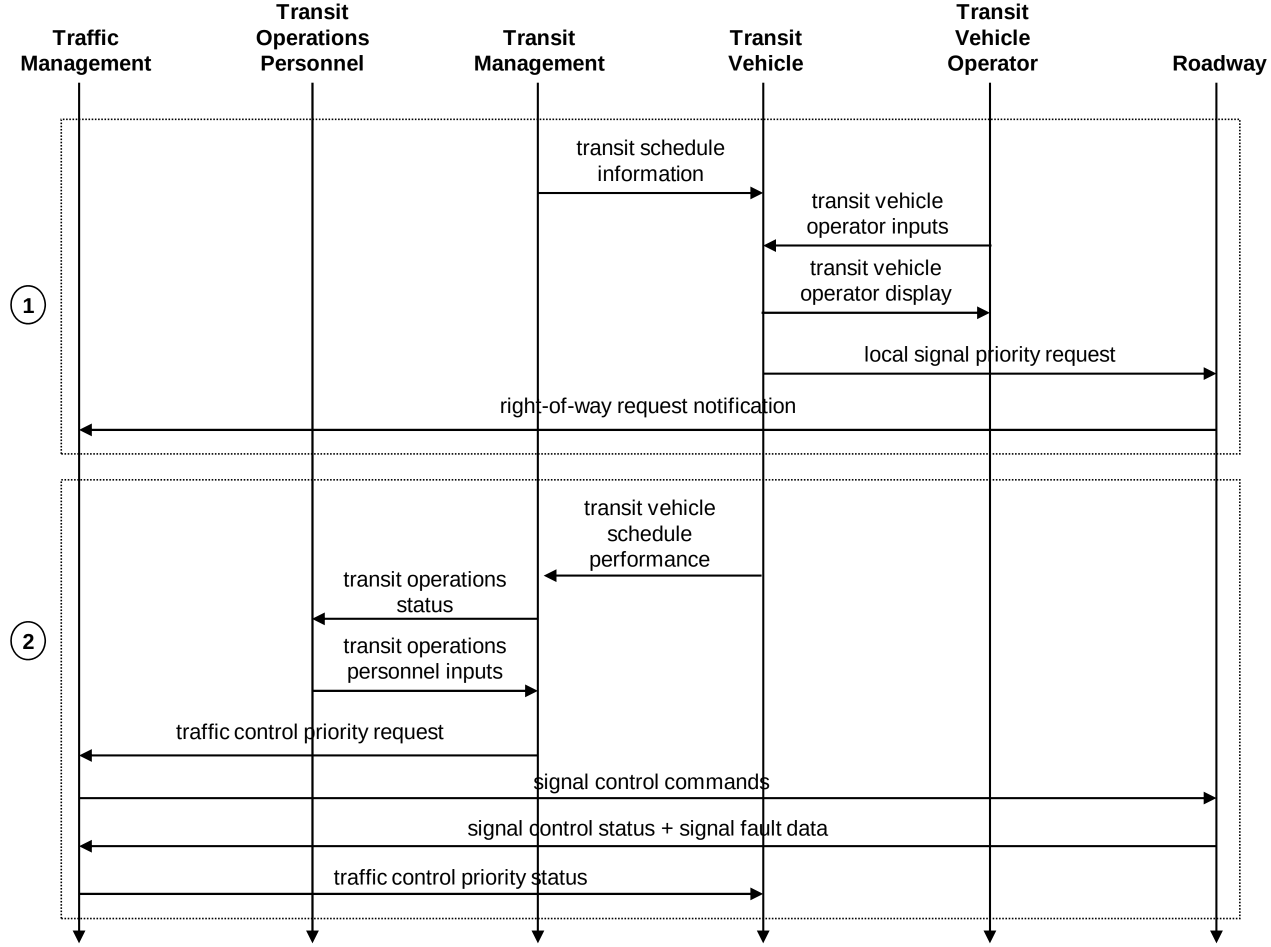
This service package determines the need for transit priority on routes and at certain intersections and requests transit vehicle priority at these locations. The signal priority may result from limited local coordination between the transit vehicle and the individual intersection for signal priority or may result from coordination between transit management and traffic management centers. Coordination between traffic and transit management is intended to improve on-time performance of the transit system to the extent that this can be accommodated without degrading overall performance of the traffic network.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The service package describes two concepts for transit vehicle signal priority. In the first the Transit Vehicle Subsystem (TRVS) communicates directly with the Roadway Subsystem (RS) to request that priority be given at the approaching intersection (*local signal priority request*). The signal priority system is monitored and controlled at a high level by the Transit Vehicle Driver (*transit vehicle operator display* and *transit vehicle operator inputs*). (Note that for safety reasons, in general, the vehicle operator should not be notified if the vehicle is behind schedule or if signal priority is being requested or given. Conversely, if the vehicle is ahead of schedule (aka "running hot"), the driver may be notified to "wait" only while the vehicle is stopped and the door is open.) The TRVS might also make its decision on whether to request the priority based upon a set of business rules regarding the status against its schedule, or the schedule of connecting routes. The flow *transit schedule information* from the TRMS could provide real time schedule information that would be used in making the decision regarding the real-time request for a priority. The intersection controller grants the priority based upon pre-established criteria and then informs the TMS that priority has been given (in the flow *right-of-way request notification*).

2. In a more advanced concept for transit vehicle signal priority, the TRMS receives location and schedule performance information from the TRVS (*transit vehicle schedule performance*). Based on interaction with the Transit Operations Personnel (*transit operations personnel inputs* and *transit operations status*), the TRMS makes the decision to request signal priority from the TMS at one or more upcoming intersections on the route (*traffic control priority request*). The TMS grants the signal priority (*signal control commands*, sent from the TMS to the RS), monitors signal controller status on the route (with the flow *signal control status* and *signal fault data*), and informs the TRMS of its actions (*traffic control priority status*).

APTS09: Transit Signal Priority



4.10 APTS10: Transit Passenger Counting

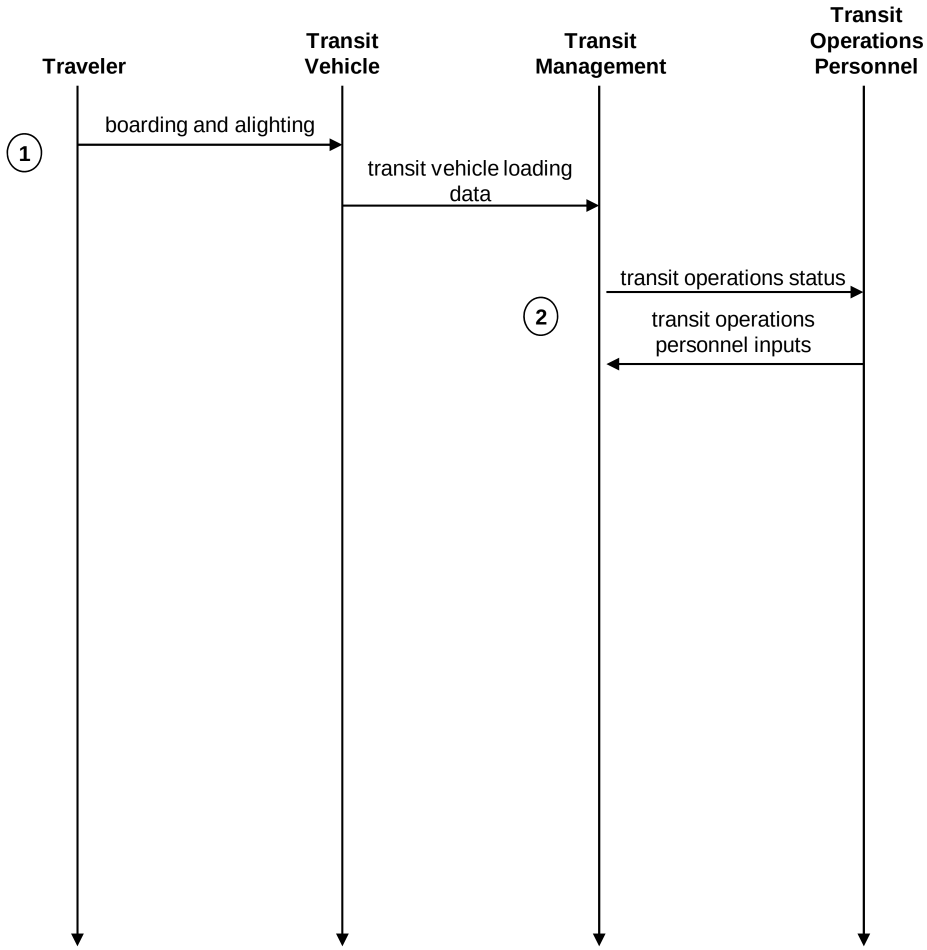
This service package counts the number of passengers entering and exiting a transit vehicle using sensors mounted on the vehicle and communicates the collected passenger data back to the management center. The collected data can be used to calculate reliable ridership figures and measure passenger load information at particular stops.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Transit Vehicle Subsystem (TRVS) detects and counts the *boarding and alighting* of passengers and provides that collected *transit vehicle loading data* to the Transit Management Subsystem (TRMS).

2. The TRMS takes the transit vehicle loading data collected from any or all of its fleet of vehicles and presents the Transit Operations Personnel via *transit operations status* with a view of the performance of the passenger loading within the system. The personnel may respond with *transit operations personnel inputs* to control and manage the data being presented - perhaps to concentrate on a particular vehicle or route or to control how often the data is presented.

APTS10: Transit Passenger Counting



4.11 APTS11: Multimodal Connection Protection

This service package supports the coordination of multimodal services to optimize the travel time of travelers as they move from mode to mode (or to different routes within a single mode). A near term function supported by this service package would be for a single transit agency to coordinate crossing routes so that passengers on one route would have the opportunity to transfer with minimum wait time to another route within the same transit system. The next level of complexity of this service package would be for this coordination to occur across transit agencies, or between transit agencies and other modes of transportation. The most advanced functions of this service package would be to track the route of an individual traveler and ensure that connections are properly scheduled on an individual basis. This final capability represents a long-term functionality, which could be managed either through an Information Serviced Provider or through a Transit Management subsystem.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

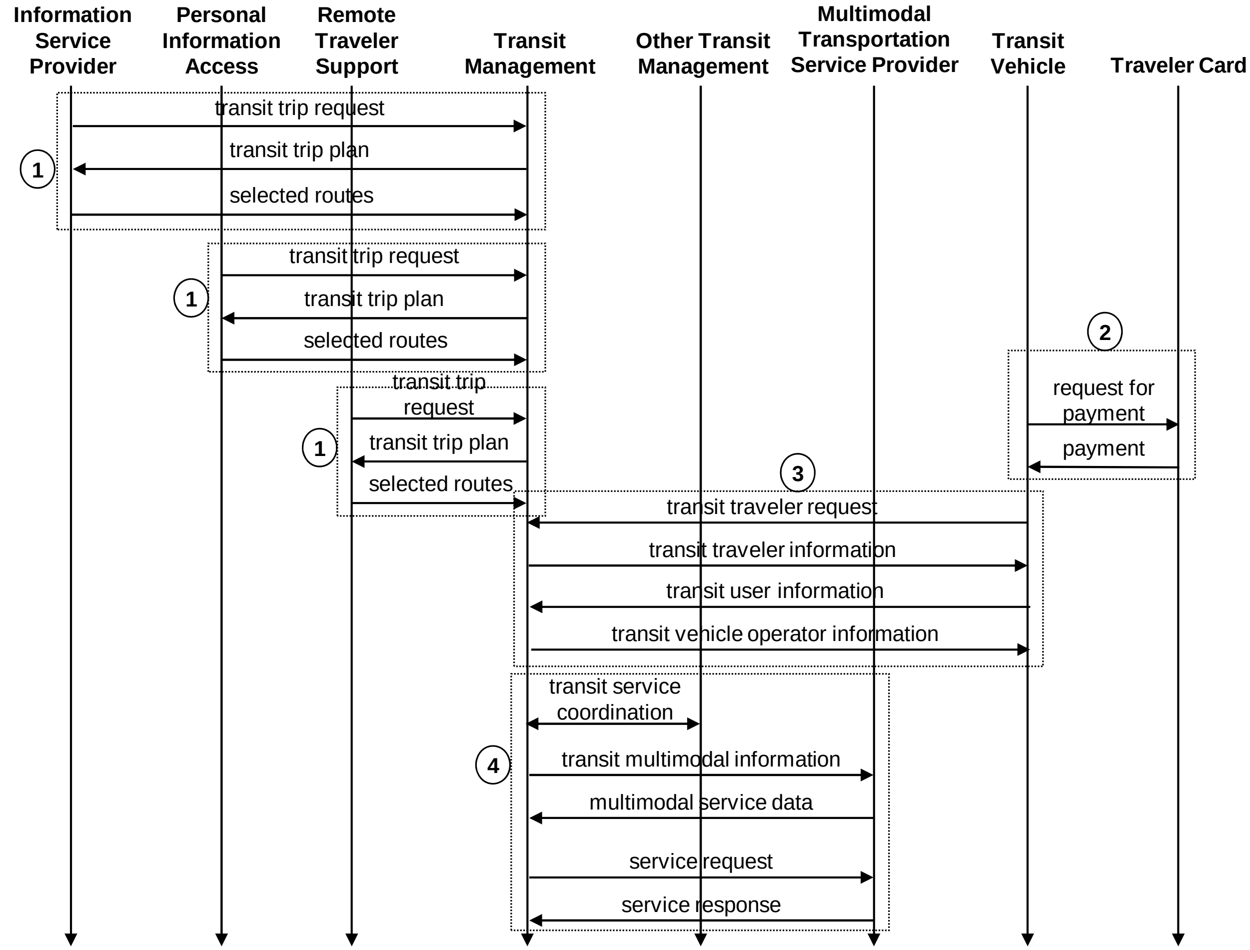
1. The Transit Management Subsystem learns of specific traveler trip plans for connections when the traveler, through either an ISPS, PIAS or RTSS, negotiates a specific trip plan (*transit trip request*, *transit trip plan* and *selected routes*). Alternatively, the Transit Management entity may simply know of the expected traveler demand model to need to make specific transit modal connections.

2. When a traveler pays for a trip (or validates a contract for a trip) on a transit vehicle (TRVS) with their Traveler Card payment instrument, the Transit Vehicle is essentially notified of the travelers presence and specific trip need (*request for payment* and *payment*) with possible connection protection requirements.

3. The TRVS can notify the TRMS of specific *transit traveler request* or *transit user information* requirements that may include connection protection as part of normal traveler information operations.

4. The TRMS now coordinates with Other Transit Management subsystems (*transit service coordination*) that a transit route needs to wait if necessary for a connection so that specific passengers can make the connection that has been negotiated. Alternatively the TRMS can notify the Multimodal Transportation Service Provider that either there are expected travelers needing to make a connection (*transit multimodal information* and *multimodal service data*) or there are specific travelers needing to make the connection (*service request* and *service response*).

APTS11: Multimodal Connection Protection



5 Emergency Management

This section provides the Theory of Operations for the Emergency Management Service Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each service package section) to identify these service packages is EM—Emergency Management.

5.1 EM01: Emergency Call-Taking and Dispatch

This service package provides basic public safety call-taking and dispatch services. It includes emergency vehicle equipment, equipment used to receive and route emergency calls, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. Coordination between Emergency Management Subsystems supports emergency notification between agencies. Wide area wireless communications between the Emergency Management Subsystem and an Emergency Vehicle supports dispatch and provision of information to responding personnel.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The process is under the asynchronous monitoring and control of the Emergency System Operator. In the initial steps of this process, the Emergency System Operator represents the call-taker, who interacts with callers, monitors alarms, and other incident reports (*emergency operations status*) and enters incident information into the system to support incident tracking and response (*emergency operations inputs*).

2. Incidents are reported by the public through the Emergency Telecommunications System (*incident notification*), including a description of the incident and information about the caller. This represents the Public Safety Answering Point's (PSAPs) interface to 911 and other emergency access numbers. The Emergency System Operator interacts with the caller, collecting additional information and verifying the information provided and providing an indication of incident response status back to the caller (*incident notification response*).

3. Transit Management can notify Emergency Management about incidents associated with the transit system (*transit emergency data*).

4. If Traffic Management permits, the Emergency Management subsystem can control the field surveillance equipment (*remote surveillance control*) associated with a Traffic Management subsystem (e.g., pan, tilt, and zoom). Traffic images are returned that contain the product of that surveillance (*traffic images*). These images may be used by the call-taker to verify the incident location and gather additional information about the incident.

5. Reported incident information is provided to the appropriate dispatcher based on location and the nature of the reported incident (*incident report*). This incident report may represent a positive hand-off of an incident between two systems in scenarios where the call-taker and dispatcher are on different systems, or it may represent the providing of incident information between peer

response agencies. As a response is dispatched, incident response information is shared with the call-taker (*incident response coordination*) so that accurate response information can be conveyed back to the caller. In the case of peer response agencies the *incident response coordination* allows response coordination between the agencies.

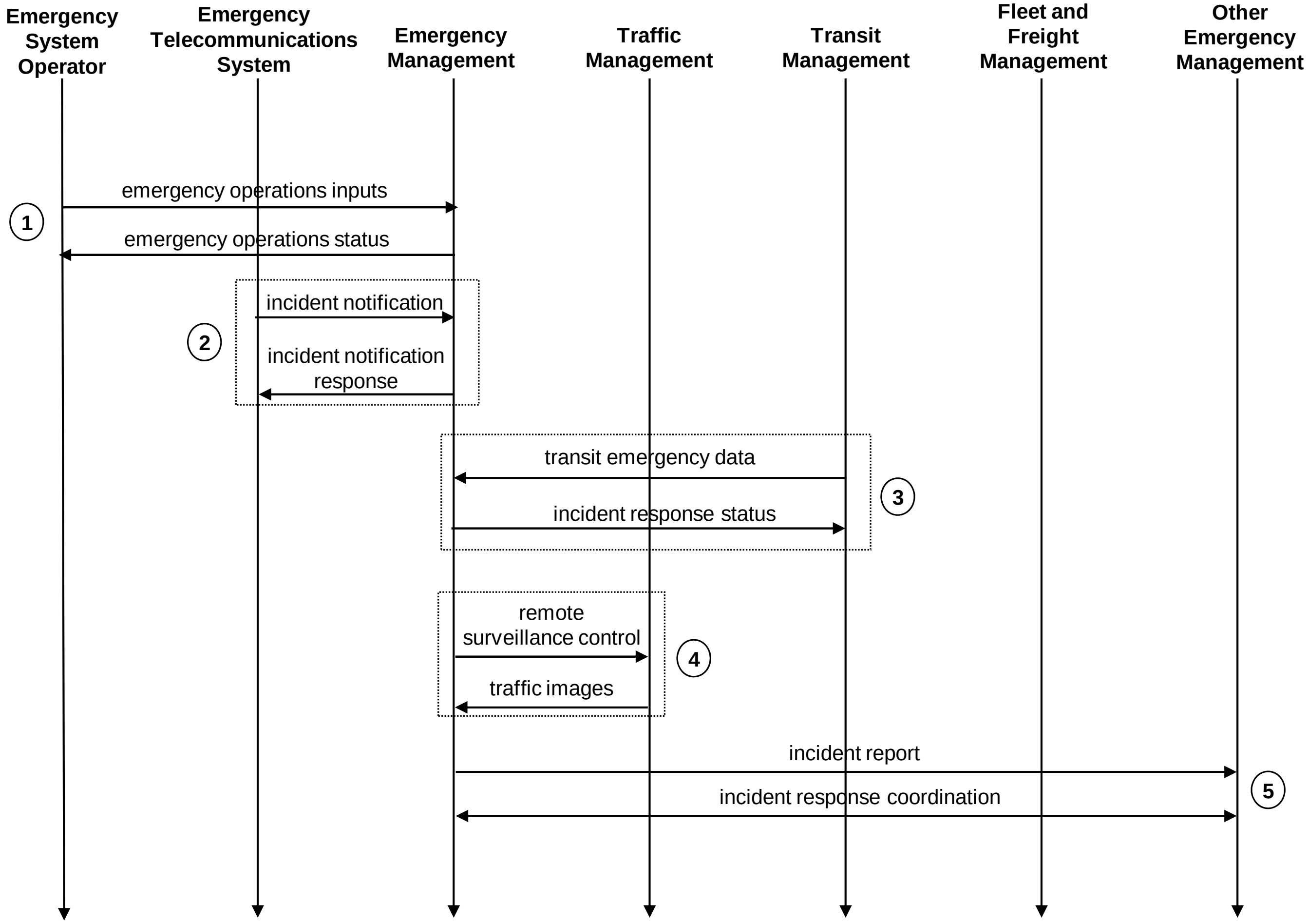
6. Like the call-taking process described in the previous steps, the dispatch process is also under the continuous asynchronous monitoring (*emergency operations status*) and control (*emergency operations inputs*) of the Emergency Systems Operator, representing the dispatcher in the final steps of this process. Note that the call-taker and dispatch positions may be operated by the same person, by different people in the same communications center, or by different people in different communications centers.

7. An *incident report* is provided to the Emergency Management Subsystem, representing communication to the Computer-Aided Dispatch system. As a response is dispatched, incident response information is shared with other Emergency Management Subsystems, supporting coordinated dispatch in mutual aid scenarios and other scenarios where more than one agency is supporting the incident response (*incident response coordination*).

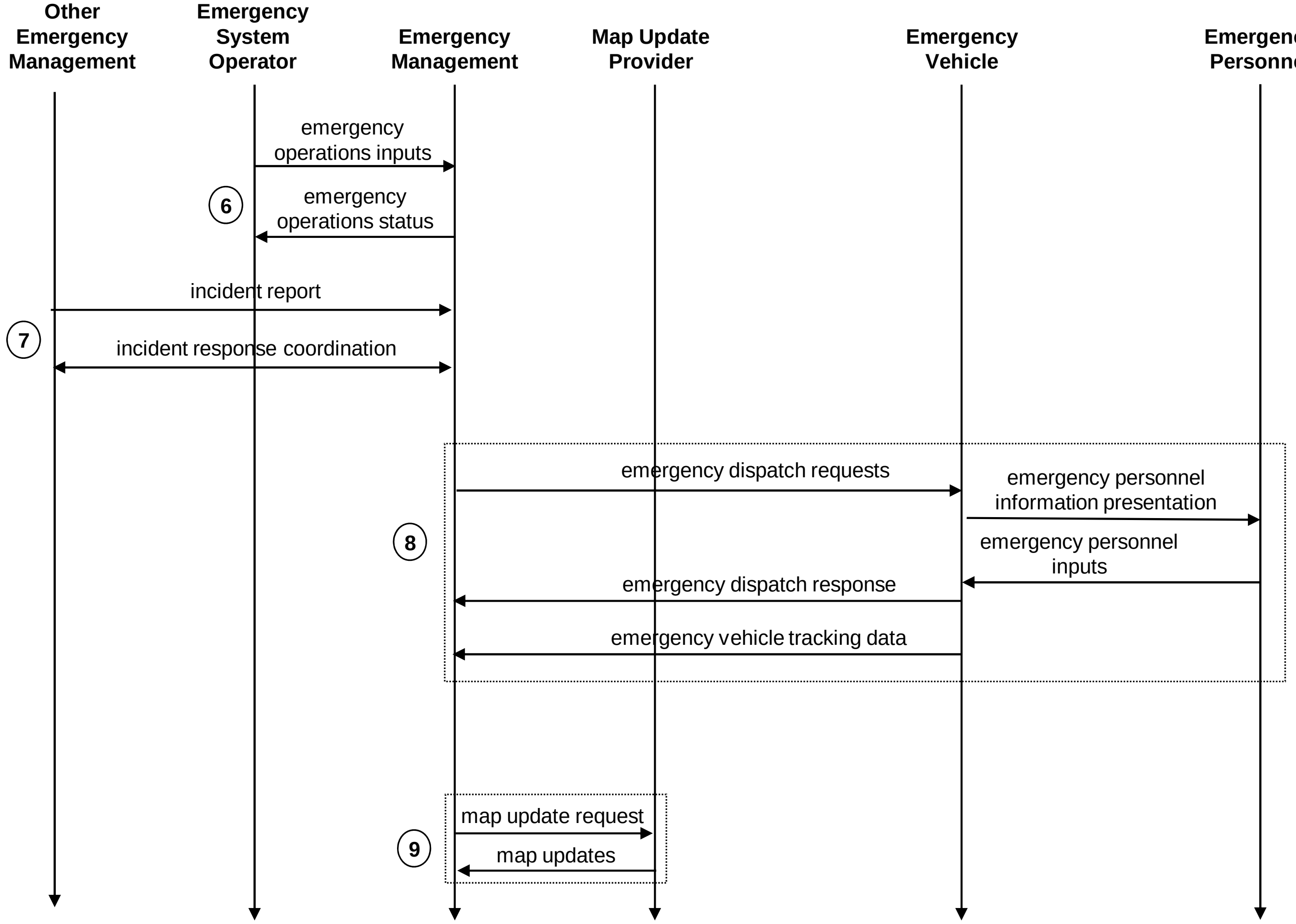
8. One or more units are dispatched to the reported incident (*emergency dispatch requests*) and the information is made available to the emergency personnel in the vehicle (*emergency personnel information presentation*). Emergency personnel may confirm the dispatch request (*emergency personnel inputs*), which is relayed to the Emergency Management Subsystem (*emergency dispatch response*). In addition, vehicle location (*emergency vehicle tracking data*) is relayed to the Emergency Management Subsystem to facilitate dispatch of the vehicle.

9. The Emergency Management Subsystem can keep its mapping system current by subscribing to a map update service. *Map updates* are provided on request (*map update request*) to support CAD system operation and facilitate interoperability between CAD systems.

EM01: Emergency Call-Taking and Dispatch (1 of 2) (Call-Taking)



EM01: Emergency Call-Taking and Dispatch (2 of 2) (Dispatch)



5.2 EM02: Emergency Routing

This service package supports automated vehicle location and dynamic routing of emergency vehicles. Traffic information, road conditions, and suggested routing information are provided to enhance emergency vehicle routing. Special priority or other specific emergency traffic control strategies can be coordinated to improve the safety and time-efficiency of responding vehicle travel on the selected route(s). The Emergency Management Subsystem provides the routing for the emergency fleet based on real-time conditions and has the option of requesting a route from the Traffic Management subsystem. The Emergency Vehicle may also be equipped with dedicated short range communications for local signal preemption and the transmission of alerts to surrounding vehicles. The service provides for information exchange between care facilities and both the Emergency Management Subsystem and emergency vehicles.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Emergency Management Subsystem can keep its mapping system current by subscribing to a map update service. *Map updates* are provided on request (*map update request*) to support preparation of a suggested route to Emergency Vehicles.

2. The Traffic Management Subsystem provides current road and traffic conditions (*road network conditions*). Current *work zone information*, *current asset restrictions* (e.g. dimensional constraints for bridges, tunnels and overhead clearances), and *roadway maintenance status* are also provided by the Maintenance and Construction Management Subsystem. Also *railroad schedules* are provided by Rail Operations. This information can be used later in preparing suggested routing for Emergency Vehicles.

3. The Emergency System Operator tracks the location and status of emergency vehicles and other resources, monitors incident status, traffic and road conditions, and the operation of the system itself (*emergency operations status*). The system operator controls the dispatch and routing functions performed by this process (*emergency operations inputs*).

4. The Emergency Management subsystem can request status from one or more Care Facilities (*care facility status request*). The returned information (*care facility status*) can be used to decide to which Care Facility to route an Emergency Vehicle carrying an incident victim.

5. An individual Emergency Vehicle can also directly request status from one or more Care Facilities (*care facility status request*). The request is initiated by the Emergency Personnel as part of *emergency personnel inputs*. The status information that is returned to the Emergency Vehicle (*care facility status*) and then passed along to the Emergency Personnel (as part of *emergency personnel information presentation*) can be used to decide to which Care Facility to bring an incident victim.

6. En route, an Emergency Vehicle can report *patient status* to the Care Facility. The report can be initiated by the Emergency Personnel (as part of *emergency personnel inputs*) or come from equipment on the Emergency Vehicle.

7. An Emergency Vehicle tracks its location (*position fix*) and periodically reports its actual position and status to the Emergency Management subsystem dispatch function (*emergency vehicle tracking data*). Using information collected earlier (see 1 and 2 above), the Emergency Management dispatch function can directly determine a best route for the Emergency vehicle. In special circumstances such as during disasters and evacuations when normal routes are not available, the Emergency Management Subsystem may request a route (*emergency route request*) from the Traffic Management Subsystem, which then provides the route (*emergency routes*). In addition to providing the route, the Traffic Management Subsystem can manage traffic to better support emergency vehicle progress along the suggested route. Whether the route is computed by the Emergency Management Subsystem or the Traffic Management Subsystem the suggested route is provided to the Emergency Vehicle (*suggested route*) and relayed to Emergency Personnel (*emergency personnel information presentation*).

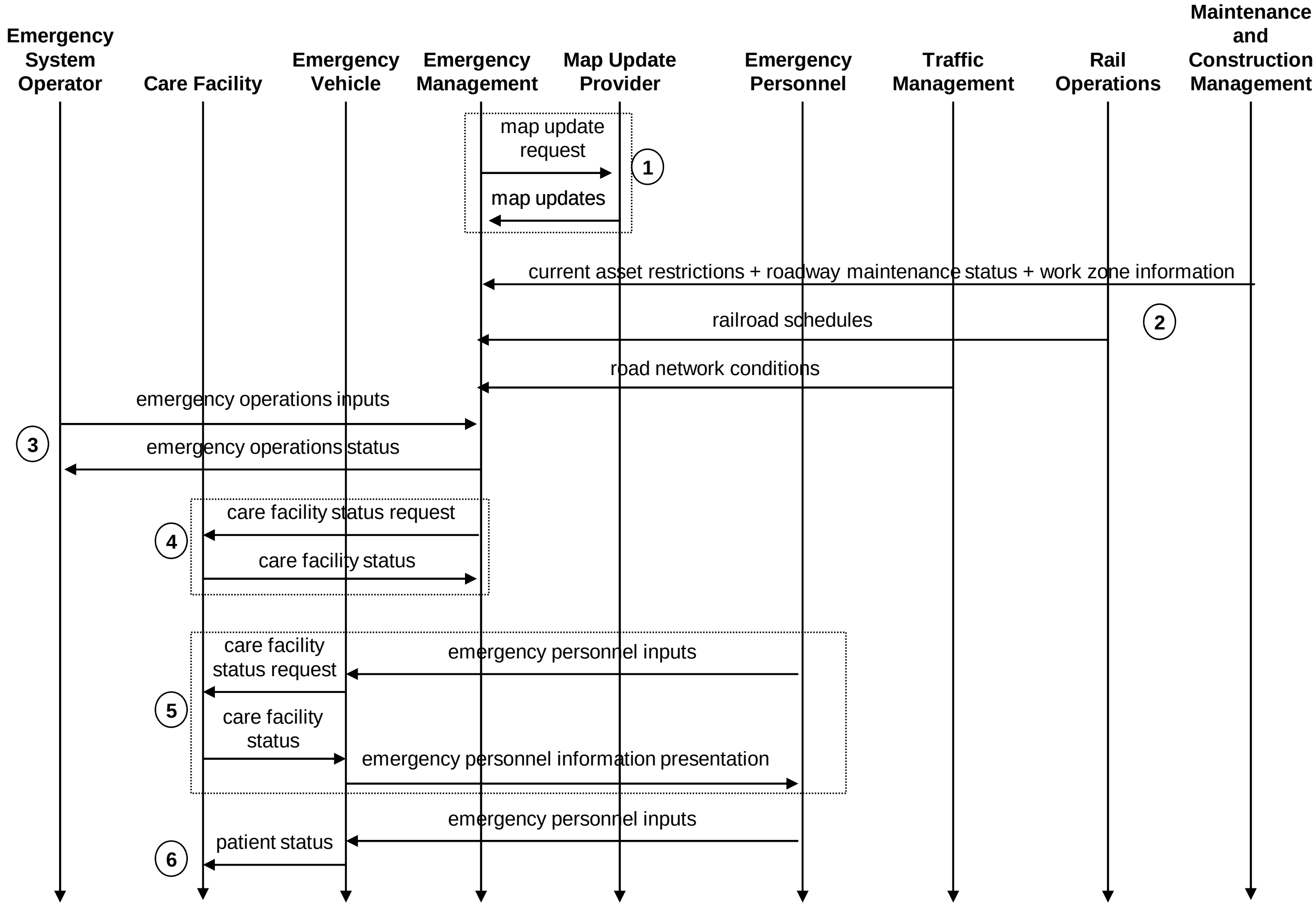
There are two options in the National ITS Architecture for signal preemption to be effected for Emergency Vehicles. The first is Center-to-Center based, and the second is based on Field-Vehicle Communications between the Emergency Vehicle and Roadway. Both approaches have their advantages.

8. Center-To-Center based Signal Preemption. The Emergency Vehicle subsystem reports its progress to an incident to the Emergency Management subsystem (*emergency vehicle tracking data*). The Emergency Management subsystem reports the anticipated route and progress along that route to the Traffic Management subsystem (*emergency traffic control request*). The Traffic Management subsystem can adjust the signal timing plans (*signal control commands*, *signal control status* and *signal fault data*) to accommodate the Emergency Vehicle by either adjusting the timing so that the Emergency Vehicle has a green signal when it arrives at an intersection, or the intersections can "go flashing red" until the Emergency Vehicle is known to have passed. Traffic Management can notify Emergency Management as to whether they can expect signal preemption or not (*emergency traffic control information*). The advantage of this operational concept is that for regions that have already deployed AVL (Automated Vehicle Location) on Emergency Vehicles, and have already deployed closed loop signal control, the marginal cost to deploy this system is very small (possibly only requiring a center-to-center information channel). It may, however, require a higher level of reliability for these systems than was required for their original deployed purpose.

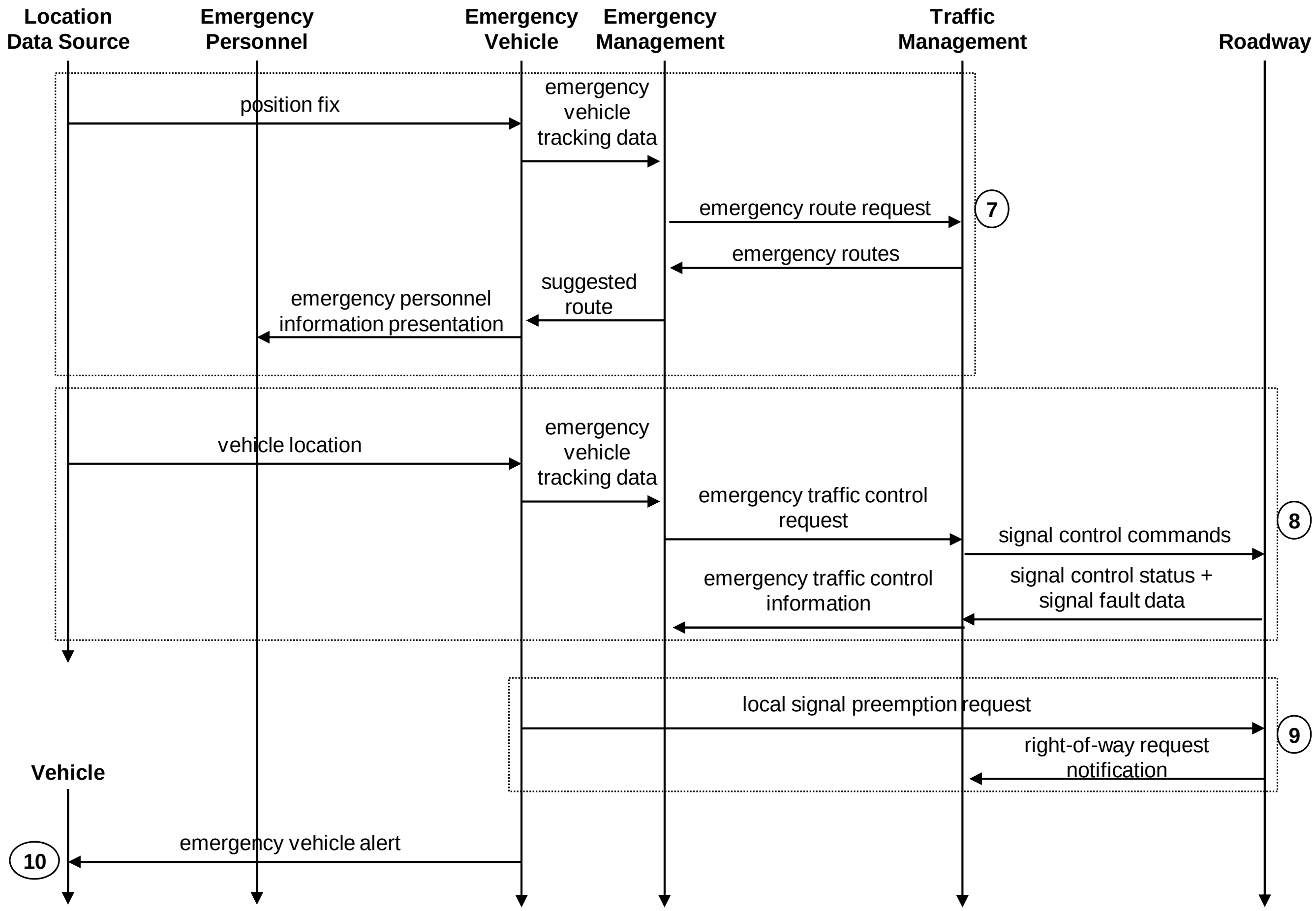
9. Alternatively, an Emergency Vehicle may use Field-Vehicle Communications with Roadway equipment at or near the intersection to preempt the signals (*local signal preemption request*) as the Emergency Vehicle approaches. The Roadway equipment may optionally notify the Traffic Management subsystem that it has been preempted (*right-of-way request notification*). This may be used by Traffic Management personnel to determine if the preemption capability is working appropriately, if it is being "abused" by any particular Emergency Vehicles, and correlate preemption actions with congestion due to de-synchronization of the traffic signal system caused by asynchronous preemptions.

10. The Emergency Vehicle may use short range communications to warn other vehicles in the vicinity (*emergency vehicle alert*) so that the vehicles can warn their drivers of an approaching emergency vehicle.

EM02: Emergency Routing (1 of 2)
(EM Center Information Collection and Care Facility Coordination)



EM02: Emergency Routing (2 of 2)
(Routing and Signal Preemption)



5.3 EM03: Mayday and Alarms Support

This service package allows the user (driver or non-driver) to initiate a request for emergency assistance and enables the Emergency Management Subsystem to locate the user, gather information about the incident, and determine the appropriate response. The request for assistance may be manually initiated or automated and linked to vehicle sensors. This service package also includes general surveillance capabilities that enable the Emergency Management Subsystem to remotely monitor public areas (e.g., rest stops, parking lots) to improve security in these areas. The Emergency Management Subsystem may be operated by the public sector or by a private sector telematics service provider.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. **Mayday originating from a Driver**. The Driver communicates a request for Mayday service to the Vehicle subsystem (*request for service*). Current vehicle location is determined (*position fix*) and an *emergency notification* message is transmitted to the Emergency Management subsystem, representing a Telematics Service Provider or other center that handles mayday messages. The Emergency Management Subsystem provides the incident information to the Emergency System Operator (*emergency operations status*), who verifies that an incident has occurred and assistance is needed, and determines and initiates an appropriate response (*emergency operations inputs*). The center acknowledges receipt of the Mayday (*emergency acknowledge*) and maintains contact with the driver (*driver updates*) as a response is initiated

2. When required, the verified incident information (*incident report*) is provided to the appropriate responding organization (e.g., the public safety answering point covering the vehicle's location), represented by "Other Emergency Management".

3. **Mayday originating from the Vehicle subsystem**. In this case, *basic vehicle measures* are monitored for indicators that an incident has occurred (e.g. airbag deployment, unusual vehicle attitude, extreme acceleration/deceleration). Current location is determined (*position fix*) and an *emergency notification* message is issued to the Emergency Management subsystem (as if the message was issued by a Driver). All other operations are the same as above except that instead of an emergency acknowledge message, an *emergency data request* message is issued to query the vehicle subsystem for any change in incident status. Depending on the scenario, additional emergency data requests may be issued for either driver or vehicle initiated Maydays and updated information is returned (*emergency notification*) for each request.

4. An *incident report* may be issued at the same time to another Emergency Management subsystem ("Other Emergency Management") for appropriate response or mutual aid in responding to the incident.

5. **Mayday originating from a Traveler with a Personal Information Access subsystem (PIAS).** The Traveler communicates a request for Mayday service to the PIAS (*traveler inputs*), which issues the *emergency notification* message to the Emergency Management subsystem, which forwards the information from the traveler to the Emergency System Operator (*emergency operations status*).

The operator returns an acknowledgment message using the same path back to the traveler (*emergency operations inputs*, *emergency acknowledge*, and *traveler interface updates*).

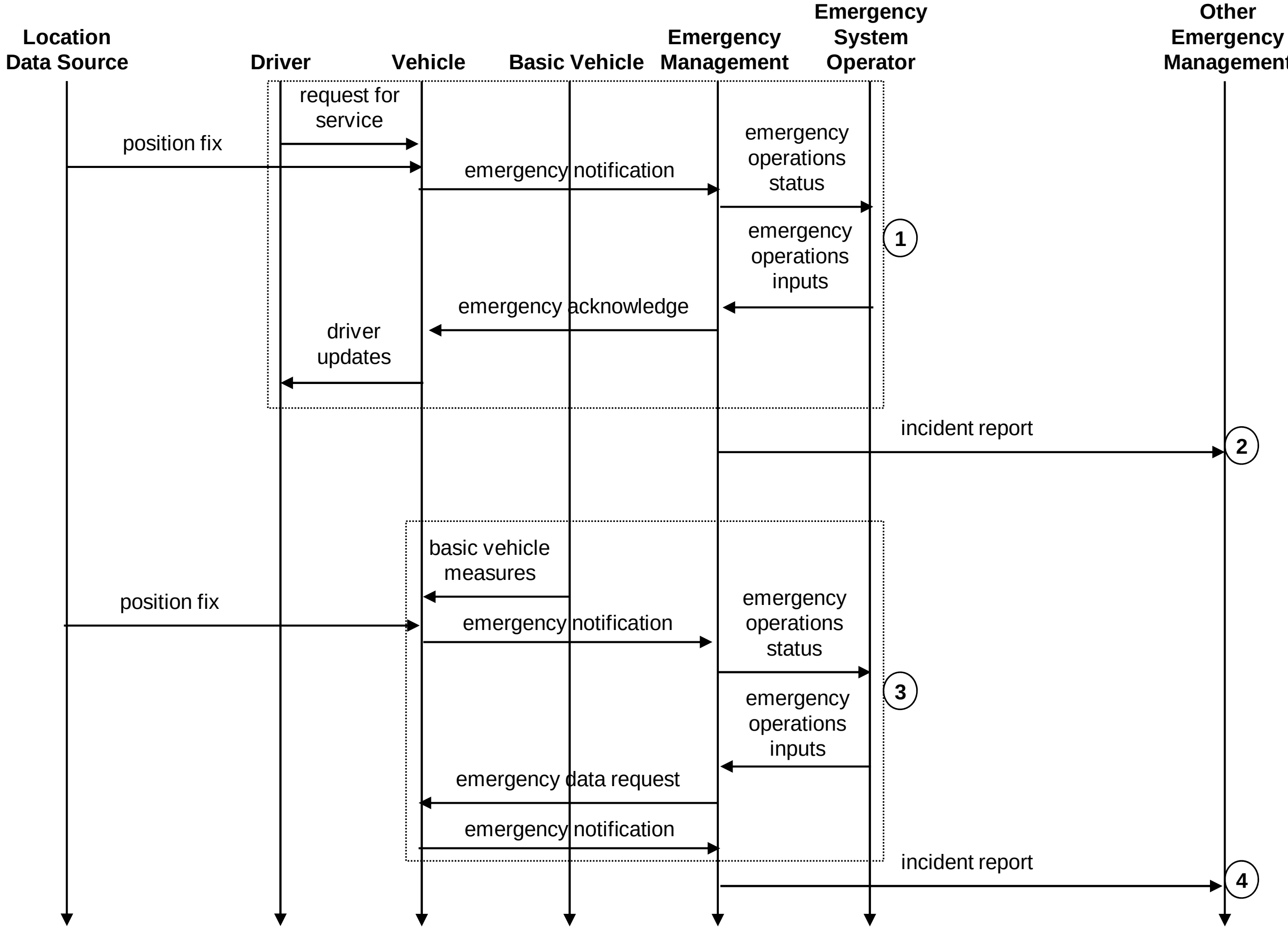
6. An *incident report* may be issued at the same time to another Emergency Management subsystem ("Other Emergency Management") for appropriate response or mutual aid in responding to the incident.

7. **Mayday originating from a Remote Traveler Support subsystem (RTS).** The Traveler communicates a request for Mayday service to the RTS (*traveler inputs*), which, issues the *alarm notification* message to the Emergency Management subsystem, which forwards the information from the traveler to the Emergency System Operator (*emergency operations status*). The operator returns an acknowledgment message using the same path back to the traveler (*emergency operations inputs*, *alarm acknowledge*, and *traveler interface updates*).

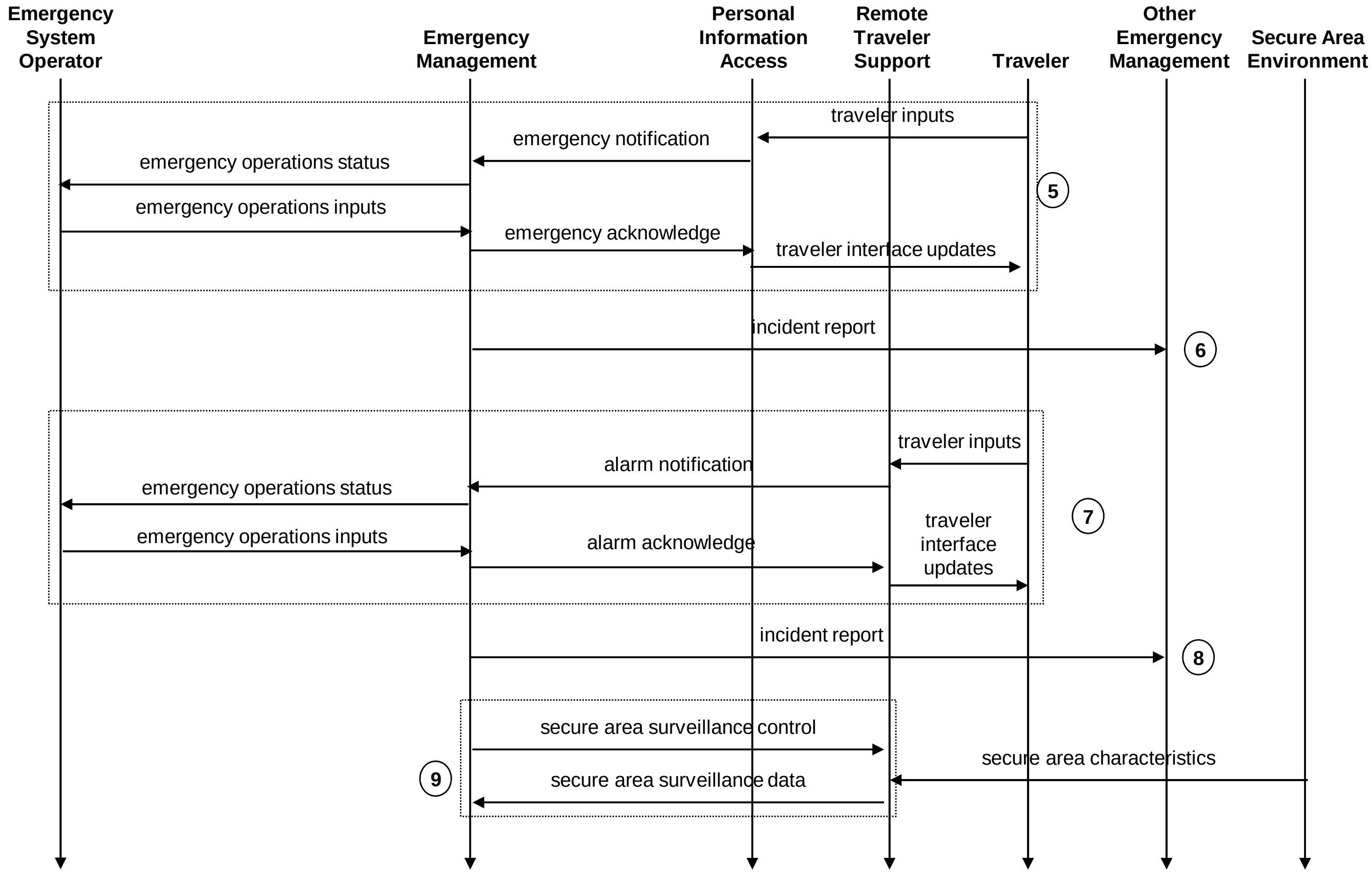
8. An *incident report* may be issued at the same time to another Emergency Management subsystem ("Other EM") for appropriate response or mutual aid in responding to the incident.

9. The Emergency Management subsystem may control the RTS surveillance equipment (*secure area surveillance control* e.g., pan/tilt/zoom for a CCTV camera) and receive *secure area surveillance data* including images and other surveillance data from the RTS in order to classify or monitor the incident. The actual environment that is monitored is represented by the *secure area characteristics* flow.

EM03: Mayday and Alarms Support (1 of 2)
(Vehicle Mayday)



EM03: Mayday and Alarms Support (2 of 2)
(PIAS or RTS Mayday)



5.4 EM04: Roadway Service Patrols

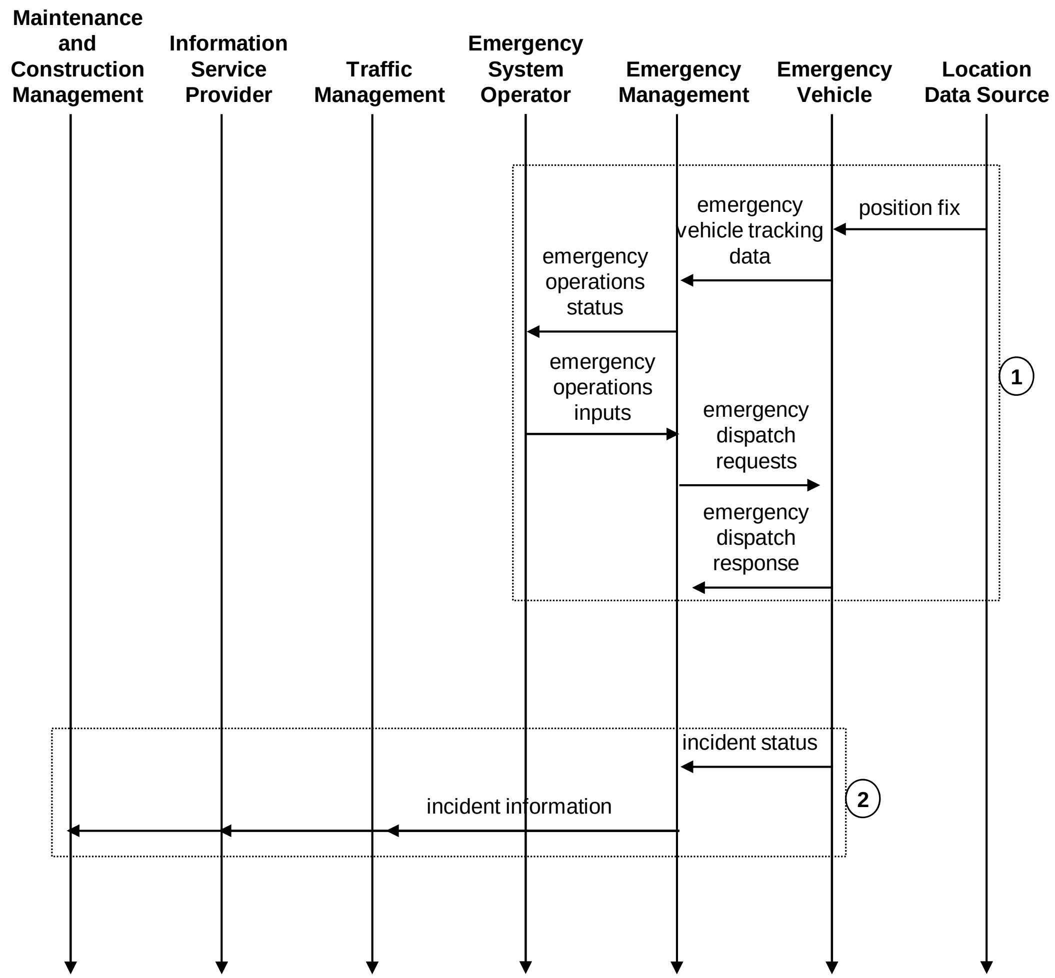
This service package supports roadway service patrol vehicles that monitor roads that aid motorists, offering rapid response to minor incidents (flat tire, accidents, out of gas) to minimize disruption to the traffic stream. If problems are detected, the roadway service patrol vehicles will provide assistance to the motorist (e.g., push a vehicle to the shoulder or median). The service package monitors service patrol vehicle locations and supports vehicle dispatch to identified incident locations. Incident information collected by the service patrol is shared with traffic, maintenance and construction, and traveler information systems.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Emergency Vehicle (i.e., the service patrol vehicle) determines its location (*position fix*) and reports its position and status to the Emergency Management dispatch function (*emergency vehicle tracking data*). Service patrol vehicle location and status is reported to the Emergency System Operator (*emergency operations status*). When necessary, the Emergency System Operator can enter commands (*emergency operations inputs*) that result in *emergency dispatch requests* to the service patrol vehicle. The dispatched vehicle can acknowledge the dispatch request (*emergency dispatch response*).

2. At the scene of an incident, the service patrol vehicle can report the *incident status* to the Emergency Management dispatch function, which can relay the status as *incident information* to Traffic Management (e.g. reporting the severity and estimated duration of an incident), Information Service Providers (e.g. to report the incident information to their clients) and Maintenance and Construction Management (e.g. for incident cleanup) as appropriate.

EM04: Roadway Service Patrols



5.5 EM05: Transportation Infrastructure Protection

This service package includes the monitoring of transportation infrastructure (e.g., bridges, tunnels and management centers) for potential threats using sensors and surveillance equipment and barrier and safeguard systems to control access, preclude an incident, and mitigate the impact of an incident if it occurs. Threats can result from acts of nature (e.g., hurricanes, earthquakes), terrorist attacks or other incidents causing damage to the infrastructure (e.g., stray barge hitting a bridge support). Infrastructure may be monitored with acoustic, environmental threat (such as nuclear, biological, chemical, and explosives), infrastructure condition and integrity, motion and object sensors and video and audio surveillance equipment. Data from such sensors and surveillance equipment may be processed in the field or sent to a center for processing. The data enables operators at the center to detect and verify threats. When a threat is detected, agencies are notified. Detected threats or advisories received from other agencies result in an increased level of system preparedness. In response to threats, barrier and safeguard systems may be activated by Traffic Management Subsystems to deter an incident, control access to an area or mitigate the impact of an incident. Barrier systems include gates, barriers and other automated and remotely controlled systems that manage entry to transportation infrastructure. Safeguard systems include blast shields, exhaust systems and other automated and remotely controlled systems that mitigate impact of an incident.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The process of transportation infrastructure protection is under the asynchronous monitoring and control of the Emergency System Operator. The Emergency System Operator monitors (*emergency operations status*) and controls (*emergency operations inputs*) the sensor and surveillance equipment used to monitor transportation infrastructure.

2. Physical and environmental characteristics such as visual, audible, chemical, biological, radiological, motion, and presence are monitored by surveillance and sensor systems (*secure area characteristics*). This equipment is located in areas frequented by travelers (Remote Traveler Support Subsystem, RTS) as well as areas typically away from travelers such as bridges, tunnels, etc. (Security Monitoring Subsystem, SMS).

3. Environmental threat sensors (e.g., thermal, acoustic, radiological, chemical), object, motion and intrusion detection sensors are used to detect threats to transportation infrastructure. These sensors are located at the RTS or the SMS. The Emergency Management Subsystem (EM) monitors the sensor outputs, receiving either raw sensor outputs or outputs that have been processed at the RTS or SMS (*secure area sensor data*). The EM also controls (*secure area sensor control*) the sensors and preliminary processing that may occur in the field.

4. Audio and video surveillance systems are used to monitor activity at and around transportation infrastructure. These systems can be located at the RTS or the SMS. The Emergency Management Subsystem monitors (*secure area surveillance data*) and controls (*secure area surveillance control*)

the surveillance systems. The RTS or SMS systems may process the data prior to sending *secure area surveillance data* to the EM.

5. Sensors located in the SMS are also used to monitor the condition or integrity of transportation infrastructure including bridges, tunnels, transit rail or guideways, etc. The Emergency Management Subsystem monitors the sensors (*infrastructure monitoring sensor data*) and controls (*infrastructure monitoring sensor control*) the sensors. The SMS sensors may process the data prior to sending *infrastructure monitoring sensor data* to the EM.

6. The Emergency Management Subsystem collects and/or processes the infrastructure condition and integrity data and provides *transportation system status* to the Traffic Management, Transit Management, Maintenance and Construction Management Subsystems.

7. The Maintenance and Construction Management Subsystem is responsible for maintenance and repair of the equipment used to monitor transportation infrastructure. The Emergency Management Subsystem notifies the Maintenance and Construction Management Subsystem of the current operation and fault status of the sensors or surveillance equipment (*security field equipment status*). When maintenance is performed, the Maintenance and Construction Management Subsystem notifies the Emergency Management Subsystem (*security equipment maintenance status*).

8. In addition to the data collected from its own sensors and surveillance equipment, the Emergency Management Subsystem receives information on imminent or in-progress threats or emergencies (*alerts and advisories*) from Alerting and Advisory Systems. In response to alerts and advisories, the Emergency Management Subsystem may heighten protection of transportation infrastructure.

9. The Emergency Management Subsystem coordinates and exchanges sensor and surveillance data and threat information (*threat information coordination*) and incident information (*incident report*) with Other Emergency Management systems.

10. The Emergency Management Subsystem analyzes and correlates the sensor and surveillance data it has collected, as well as threat data, alerts and advisories from other agencies. Based on this information, it detects and verifies threats, and then notifies (*threat information*) the Traffic Management, Transit Management, Maintenance and Construction Management Subsystems and Rail Operations.

11. In the event of a detected and verified threat to the transportation infrastructure, Emergency Management also notifies (*threat information*) Alerting and Advisory Systems. Emergency Management may send data from surveillance or sensor equipment (*threat data for analysis*) to Alerting and Advisory Systems for further analysis. Alerting and Advisory Systems may send additional information to assist Emergency Management Subsystem identify possible threats (*threat support data*).

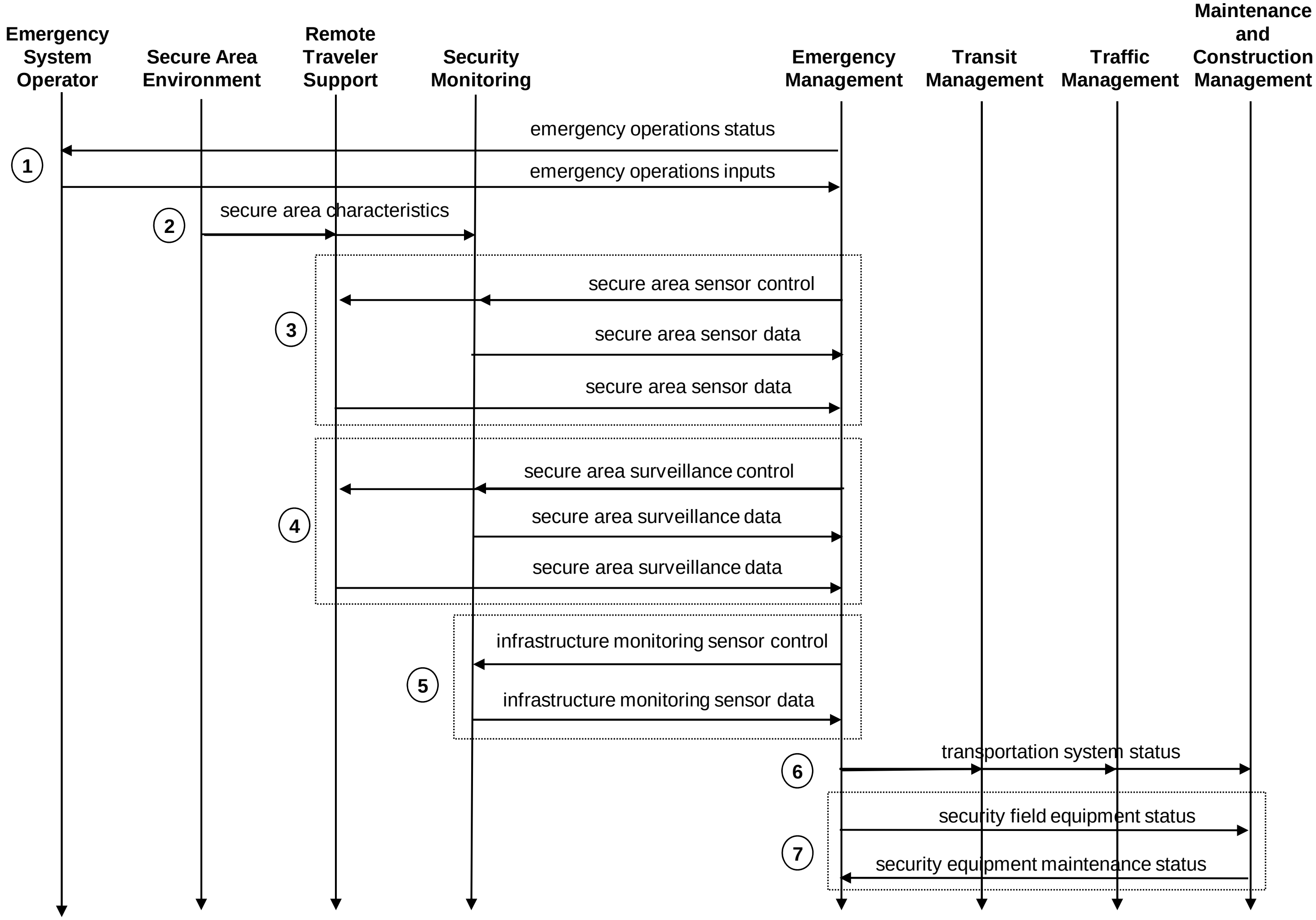
12. In response to a threat or a request (*emergency traffic control request*) from the Emergency Management Subsystem, barrier systems at the Roadway may be activated by Traffic Management Subsystems (*barrier system control*). Operational status of this equipment is monitored by the Traffic Management Subsystem (*barrier system status*). Barrier systems are operated under the command of the Traffic Systems Operator, which controls the systems (part of *traffic operator inputs*) and monitors the status of the equipment (part of *traffic operator data*). The barrier systems

might also be operated by Emergency Vehicle Subsystem commands. The Traffic Management Subsystem notifies the Emergency Management Subsystem (*emergency traffic control information*) when the barrier systems have been deployed.

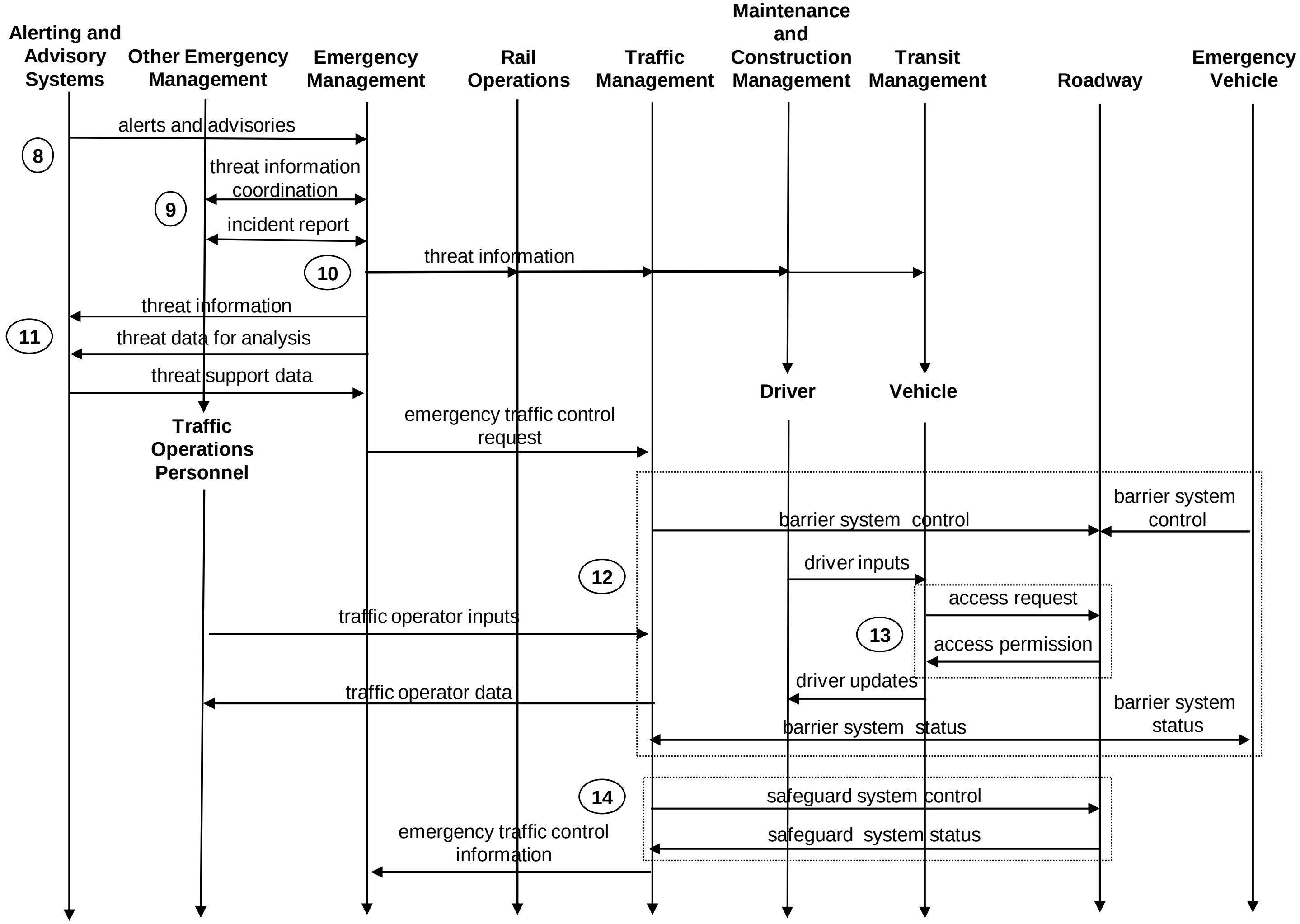
13. When a closure is in effect, the barrier system may grant access to selected vehicles (e.g., responders, residents). Using Field-Vehicle Communications, the Vehicle requests and receives permission to access the restricted area (*access request* and *access permission*). The Driver may provide information that supports the access request (*driver inputs*) and receives information indicating whether access has been granted (*driver updates*).

14. In response to a threat or a request (*emergency traffic control request*) from the Emergency Management Subsystem, safeguard systems such as blast shields and exhaust system at the Roadway may also be activated by Traffic Management Subsystems (*safeguard system control*). Operational status of this equipment is monitored by the Traffic Management Subsystem (*safeguard system status*). Safeguard systems are operated under the command of the Traffic Systems Operator, which controls the systems (part of *traffic operator inputs*) and monitors the status of the equipment (part of *traffic operator data*). The Traffic Management Subsystem notifies the Emergency Management Subsystem (*emergency traffic control information*) when the barrier systems and/or safeguard systems have been deployed.

EM05: Transportation Infrastructure Protection (1 of 2) (Monitoring)



EM05: Transportation Infrastructure Protection (2 of 2)
(Threat Notification and Response)



5.6 EM06: Wide-Area Alert

This service package uses ITS driver and traveler information systems to alert the public in emergency situations such as child abductions, severe weather events, civil emergencies, and other situations that pose a threat to life and property. The alert includes information and instructions for transportation system operators and the traveling public, improving public safety and enlisting the public's help in some scenarios. The ITS technologies will supplement and support other emergency and homeland security alert systems such as the Emergency Alert System (EAS). When an emergency situation is reported and verified and the terms and conditions for system activation are satisfied, a designated agency broadcasts emergency information to traffic agencies, transit agencies, information service providers, toll operators, and others that operate ITS systems. The ITS systems, in turn, provide the alert information to transportation system operators and the traveling public using ITS technologies such as dynamic message signs, highway advisory radios, in-vehicle displays, transit displays, 511 traveler information systems, and traveler information web sites.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The process begins when an alert is received by the Emergency Management Subsystem and is presented to the Emergency System Operator. Actual implementations must consider and allow for scenarios where multiple simultaneous alerts may be issued. This scenario describes the process of issuing a single isolated alert.

The alert may be received from Alerting and Advisory Systems (*alerts and advisories* – for example an alert received through the Emergency Alerting System) or from another Emergency Management Subsystem (*alert notification coordination* – for example, an alert generated by the state police). The alert information is presented to the Emergency System Operator (*emergency operations status*). The Emergency System Operator reviews the alert, determines whether a coordinated alert using traveler information systems is warranted, and initiates the wide-area alert for the region (*emergency operations inputs*). Alternatively, the Emergency System Operator may also be the source for alert information that is received through voice communications and entered directly (*emergency operations inputs*). The decision to issue a wide-area alert is coordinated with public safety and other allied organizations (*alert notification coordination*).

2. Under control of the Emergency System Operator, transportation system operators and traveler information providers for the region affected by the alert are notified (*alert notification*):

   - Information Service Provider
   - Traffic Management Subsystem
   - Transit Management Subsystem
   - Maintenance and Construction Management Subsystem
   - Payment Administration

The alert is also provided to the media via the Emergency Alerting System (EAS) or other mechanism, but the process for injecting alerts into the media is outside ITS and not covered by this transaction.

3. On receipt of the alert, the ISP presents the alert to the ISP Operator (*ISP operations information presentation*) who controls injection of the alert into the traveler information services operated by the ISP. The alert may be provided to travelers via:

    - Personal Information Access Subsystem (PIAS) representing personal computers, personal digital assistants (PDAs) and other personal devices.
    - Remote Traveler Support Subsystem (RTS) representing kiosks, public displays, and other public information access points.
    - Vehicle Subsystem (VS) representing in-vehicle driver information systems

As priority traveler information, the alert is broadcast to all active users (*emergency traveler information*). The *traveler interface updates* and *driver updates* flows represent the actual presentation of the alert information to the traveler and driver. The traveler (or driver in the case of the Vehicle Subsystem) can control or interact with the local device being used (*traveler inputs* for PIAS or RTS and *driver inputs* for the Vehicle.

Similarly, the alert is injected into voice-based traveler information systems such as 5-1-1 (*voice-based alert notification*). The basic alert information could be provided to all system users using a “floodgate” message – a default message presented to all users. Depending on the nature of the alert, additional detailed information may be accessed by request (*voice-based traveler request*).

Once the alerting capabilities provided by the ISP have been activated, the *alert status* is provided back to the Emergency Management Subsystem under control of the ISP operator (*ISP operator inputs*). Finally *emergency traveler information* can be shared with Other ISPs.

4. On receipt of the alert, the Traffic Management Subsystem (TMS) presents the alert to Traffic Operations Personnel (*traffic operator data*) who control formatting and injection of the alert into the driver information services provided by the TMS. An alert message may be formatted and sent to dynamic message signs, highway advisory radio, or other driver information systems in the roadway (*roadway information system data*). In some cases, the alert information may be more than can be presented on a DMS. In these cases, a brief notification message may be generated that alerts drivers and directs them to tune to a radio station or other source for additional information. The message that the driver sees on the driver information system is represented by the *driver information* flow. When the driver systems have been activated, as indicated by *roadway information system status*, the status of the alert is provided back to the Emergency Management Subsystem (*alert status*) as directed by Traffic Operations Personnel (*traffic operator inputs*).

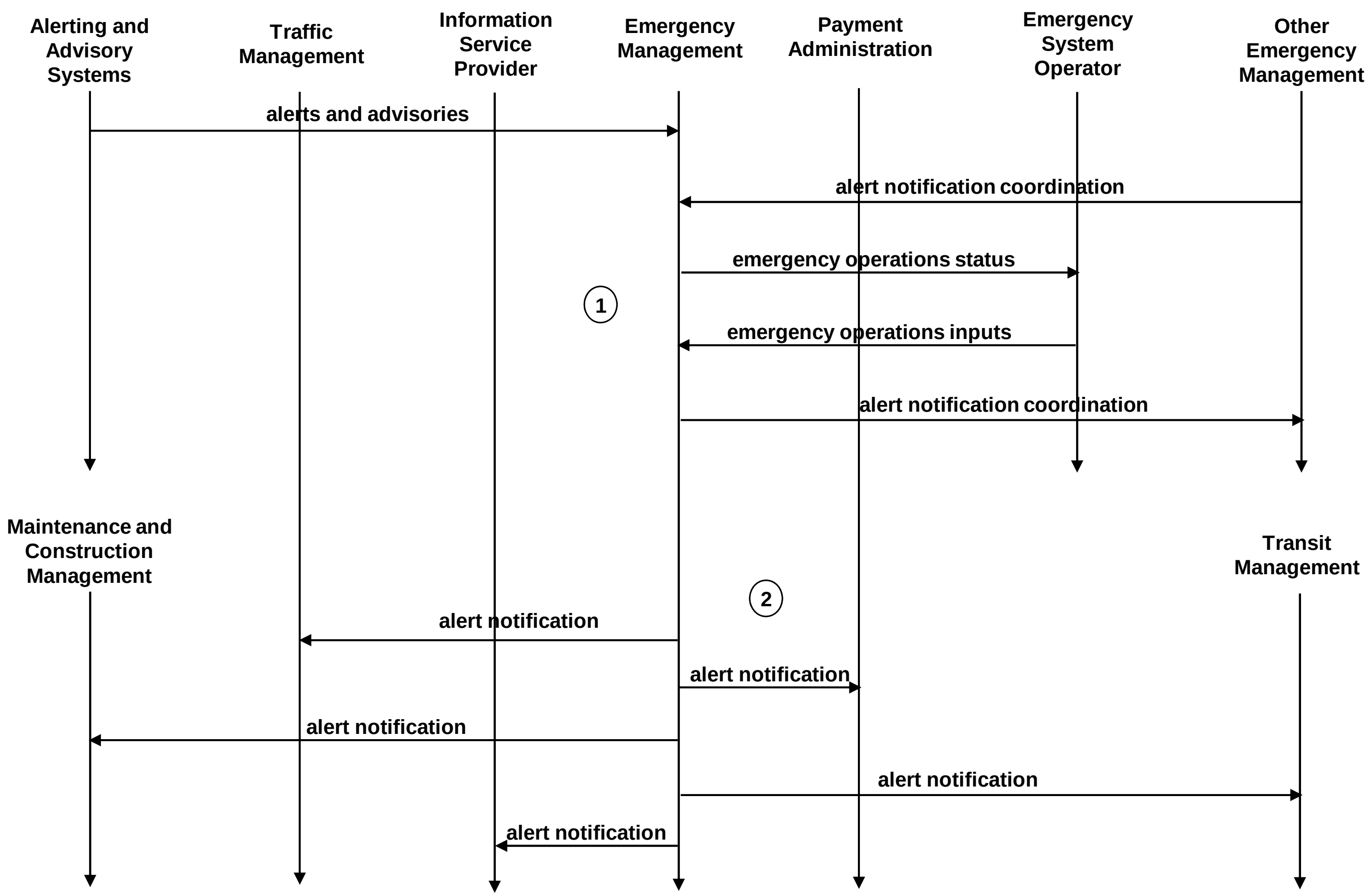
5. On receipt of the alert, the Transit Management Subsystem (TRMS) presents the alert to Transit Operations Personnel (*transit operations status*) who control formatting and injection of the alert into the traveler information services provided by the TRMS (*transit operations personnel inputs*). The alert information is provided to transit vehicle operators (*transit vehicle operator information*) and also to travelers (*transit traveler information*) through kiosks and information displays operated by the transit agency (which are represented by the Remote Traveler Support subsystem) and on-board vehicle displays that provide information to passengers (on-board the Transit Vehicle

Subsystem). The *traveler interface updates* flow represents the actual presentation of the alert information to the traveler. *Traveler inputs* represents the actual input from the traveler that requests more information.

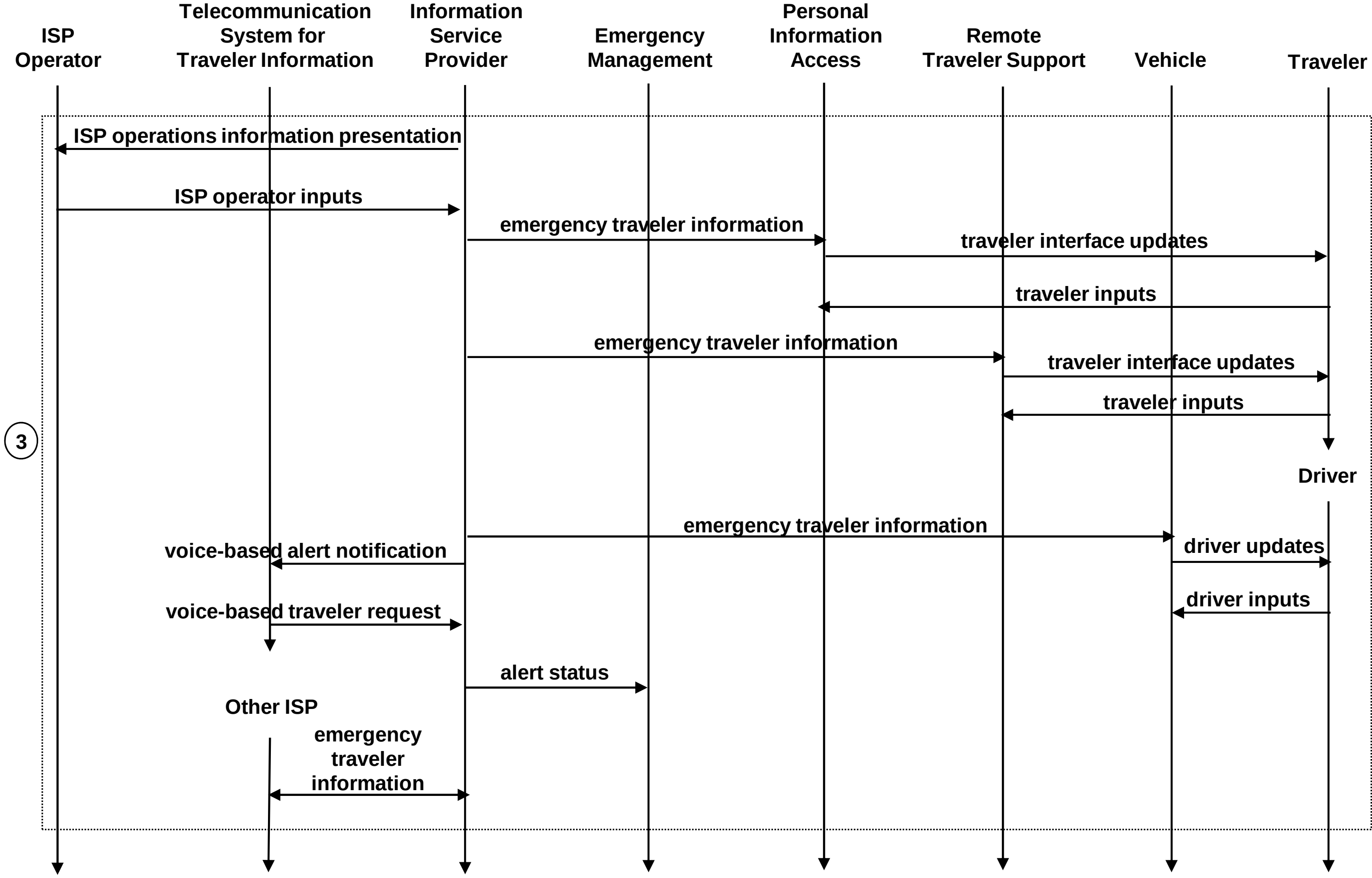
6. The Maintenance and Construction Management Subsystem also receives and presents the alert to Maintenance and Construction Center Personnel (*maint and constr operations information presentation*). Maintenance and Construction personnel control the distribution of the alert throughout the maintenance and construction organization (*maint and constr center personnel inputs*). In this case, the purpose of the alert is to notify maintenance and construction personnel in the field that should be cognizant of active alerts for their own safety and so they can participate in alerts like child abduction alerts (Amber Alerts) where assistance in locating a suspect is requested. *Alert status* is reported back to the Emergency Management Subsystem confirming receipt and distribution of the alert.

7. The Payment Administration Subsystem also receives and presents the alert to the Payment Administrator (*toll information presentation*). The Payment Administrator controls distribution of the alert within the toll organization (*payment administration requests*). This distribution includes distribution to toll operators working at toll plazas (*toll advisories*). As with Maintenance and Construction, the purpose of the alert is to notify agency personnel that should be cognizant of active alerts for their own safety and so they can participate in alerts like child abduction alerts (Amber Alerts). Alert status is reported back to the Emergency Management Subsystem confirming receipt and distribution of the alert, again under control of the Payment Administrator (*payment administration requests*).

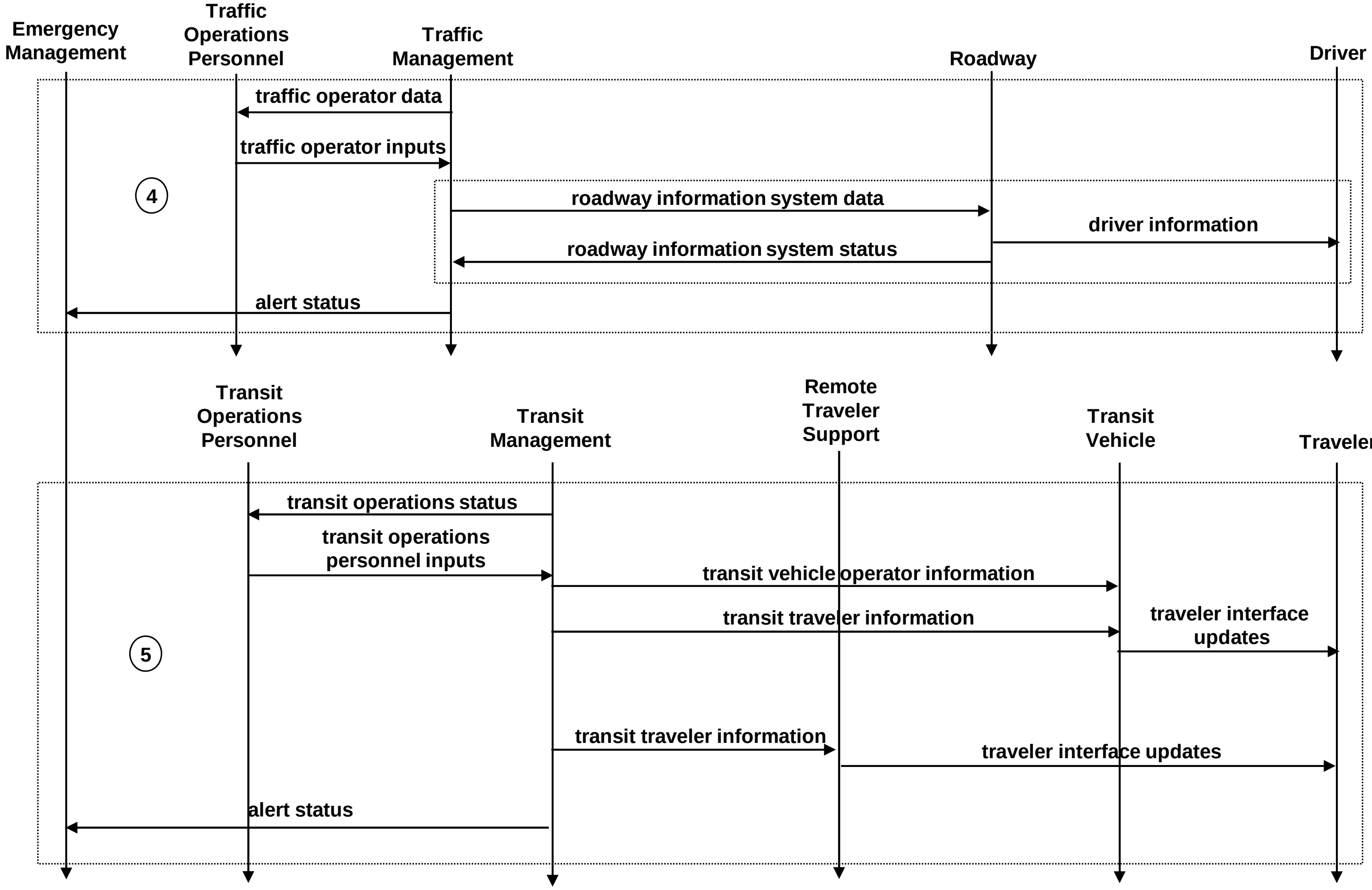
EM06: Wide-Area Alert (1 of 4)
(Issue the Alert)



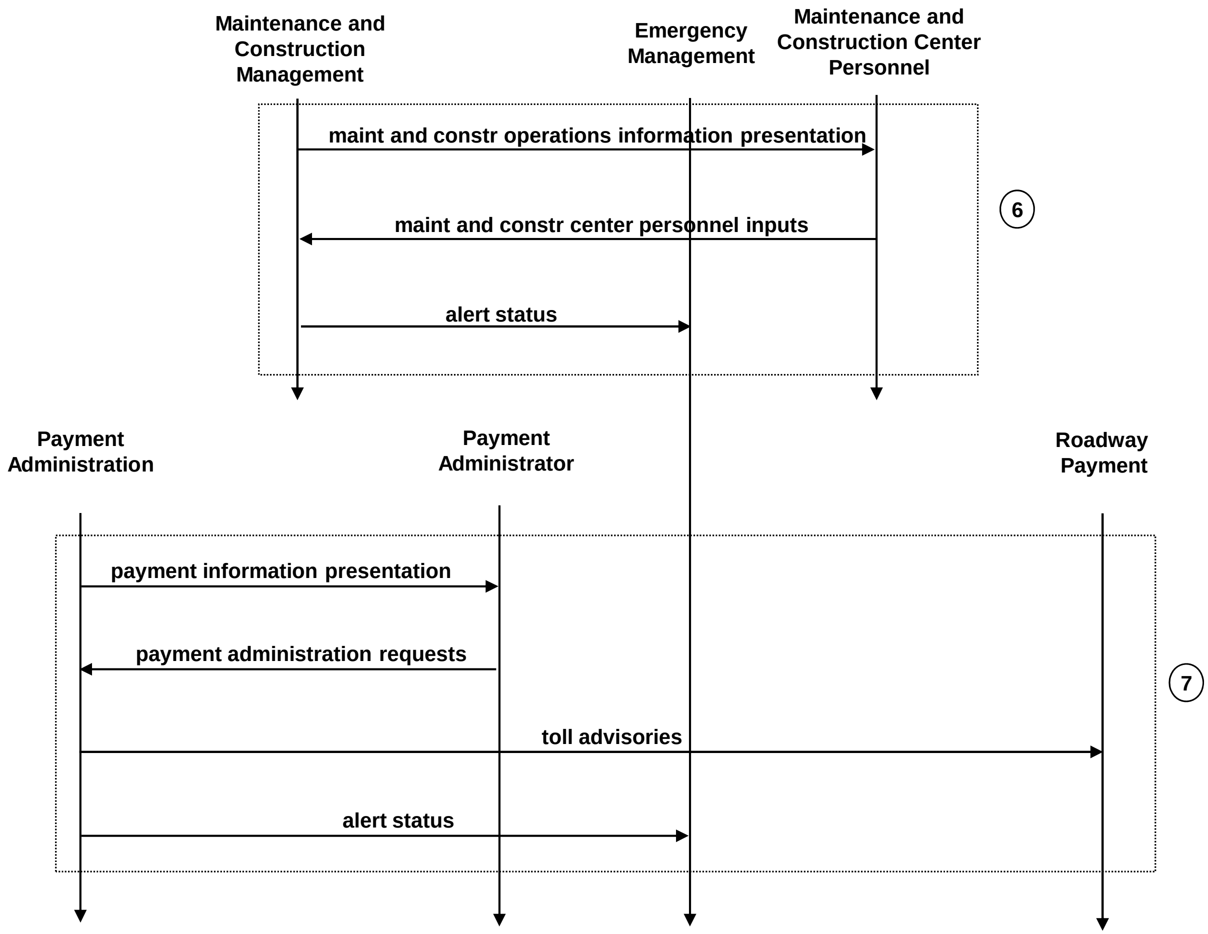
EM06: Wide-Area Alert (2 of 4) (ISP Alert Processing)



EM06: Wide-Area Alert (3 of 4)
(Traffic and Transit Management Alert Processing)



EM06: Wide-Area Alert (4 of 4)
(Maintenance and Toll Alert Processing)



5.7 EM07: Early Warning System

This service package monitors and detects potential, looming, and actual disasters including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents, nuclear power plant accidents, and acts of terrorism including nuclear, chemical, biological, and radiological weapons attacks). The service package monitors alerting and advisory systems, ITS sensors and surveillance systems, field reports, and emergency call-taking systems to identify emergencies and notifies all responding agencies of detected emergencies.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Emergency Management Subsystem detects major incidents and disasters that are reported by other agencies by monitoring and collecting information from:

    - Alerting and Advisory Systems (*alerts and advisories*): This represents systems such as the Information Sharing and Analysis Centers (ISACs), the National Infrastructure Protection Center (NIPC), the Homeland Security Advisory System (HSAS), and other systems that provide intelligence about potential, imminent, or actual attacks on the transportation infrastructure or its supporting information systems.
    - Other Emergency Management (*incident report*, *threat information coordination*): This represents local, regional, state, and federal public safety, emergency management, and other allied incident response agencies.
    - Weather Service (*weather information*): Weather watches and warnings issued by the National Weather Service
    - Surface Transportation Weather Service (*transportation weather information*). Weather information available through other specialized weather organizations; specific information may also be requested (*transportation weather information request*).

Each of these inputs are asynchronous and may occur concurrently; reports from individual systems may overlap. The Emergency System Operator monitors these inputs (*emergency operations status*) and identifies events that may be applicable to the region. All the numbered items below are controlled by the emergency system operator through asynchronous input from the Emergency System Operator (*emergency operations inputs*).

2. Early Warning Systems may be equipped with their own network of sensors and surveillance systems that provide additional intelligence of potential threats and status of reported incidents. The information supplied in the previous step may increase the alert level of the system. In response, the Emergency Management Subsystem can increase surveillance and sensor monitoring, for example by activating surveillance systems (*secure area surveillance control*) or adjusting the alarm thresholds of threat sensors (*secure area sensor control*). The returned data (*secure area surveillance data*, *secure area sensor data*) is processed by the Emergency Management Subsystem and presented to the Emergency System Operator (*emergency operations status*).

3. Asynchronously and concurrently with the previous steps, incident information is also reported to the Emergency Management Subsystem by transportation agencies:

    - Traffic Management Subsystem (*incident information*)
    - Maintenance and Construction Management Subsystem (*incident information*)
    - Transit Management Subsystem (*transit emergency data*)

4. The compiled information on identified threats (*threat information coordination*) and major incidents (*incident report*) is shared with other Emergency Management Subsystems.

5. *Incident information* and *threat information* is also shared with transportation agencies – the Traffic Management Subsystem, Transit Management Subsystem, and Maintenance and Construction Management Subsystem. This information can be used to increase preparedness as threats are identified or initiate an emergency response when a major incident or disaster is actually detected.

Steps 1-5 illustrate the process where a regional early warning system collects available threat and incident information and provides an early warning service for transportation agencies in the region. Alternatively, or in addition to this approach, transportation agencies can also directly subscribe to and/or monitor alerts and advisories provided by Alerting and Advisory Systems such as the Information Sharing and Analysis Centers (ISACs), the National Infrastructure Protection Center (NIPC), and the Homeland Security Advisory System (HSAS). This direct input is shown in steps 6 through 8.

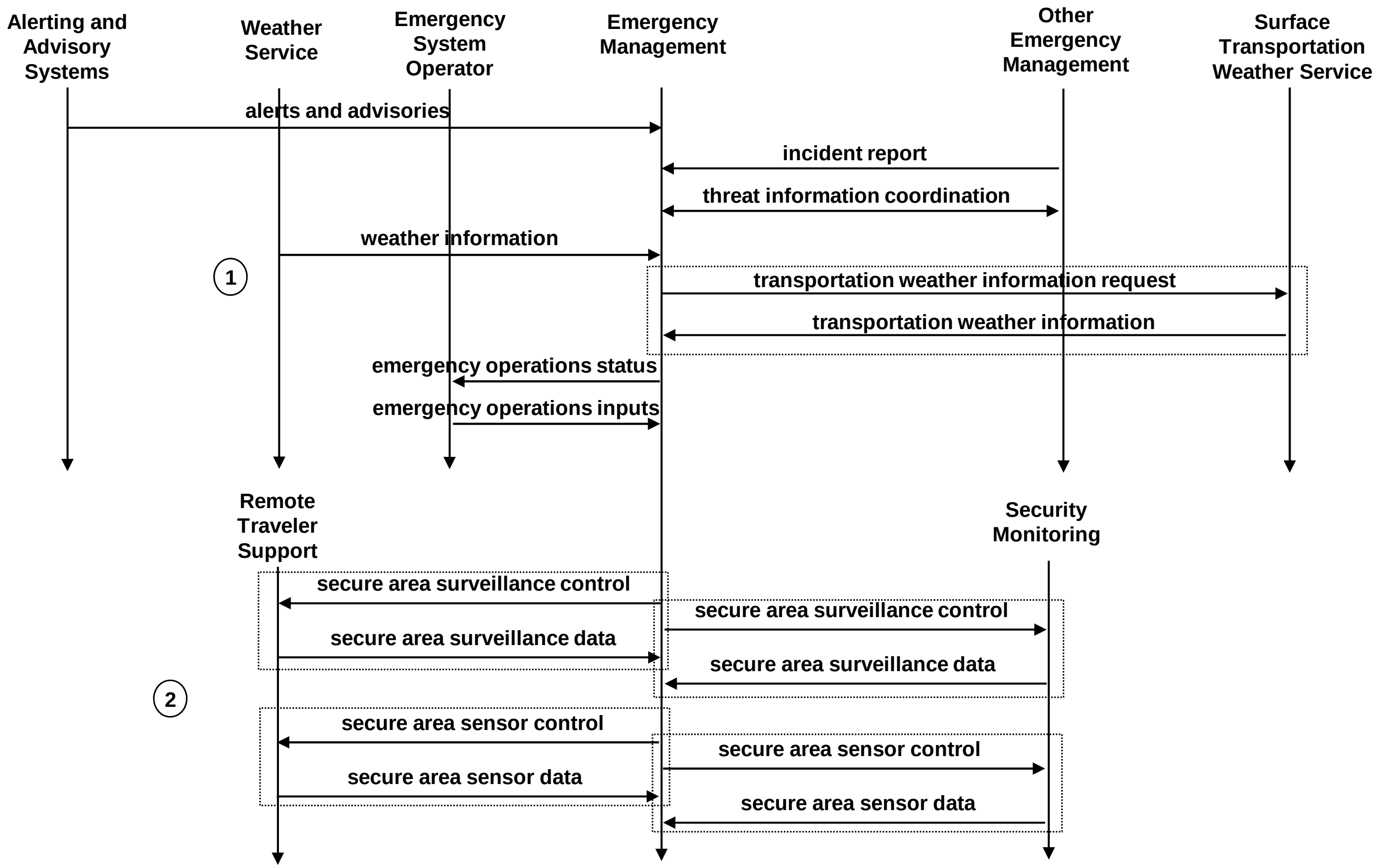
6. The Maintenance and Construction Management Subsystem monitors threat assessments, alerts, and advisories reported by the Alerting and Advisory Systems (*alerts and advisories*). These reports and the incident and threat information provided in step 5 are presented to Maintenance and Construction Center Personnel (*maint and constr operations information presentation*) who use this information to adjust system operation to increase preparedness and/or initiate an immediate response as appropriate (*maint and constr center personnel inputs*).

7. The Traffic Management Subsystem monitors threat assessments, alerts, and advisories reported by the Alerting and Advisory Systems (*alerts and advisories*). These reports and the incident and threat information provided in step 5 are presented to Traffic Operations Personnel (*traffic operator data*) who use this information to adjust system operation to increase preparedness and/or initiate an emergency response as appropriate (*traffic operator inputs*).

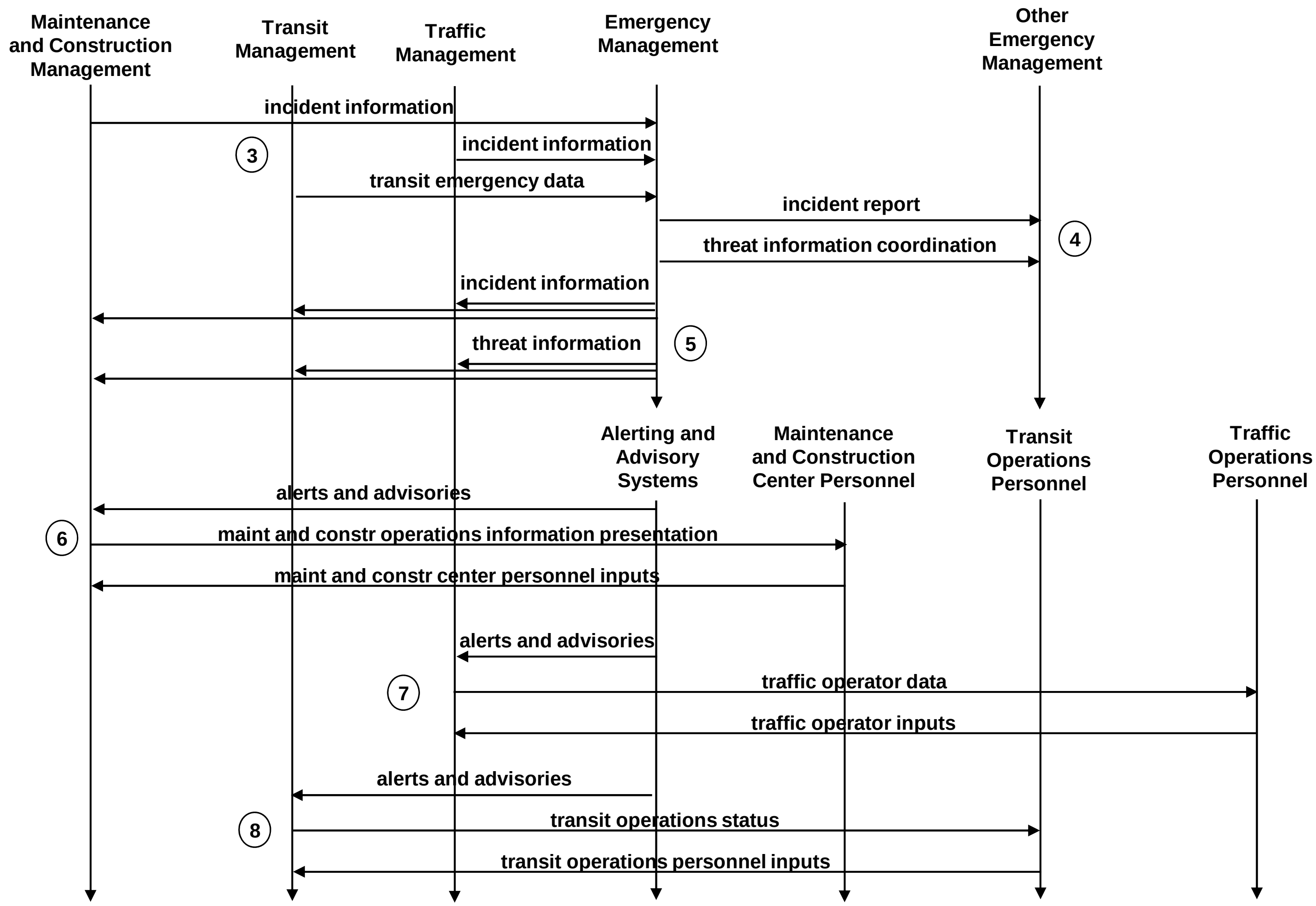
8. The Transit Management Subsystem also monitors threat assessments, alerts, and advisories reported by the Alerting and Advisory Systems (*alerts and advisories*). These reports and the incident and threat information provided in step 5 are presented to Transit Operations Personnel (*transit operations status*) who use this information to adjust system operation to increase preparedness and/or initiate an emergency response as appropriate (*transit operations personnel inputs*).

9. The process associated with increasing preparedness and responding to the threat or actual emergency based on the early warning is covered under service packages EM05: Transportation Infrastructure Protection and EM08: Disaster Response and Recovery.

EM07: Early Warning System (1 of 2) (Monitoring and Surveillance)



EM07: Early Warning System (2 of 2) (Warning Reporting)



5.8 EM08: Disaster Response and Recovery

This service package enhances the ability of the surface transportation system to respond to and recover from disasters. It addresses the most severe incidents that require an extraordinary response from outside the local community. All types of disasters are addressed including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents, nuclear power plant accidents, and national security emergencies such as nuclear, chemical, biological, and radiological weapons attacks).

The service package supports coordination of emergency response plans, including general plans developed before a disaster as well as specific tactical plans with short time horizon that are developed as part of a disaster response. The service package provides enhanced access to the scene for response personnel and resources, provides better information about the transportation system in the vicinity of the disaster, and maintains situation awareness regarding the disaster itself. In addition, this service package tracks and coordinates the transportation resources - the transportation professionals, equipment, and materials - that constitute a portion of the disaster response.

The service package identifies the key points of integration between transportation systems and the public safety, emergency management, public health, and other allied organizations that form the overall disaster response. In this service package, the Emergency Management subsystem represents the federal, regional, state, and local Emergency Operations Centers and the Incident Commands that are established to respond to the disaster. The interface between the Emergency Management Subsystem and the other center subsystems provides situation awareness and resource coordination among transportation and other allied response agencies. In its role, traffic management implements special traffic control strategies and detours and restrictions to effectively manage traffic in and around the disaster. Maintenance and construction provides damage assessment of road network facilities and manages service restoration. Transit management provides a similar assessment of status for transit facilities and modifies transit operations to meet the special demands of the disaster. As immediate public safety concerns are addressed and disaster response transitions into recovery, this service package supports transition back to normal transportation system operation, recovering resources, managing on-going transportation facility repair, supporting data collection and revised plan coordination, and other recovery activities.

This service package builds on the basic traffic incident response service that is provided by ATMS08, the Traffic Incident Management service package. This service package addresses the additional complexities and coordination requirements that are associated with the most severe incidents that warrant an extraordinary response from outside the local jurisdictions and require special measures such as the activation of one or more emergency operations centers. Many users of the National ITS Architecture will want to consider both ATMS08 and this service package since every region is concerned with both day-to-day management of traffic-related incidents and occasional management of disasters that require extraordinary response.

Disaster Response and Recovery is also supported by EM10, the "Disaster Traveler Information" service package that keeps the public informed during a disaster response. See that service package for more information.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Emergency plans are coordinated between emergency management, public safety, transportation, and other allied agencies that manage or participate in disaster response. This *emergency plan coordination* begins prior to a disaster as region-wide and agency-specific plans are developed and coordinated. Later, when a disaster occurs, tactical plans with specific objectives and time horizons are also developed and coordinated on the same interfaces. Plan coordination is asynchronous and on-going before, during, and after a disaster as lessons-learned are incorporated into the plans.

2. The process of detecting and verifying a disaster is covered by service package EM07: Early Warning System. For transportation, one of the first activities following a disaster is an immediate assessment of the regional transportation system, identifying damage incurred by the disaster and remaining capacity and transportation resources that are still operating and available. Each operating agency ascertains and reports the operating status of its own facilities in this step and the following step.

A complete assessment of road network status is derived from inputs from Asset Management systems (*asset damage assessment*), sensors, surveillance, field equipment diagnostics, and inspections that may be compiled and shared between Maintenance and Construction and Traffic Management (*road network status assessment*).

3. Each mode and jurisdiction provides an overall assessment to the Emergency Operations Center (EOC), represented by the Emergency Management Subsystem. In addition to infrastructure damage, each assessment identifies alternative routes and resources and identifies and coordinates closure of high-risk facilities such as bridges, tunnels, or at-risk sections of roadway.

    - Traffic Management Subsystem (*road network status assessment*)
    - Transit Management Subsystem (*transit system status assessment*)
    - Maintenance and Construction Management Subsystem (*road network status assessment*)
    - Rail Operations (*rail system status assessment*)

4. The Emergency Management Subsystem compiles an overall assessment of transportation system status and makes this assessment available to transportation operators in the region (*transportation system status*). Depending on the disaster scenario, agency-specific, regional, state, and federal EOCs may be activated. A current assessment of *transportation system status* is shared between these EOCs, represented by communication between the Emergency Management Subsystem and Other Emergency Management.

5. For emergencies that involve bio-hazards or other threats to public health, public health organizations may be queried as a response is formulated. Recommended courses of action (*public*

health response) are provided to the Emergency Management Subsystem on request (*public health request*).

6. In parallel with the previous steps, a multi-agency response to the disaster is unfolding. An incident command system is established by first responders in proximity to the disaster and communications are established between the Incident Command and Public Safety Communications Centers, and other centers, providing situation awareness and coordinating needed resources (represented by the flow *incident command information coordination* between EM and Other Emergency Management). One or more emergency operations centers may be established to oversee the response to large, multi-jurisdictional disaster areas. Continual coordination and liaison is established and maintained between all of the EOCs (*incident response status*) involved in disaster response operations. Emergency System Operators, representing emergency personnel in each of the operation centers, may provide status updates and query the system (*emergency operations inputs*) and receive current situation information (*emergency operations status*) on an on-going basis throughout the response and recovery operation.

Current *incident response status* is shared with transportation systems in the region (Traffic Management Subsystem, Transit Management Subsystem, Maintenance and Construction Management Subsystem, and Rail Operations), providing situation awareness for transportation system operators in the disaster area. This response status is updated as the response evolves and continues as the response transitions into recovery. The information provided would include EOC activation information and location and status of incident command(s) and staging area(s). Representatives from transportation agencies in the region provide staff support to the Emergency Operations Center(s) as they are activated. Coordination between Emergency Management Subsystems provides situation awareness and resource coordination among allied response agencies (*incident response coordination*).

7. Maintenance and Construction Center Personnel manage the Maintenance and Construction Management Subsystem's disaster response. They review the collected road network status information, incident reports, and resource requests received during the response (*maint and constr operations information presentation*) and mobilize resources for clean-up, repair, and recovery operations (*maint and constr center personnel inputs*). Maintenance and construction resources are requested to remove debris, perform repairs, and other response and recovery activities. These requests may be for pre-staging, staging, or immediate dispatch of resources, depending on the scenario. Depending on DOT organization, these resource requests may be made to a traffic operations center (*resource request*) represented by the Traffic Management Subsystem, which then makes a request to the appropriate Maintenance and Construction Management Subsystem (MCMS) (*maint and constr resource request*). The MCMS either services the request locally, or may in turn relay the request to other districts/jurisdictions (*maint and constr resource coordination* going to Other Maintenance and Construction Management) if the request for resources cannot be met locally. The Other Maintenance and Construction Management system would respond back to the requesting system with *maint and constr resource coordination*. A response to the resource request is provided from the MCMS to the TMS that indicates the status of resources that will be deployed (*maint and constr resource response*). When the Traffic Management Subsystem has made the request on behalf of another system (e.g., an EOC), the resource deployment status is provided back to the EM's resource management/tracking system that made the request (*resource deployment status*).

8. Alternatively, the Emergency Management Subsystem can request resources directly from the Maintenance and Construction Management Subsystem (*maint and constr resource request*/ *maint and constr resource response*). As in the previous step, this request is serviced under control of the Maint and Constr Center Personnel and may be locally serviced or it may be coordinated between maintenance districts/jurisdictions.

9. As part of the disaster response, transit resources may be used to move responders to/from the disaster area. Transit services may also be adjusted to meet transit needs created by the impact of the disaster on the transportation system and travel patterns. Service changes and transit resources are requested by EM (*emergency transit service request*), the ability of the transit system to service the request is determined by the Transit Operations Personnel (*transit operations status*/*transit operations personnel inputs*), and a response is provided indicating the availability of the requested service or resources (*emergency transit service response*). As with other requests, the service requests may be for pre-staging, staging, or immediate dispatch of the transit resources.

10. Updated transit service information for the disaster area is made available to other transportation agencies and emergency response agencies (*emergency transit schedule information*). Updated service schedules are coordinated across jurisdictions (*transit service coordination*) and may reflect additional transit services that temporarily replace transport capacity lost to disaster damage.

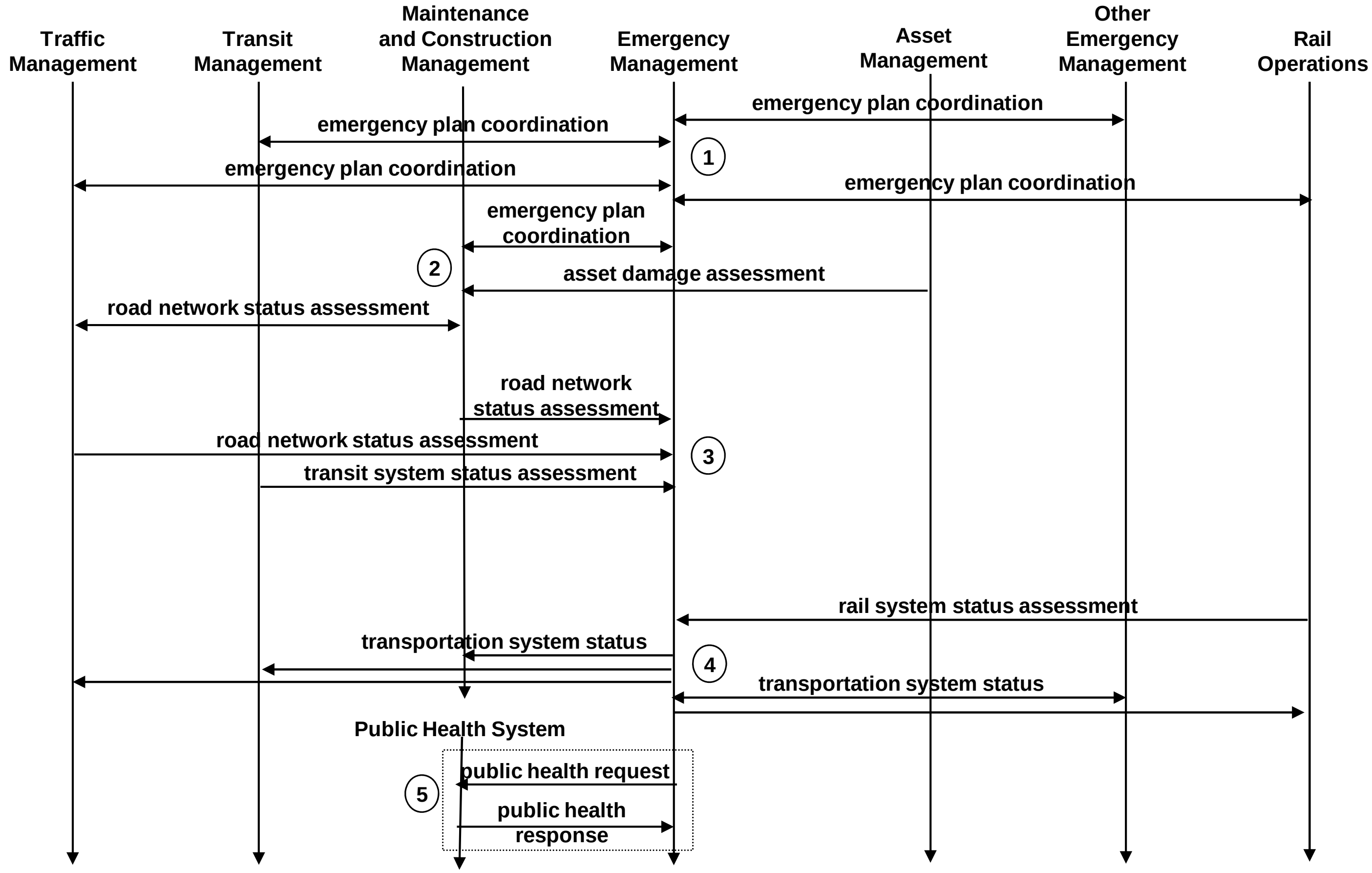
11. By definition, a disaster response exceeds the capabilities of the local responding agencies and may require resources from other regions, states, and the federal government. Comprehensive resource management principals are followed and a common resource tracking system coordinates resource requests and current resource status among all responding agencies (*resource coordination*). Resources include, but are not limited to, transportation equipment (e.g., maintenance and construction equipment, transit vehicles, passenger and utility vans, portable signs, trucks and/or trailers, aircraft and associated ground and operations personnel), transportation facilities (e.g., vehicle repair facilities, fleet parking and storage areas, motor pool and vehicle service facilities, operational centers, surveillance equipment), and transportation personnel (personnel resources including special certifications/skills as applicable).

12. Current *road network conditions* for the area surrounding the disaster, including detours and closures, are provided by the Traffic Management Subsystem. In circumstances where the installed monitoring infrastructure has been impacted by the disaster, or does not meet the special monitoring needs in the disaster, portable equipment may be installed to supplement existing surveillance capabilities. The Traffic Management Subsystem response is under continuous and asynchronous monitoring and control of Traffic Operations Personnel (*traffic operator inputs*/*traffic operator data*).

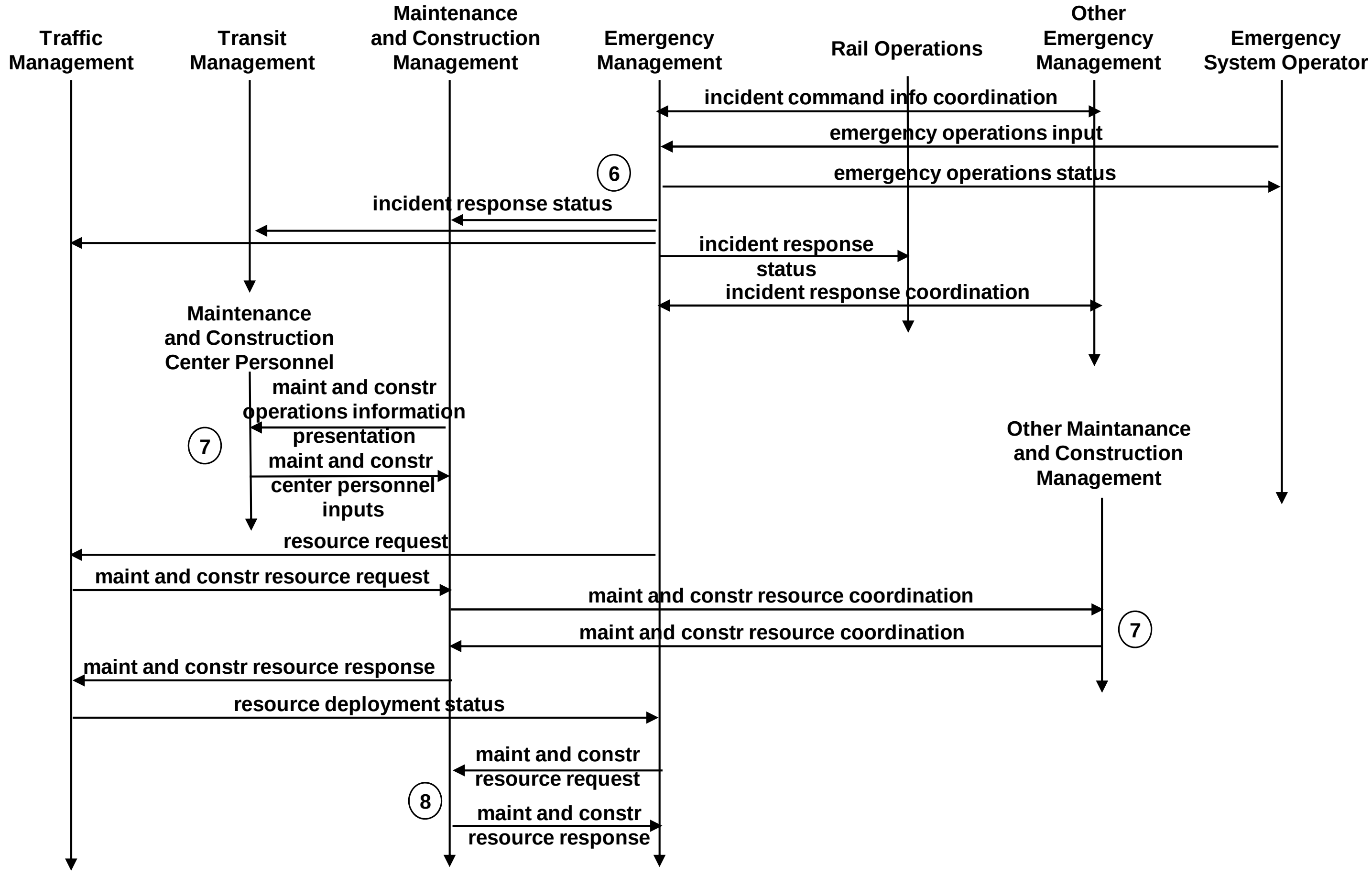
Emergency access to the disaster area is established and coordinated between the Traffic Management and Emergency Management Subsystems. Specific traffic management actions are identified to maintain a smooth flow for transport of emergency resources, including traffic control points, barricade plans, and potential one-way/reverse lane operations. The Emergency Management Subsystem, representing an EOC, may make direct traffic control requests to the Traffic Management Subsystem to establish and maintain access (*emergency traffic control request*). These requests may preempt the current traffic control strategy in effect at one or more signalized intersections or highway segments, activate traffic control and closure systems such as gates and barriers, activate safeguard systems, or use driver information systems such as DMS or HAR. The Traffic Management Subsystem returns information indicating the Traffic Management Subsystem's status in implementing the traffic control request (*emergency traffic control information*). The same architecture flow carries information indicating the status of requested emergency access routes.

13. Traffic information and control are coordinated across traffic management jurisdictions (*emergency traffic coordination*). In addition to normal coordination to facilitate traffic control at jurisdictional boundaries, this coordination allows one center to take over for another center in scenarios where local center operations are impacted by the disaster.

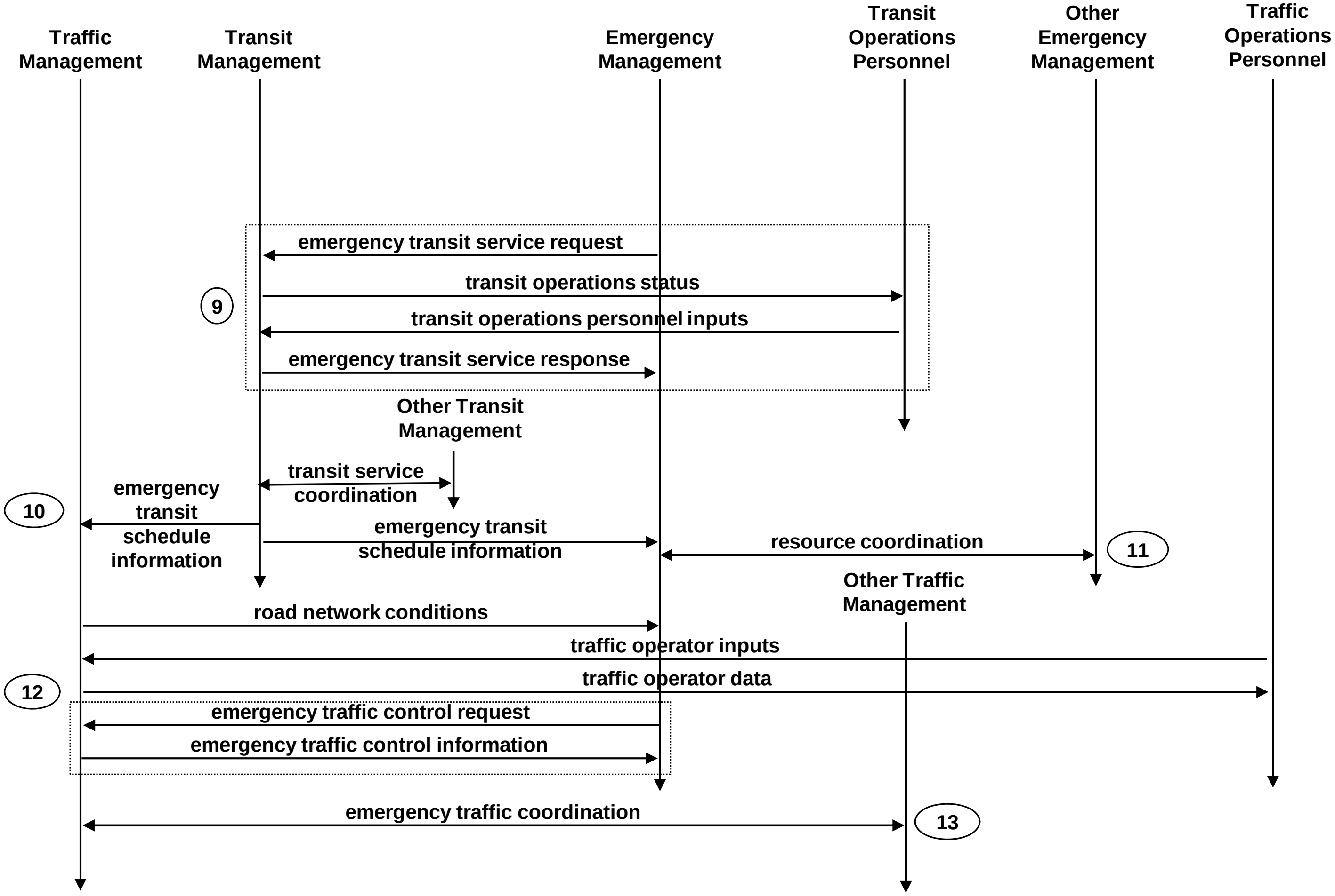
EM08: Disaster Response and Recovery (1 of 3)
(Plan Coordination and Damage Assessment)



EM08: Disaster Response and Recovery (2 of 3)
(Response and Recovery Coordination 1)



EM08: Disaster Response and Recovery (3 of 3)
(Response and Recovery Coordination 2)



5.9 EM09: Evacuation and Reentry Management

This service package supports evacuation of the general public from a disaster area and manages subsequent reentry to the disaster area. The service package addresses evacuations for all types of disasters, including disasters like hurricanes that are anticipated and occur slowly, allowing a well-planned orderly evacuation, as well as disasters like terrorist acts that occur rapidly, without warning, and allow little or no time for preparation or public warning.

This service package supports coordination of evacuation plans among the federal, state, and local transportation, emergency, and law enforcement agencies that may be involved in a large-scale evacuation. All affected jurisdictions (e.g., states and counties) at the evacuation origin, evacuation destination, and along the evacuation route are informed of the plan. Information is shared with traffic management agencies to implement special traffic control strategies and to control evacuation traffic, including traffic on local streets and arterials as well as the major evacuation routes. Reversible lanes, shoulder use, closures, special signal control strategies, and other special strategies may be implemented to maximize capacity along the evacuation routes. Transit resources play an important role in an evacuation, removing many people from an evacuated area while making efficient use of limited capacity. Additional shared transit resources may be added and managed in evacuation scenarios. Resource requirements are forecast based on the evacuation plans, and the necessary resources are located, shared between agencies if necessary, and deployed at the right locations at the appropriate times.

Evacuations are also supported by EM10, the "Disaster Traveler Information" service package, which keeps the public informed during evacuations. See that service package for more information.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The evacuation process is asynchronously monitored (*emergency operations status*) and managed (*emergency operations inputs*) by the Emergency System Operator and the operators of the other systems involved in this process. Note that while evacuation strategies are implemented under system operator control, the evacuation itself may begin spontaneously as the public reacts to disasters that may have little or no forewarning.

2. Evacuation plans are developed at the county, state, and multi-state levels and coordinated between emergency management, public safety, transportation, and other allied agencies that manage evacuation and reentry. In the National ITS Architecture this is represented as *emergency plan coordination* between Emergency Management Subsystem (EM) and Other Emergency Management, Traffic Management Subystem (TMS), Maintenance and Construction Management Subsystem (MCMS), Transit Management Subsystem (TRMS), and Rail Operations. This coordination begins prior to an evacuation as regional plans are developed for anticipated evacuation scenarios. These plans coordinate evacuation routes across jurisdictional boundaries and supporting models allow evacuation route designs to be reviewed and modified if necessary to support planned

evacuation strategies. During an actual evacuation, the plans may be tailored and coordinated in near real-time to account for the specific scope and nature of the disaster and unanticipated system impacts and requirements. Modeling and simulation tools may be used in the future to tailor plans in near real-time. Plan coordination is asynchronous and on-going before, during, and after an evacuation as lessons-learned are incorporated into the plans.

3. For emergencies that involve bio-hazards or other threats to public health, public health organizations may be queried as evacuation requirements are determined. Recommended courses of action (*public health response*) are provided to the Emergency Management Subsystem on request (*public health request*).

4. When evacuation is required, an evacuation strategy is identified and current and forecast evacuation information is shared with transportation, emergency management, law enforcement, and other allied agencies at the county, multi-county, and multi-state levels, represented by the following National ITS Architecture entities:

    - Other Emergency Management (*evacuation coordination*)
    - Traffic Management (*evacuation information*)
    - Transit Management (*evacuation information*)
    - Maintenance and Construction Management (*evacuation information*)
    - Rail Operations (*evacuation information*)
    - Shelter Providers (*evacuation information*)

This coordination includes the evacuated counties (evacuation origins), host and response counties (evacuation destinations and counties that provide assistance in the evacuation process) and counties on evacuation routes. Coordination across state boundaries is also important where applicable to ensure that evacuees from one state do not compound evacuation problems in another state.

The evacuation information includes the evacuation strategy, specifying evacuation times and routes, evacuating the population in shifts to reduce demand where possible. It also provides current and forecast status information as the evacuation progresses. The evacuation information is continuously updated and made available throughout the evacuation and reentry process. This on-going coordination keeps participating agencies appraised of current evacuation status. Examples of events that require on-going coordination during an evacuation include new events (e.g., additional disasters, secondary incidents) that require evacuation strategy changes, potential decision to terminate an evacuation under emergency circumstances, and reentry decisions and information.

5. Shelter providers, such as the American Red Cross, establish shelters at evacuation destinations that provide basic shelter, food, and health services to evacuees. The shelter provider coordinates with the Emergency Management Subsystem to identify evacuation destinations and anticipate sheltering needs. Where feasible, shelters are identified close to evacuation origins to reduce demand on overtaxed transportation facilities. Specific evacuation destination and shelter information is coordinated with the Emergency Management Subsystem (*shelter information*).

6. Changes in toll facility operation to support evacuation, including temporary lifting of tolls and changes in toll facility restrictions, are coordinated with the Payment Administration Subsystem (*toll service change request*, *toll service change response*).

7. Maintenance and construction resources are requested to clear evacuation routes, control access, and provide other evacuation-support tasks. These requests may be for pre-staging, staging, or immediate dispatch of resources, depending on the scenario. The Emergency Management Subsystem requests resources to support the evacuation plan (*maint and constr resource request*). These requests are provided to the Maintenance and Construction Center Personnel (*maint and constr operations information presentation*). The MCMS, under control of Maintenance and Construction Center Personnel (*maint and constr center personnel inputs*), services the request and provides a response to the resource request that indicates the status of resource request (*maint and constr resource response*).

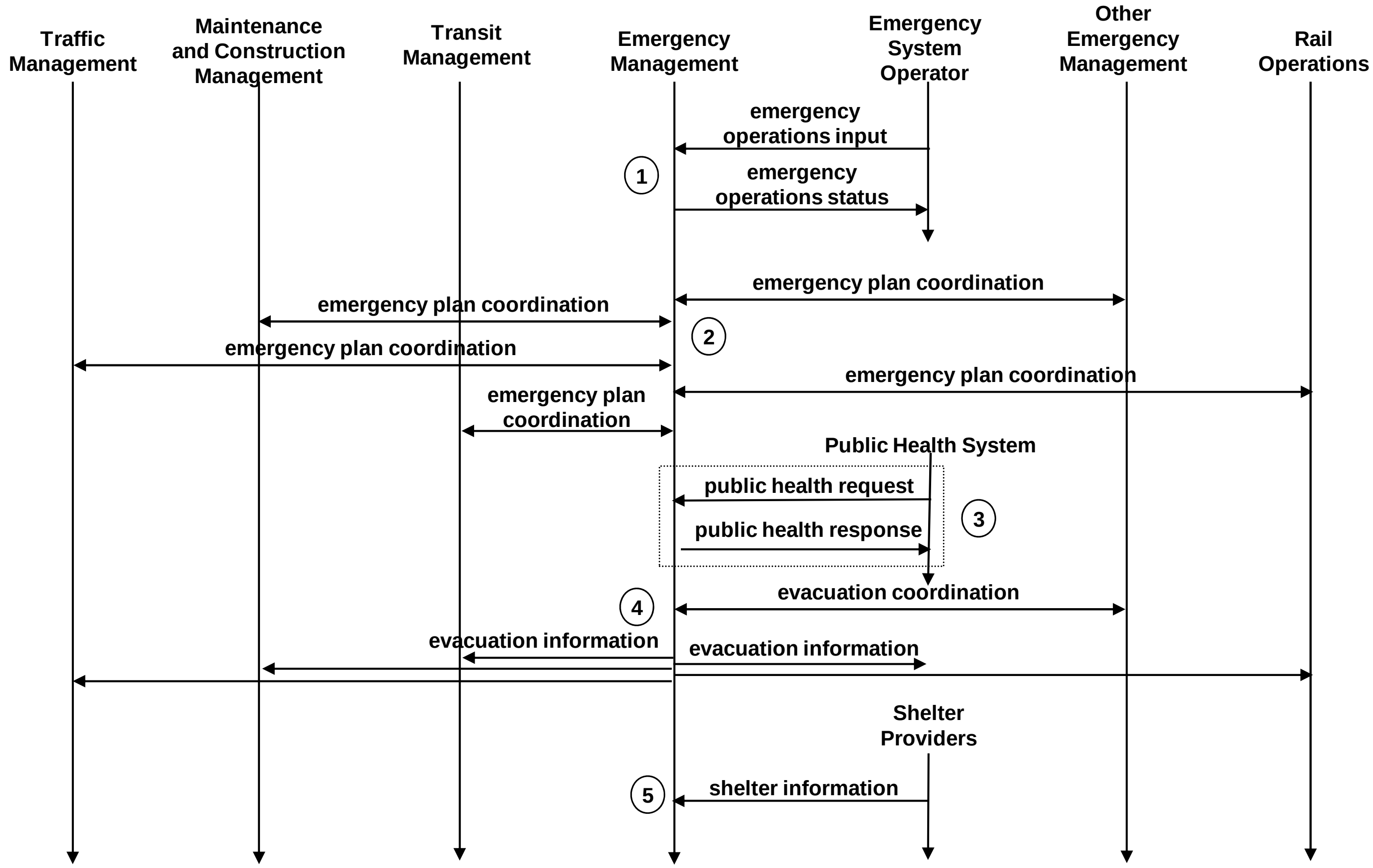
8. Transit resources play an important role in an evacuation, removing many people from an evacuated area while making efficient use of limited capacity. Transit also plays a critical role in evacuation of those with special needs. Additional shared transit resources may be added and managed in evacuation scenarios to meet these needs. Service changes and transit resources are requested (*emergency transit service request*), and provided to the Transit Operations Personnel (*transit operations status*). The ability of the transit system to service the request is determined by the Transit Operations Personnel (*transit operations personnel inputs*), and a response is issued indicating the availability of the requested service or resources (*emergency transit service response*). As with other requests, the service requests that request resources may request pre-staging, staging, or immediate dispatch of the transit resources.

9. Transit service changes are coordinated with other transportation agencies, emergency response agencies, and traveler information providers (*emergency transit schedule information*).

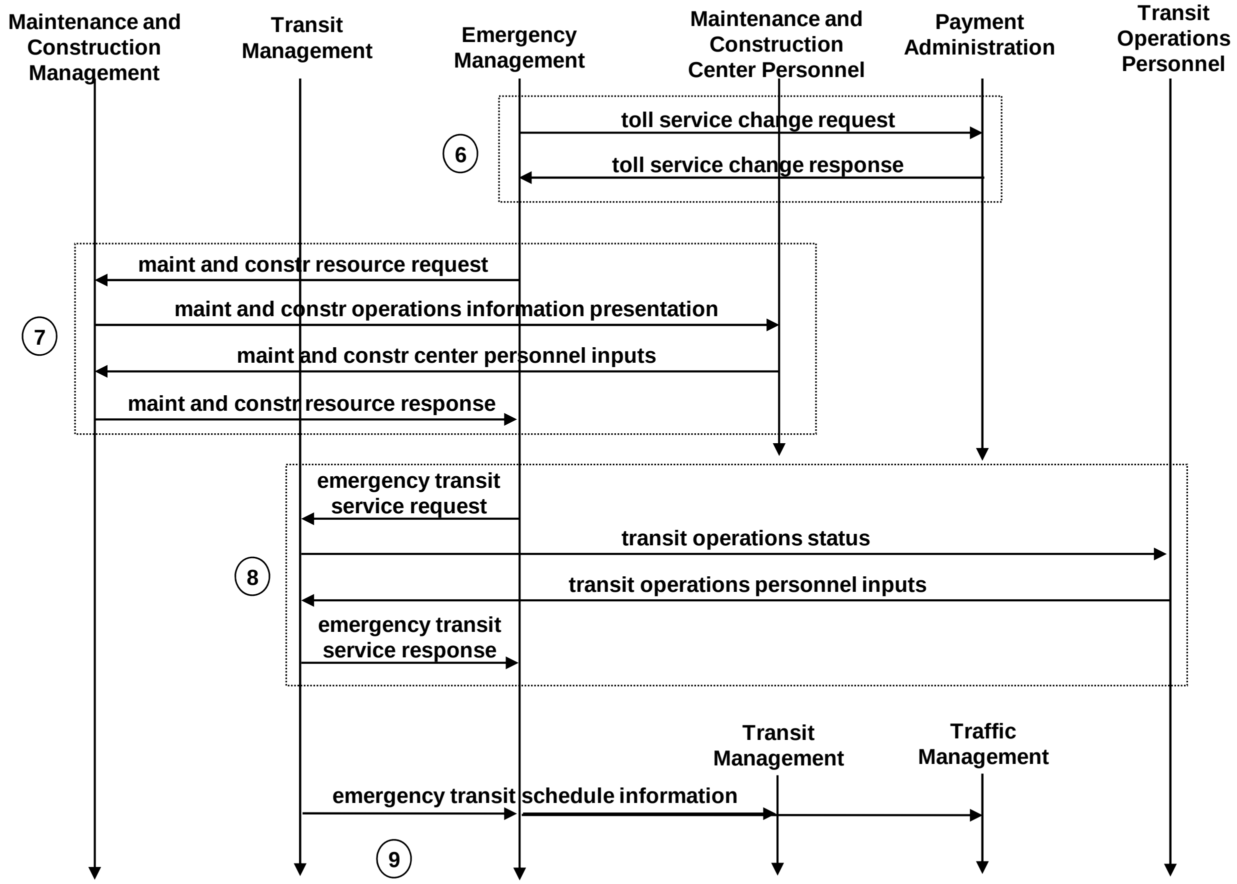
10. The Traffic Management Subsystem adapts the traffic control strategy to simultaneously meet the needs of the evacuation while maintaining ingress and egress routes to the disaster for emergency response personnel. Special traffic control strategies are implemented to control evacuation traffic, including traffic on local streets and arterials as well as the major evacuation routes. Reversible lanes, shoulder use, closures, special signal control strategies, and other special strategies may be implemented to maximize capacity along the evacuation routes. The Emergency Management Subsystem may make explicit traffic management requests (*emergency traffic control request*), or the Traffic Management Strategy can adapt system operation based on the evacuation strategy provided by the Emergency Management Subsystem earlier in the process. In both cases, the evacuation and reentry traffic control strategy is under the asynchronous monitoring and control of the Traffic Operations Personnel (*traffic operator inputs* / *traffic operator data*). The traffic control strategy is updated over the course of the evacuation and again during reentry. The current traffic control strategy is made available to the Emergency Management Subsystem (*emergency traffic control information*).

11. Traffic information and control are coordinated across traffic management jurisdictions. The sharing of traffic control responsibilities between centers (*emergency traffic coordination*) allows one center to take over for another center in scenarios where local center operations are impacted by the disaster.

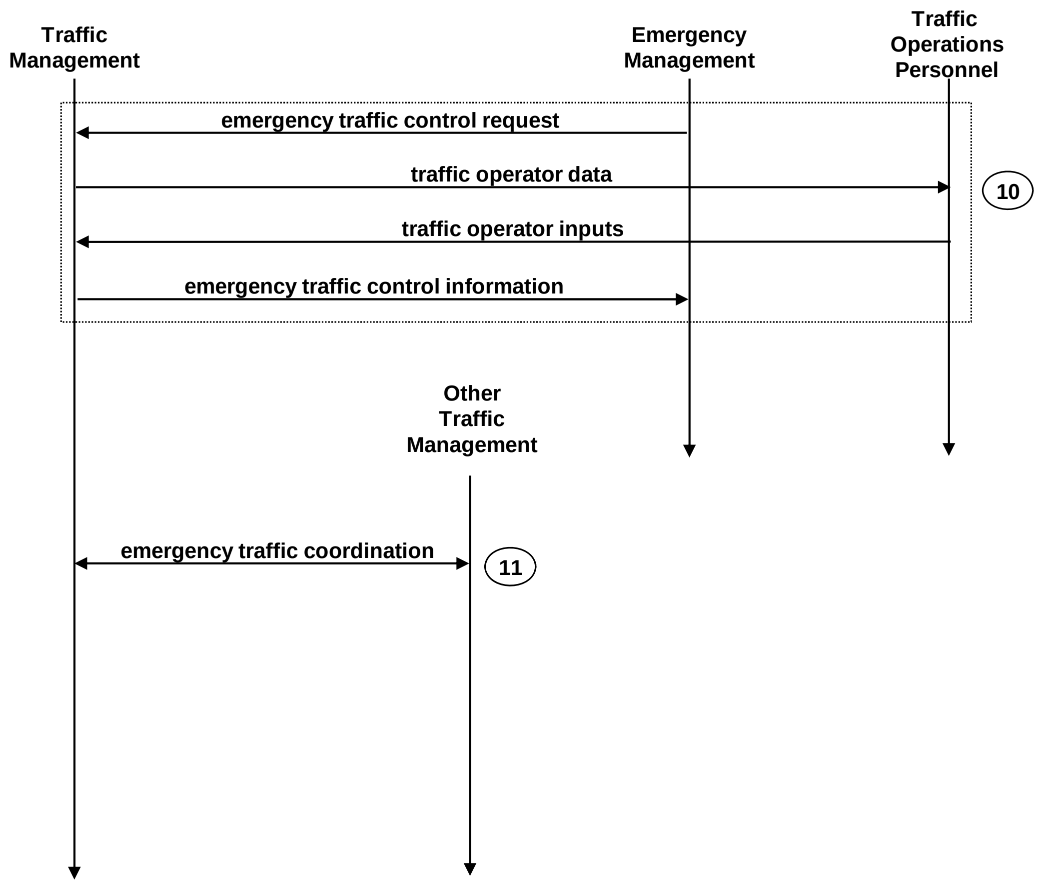
EM09: Evacuation and Reentry Management (1 of 3)
Planning and Strategy Coordination



EM09: Evacuation and Reentry Management (2 of 3) (Evacuation Operations 1)



EM09: Evacuation and Reentry Management (3 of 3) (Evacuation Operations 2)



5.10 EM10: Disaster Traveler Information

This service package uses ITS to provide disaster-related traveler information to the general public, including evacuation and reentry information and other information concerning the operation of the transportation system during a disaster. This service package collects information from multiple sources including traffic, transit, public safety, emergency management, shelter provider, and travel service provider organizations. The collected information is processed and the public is provided with real-time disaster and evacuation information using ITS traveler information systems.

A disaster will stress the surface transportation system since it may damage transportation facilities at the same time that it places unique demands on these facilities to support public evacuation and provide access for emergency responders. Similarly, a disaster may interrupt or degrade the operation of many traveler information systems at the same time that safety-critical information must be provided to the traveling public. This service package keeps the public informed in these scenarios, using all available means to provide information about the disaster area including damage to the transportation system, detours and closures in effect, special traffic restrictions and allowances, special transit schedules, and real-time information on traffic conditions and transit system performance in and around the disaster.

This service package also provides emergency information to assist the public with evacuations when necessary. Information on mandatory and voluntary evacuation zones, evacuation times, and instructions are provided. Available evacuation routes and destinations and current and anticipated travel conditions along those routes are provided so evacuees are prepared and know their destination and preferred evacuation route. Information on available transit services and traveler services (shelters, medical services, hotels, restaurants, gas stations, etc.) is also provided. In addition to general evacuation information, this service package provides specific evacuation trip planning information that is tailored for the evacuee based on origin, selected destination, and evacuee-specified evacuation requirements and route parameters.

This service package augments the ATIS service packages that provide traveler information on a day-to-day basis for the surface transportation system. This service package provides focus on the special requirements for traveler information dissemination in disaster situations.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous monitoring (*ISP operations information presentation*) and control (*ISP operator inputs*) by the ISP Operator.

2. Concurrently and asynchronously, information is collected by the Information Service Provider from many sources. The ISP collects from the Emergency Management Subsystem information characterizing the disaster (*incident information*), its impact on the transportation system and

alternative transportation services that are available (*transportation system status*), and evacuation instructions and information (*evacuation information*).

3. The ISP collects care facility information, identifying permanent and temporary facilities providing emergency healthcare, including facility type and capabilities, facility status, and ability to admit new patients (*care facility status*).

4. The ISP collects weather information, including weather watches and warnings and other severe weather information (*weather information*) as well as weather information tailored to surface transportation (*transportation weather information*) based on request parameters (*transportation weather information request*).

5. The ISP collects *travel service information* from Yellow Pages Service Providers, including information on basic travel services in the disaster area, along evacuation routes, and at evacuation destinations. Services include lodging, restaurants, fueling stations, retail, rest areas, and restrooms. This information can be tailored based on a *travel service information request*.

6. The ISP collects transit service information, including special transit services supporting transport in the disaster area and evacuation (*emergency transit schedule information*).

7. The ISP collects current traffic and road information for the disaster area, evacuation routes, and evacuation destinations (*road network conditions*, *traffic images* and *incident information*) from the Traffic Management Subsystem (TMS). This includes detours and restrictions, closure information, road conditions, and current and forecast traffic conditions.

8. The ISP collects *shelter information* from Shelter Providers, including location, hours of operation, special accommodations, and current vacancy/availability information.

Information collected by the ISP from some sources may come as the result of a specific request or be obtained through subscriptions. With subscriptions, providers may send periodic or as-needed updates.

9. In order to assure that the collected disaster information gets the broadest possible distribution, the ISP shares *emergency traveler information* with Other ISPs.

10. Asynchronously, and as often as desired, Travelers may enter requests for information (*traveler inputs*) into the Personal Information Access Subsystem (PIAS) (e.g. personal computing device). Requests may be for personalized evacuation route information, information for a particular route in a disaster area, or any other specific traveler request. The traveler request could be satisfied locally based on information that was previously downloaded, but more likely, the request is in turn made to the ISP (*emergency traveler information request*). This request elicits a specific response (*emergency traveler information*) from the ISP. This information is provided to the Traveler by the PIAS through visual or audio means (*traveler interface updates*). The cycle of request and response may be repeated as often as needed. A single request may identify the area of interest and register a user for future updates, depending on implementation. Also, *emergency traveler information* may be provided as broadcast or multicast information, without need for an explicit request message.

11. In a similar manner, Drivers may make information requests (*driver inputs*) and then an *emergency traveler information request* and corresponding *emergency traveler information* may be exchanged

between a Vehicle and an ISP, and the result (*driver updates*) are returned to the Driver. This allows drivers to receive updated emergency traveler information while en-route.

12. In a similar manner, Travelers may enter requests (*traveler inputs*) into the Remote Traveler Support Subsystem, RTS (e.g., kiosks at rest stops, shelters, etc.) and then an *emergency traveler information request* and corresponding *emergency traveler information* may be exchanged between the RTS and an ISP, and the result (*traveler interface updates*) is returned to the Traveler.

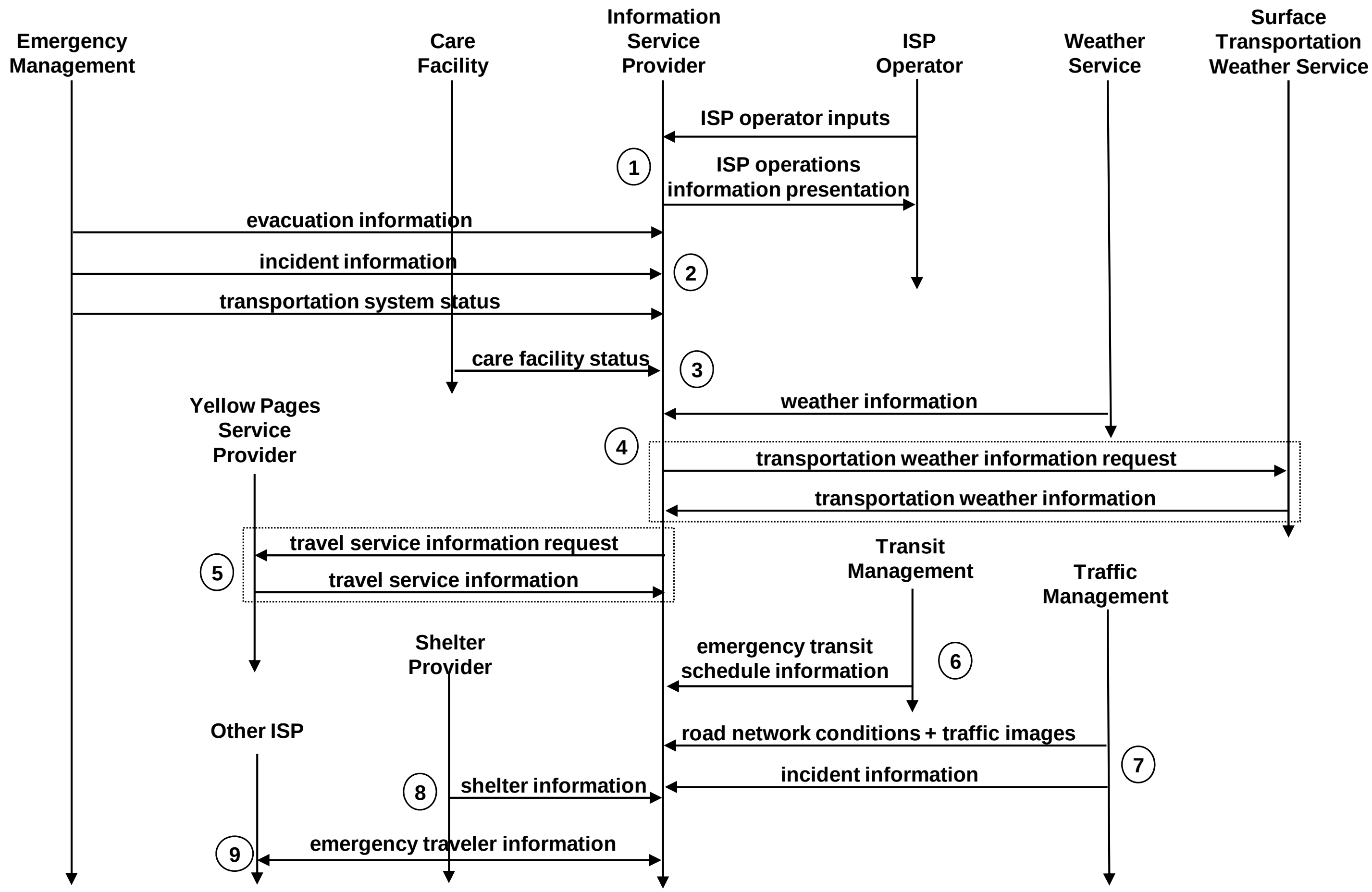
13. Emergency traveler information is also made available over voice-based traveler information systems like 511. Information (*voice-based traveler information*) is made available in response to traveler requests (*voice-based traveler request*).

14. *Emergency traveler information* is also made available to shelter providers, for use in informing shelter users of current travel conditions, reentry information, and other emergency travel information.

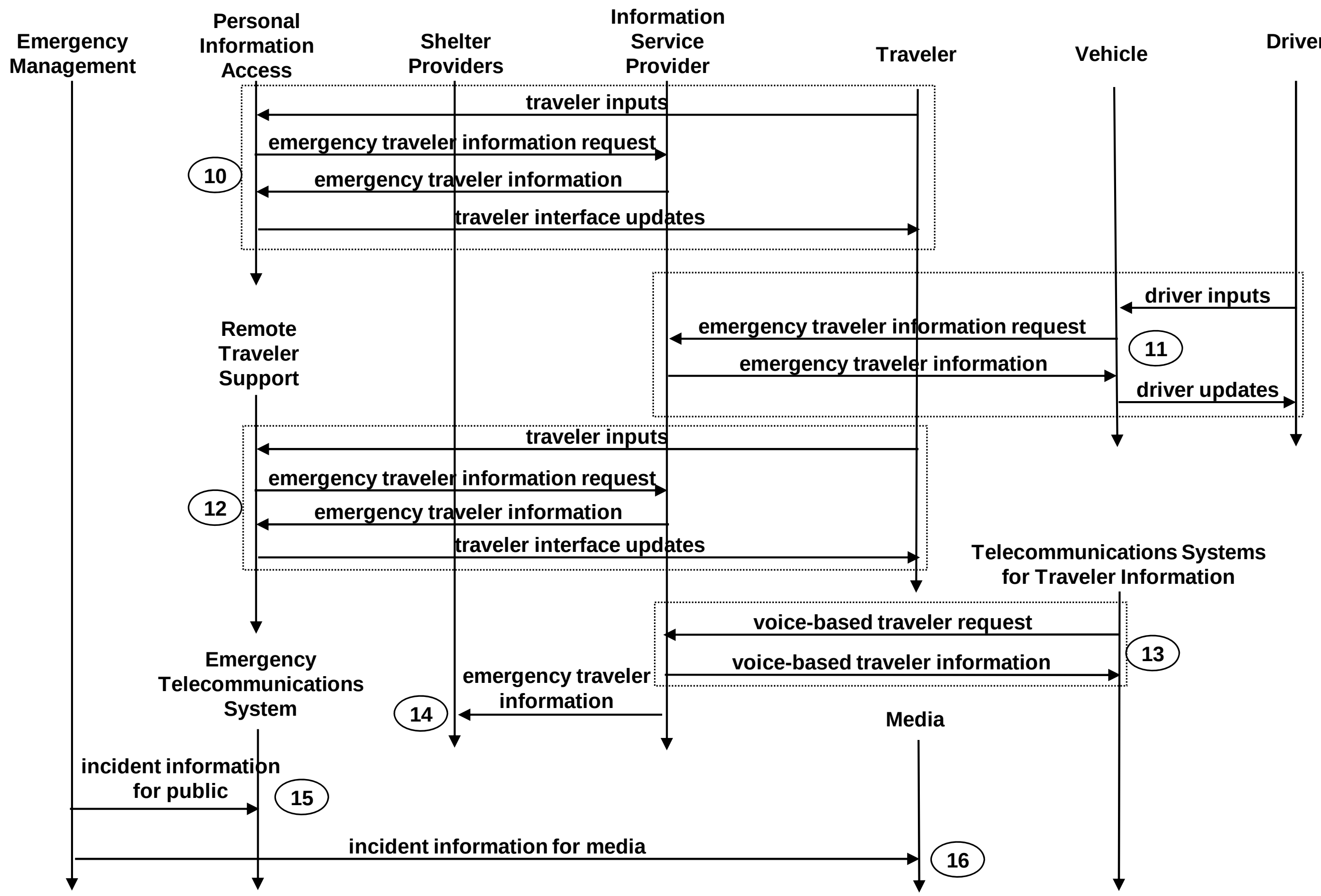
15. Systems such as reverse 911 systems that distribute salient information about an incident to the general public in a precise geographic area may also be used. In the architecture, this is represented by the *incident information for public* flow to the Emergency Telecommunications System.

16. Emergency traveler information is also made available to the media (*incident information for media*).

EM10: Disaster Traveler Information (1 of 2) (Information Collection)



EM10: Disaster Traveler Information (2 of 2) (Information Distribution)



6 Commercial Vehicle Operations

This section provides the Theory of Operations for the Commercial Vehicle Operations Service Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each service package section) to identify these service packages is CVO—Commercial Vehicle Operations.

6.1 CVO01: Carrier Operations and Fleet Management

This service package provides the capabilities to manage a fleet of commercial vehicles. The Fleet and Freight Management subsystem provides the route for a commercial vehicle by either utilizing an in-house routing software package or an Information Service Provider. Routes generated by either approach are constrained by hazardous materials and other restrictions (such as height or weight). Any such restricted areas are determined by the Commercial Vehicle Administration. A route would be electronically sent to the Commercial Vehicle with any appropriate dispatch instructions. The location of the Commercial Vehicle can be monitored by the Fleet and Freight Management subsystem and routing changes can be made depending on current road network conditions. Once a route has been assigned, changes must be coordinated between the Fleet and Freight Management subsystem and the Commercial Vehicle. Commercial Vehicle Drivers would be alerted to any changes in route from the planned route and given an opportunity to justify a rerouting. Any unauthorized or unexpected route changes by the Commercial Vehicle will register a route deviation alert with the Fleet and Freight Management subsystem. The Fleet and Freight Management subsystem can also notify local public safety agencies of the route deviation when appropriate (e.g., if there is safety sensitive HAZMAT being carried), by sending an alarm to the Emergency Management subsystem.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Fleet-Freight Manager may request (*fleet manager inquiry*) the *fleet status* from the Fleet and Freight Management Subsystem (FFMS), including enrollment status, routing/itinerary information, emergency information, current vehicle locations and other information. As part of a new driver enrollment the Commercial Vehicle Administration (CVAS) will provide the commercial vehicle driver's record (*cv driver record*) along with any *credentials status information* that will in turn be presented to the manager.

2. On an asynchronous basis the Commercial Vehicle Subsystem tracks its location (*position fix*). The Commercial Vehicle Subsystem can send the vehicle's location, along with driver messages and on-board sensor data, to the Fleet and Freight Management Subsystem (*on-board vehicle data*) upon request (*on-board vehicle request*).

3. The Fleet and Freight Management Subsystem can periodically request information about a trip (*trip log request*). The Commercial Vehicle Subsystem can electronically provide the Fleet and Freight Management Subsystem with the driver's daily log, mileage and trip activity (*trip log*).

4. Initial dissemination and periodic updates of restrictions in routing (*route restrictions*) are provided by the Commercial Vehicle Administration Subsystem to the Fleet and Freight Management Subsystem.

5. Periodically or asynchronously, the Fleet and Freight Management Subsystem may make a *map update request* and receive *map updates* from the Map Update Provider. Alternatively, via a subscription, the Map Update Provider may push updates to the Fleet and Freight Management Subsystem as changes occur. Map updates are necessary in order for the Fleet and Freight Management Subsystem to determine the best routes for commercial goods shipments.

6. Asynchronously and periodically, the Information Service Provider Subsystem can provide the Fleet and Freight Management Subsystem with current and forecasted traffic information (*road network conditions* and *incident information*), which could be used to alter an existing route or as a parameter for the Fleet and Freight Management Subsystem's route generation program.

7. When preparing for a trip, typical fleet operations include several process steps:

    - The Commercial Vehicle Driver can contact the Commercial Vehicle Subsystem with trip specific information, which may include carrier, driver and vehicle information, or a request for a route (*CVO driver initialization*).
    - The Commercial Vehicle Subsystem will forward the route request to the Fleet and Freight Management Subsystem (*driver to fleet request*).
    - The Fleet and Freight Management Subsystem can internally generate a route or forward the request on to the Information Service Provider Subsystem (*route request*).
    - Using the constraints provided with the route request and any route restrictions (if applicable), the Information Service Provider Subsystem generates a route and sends it to the Fleet and Freight Management Subsystem (*route plan*).
    - The route information, along with any messages, alerts, or special instructions, is sent to the Commercial Vehicle Subsystem (*fleet to driver update*) where it is forwarded to the Commercial Vehicle Driver as updates to the trip log (*trip log information*) or alerts or messages (*alerts*).

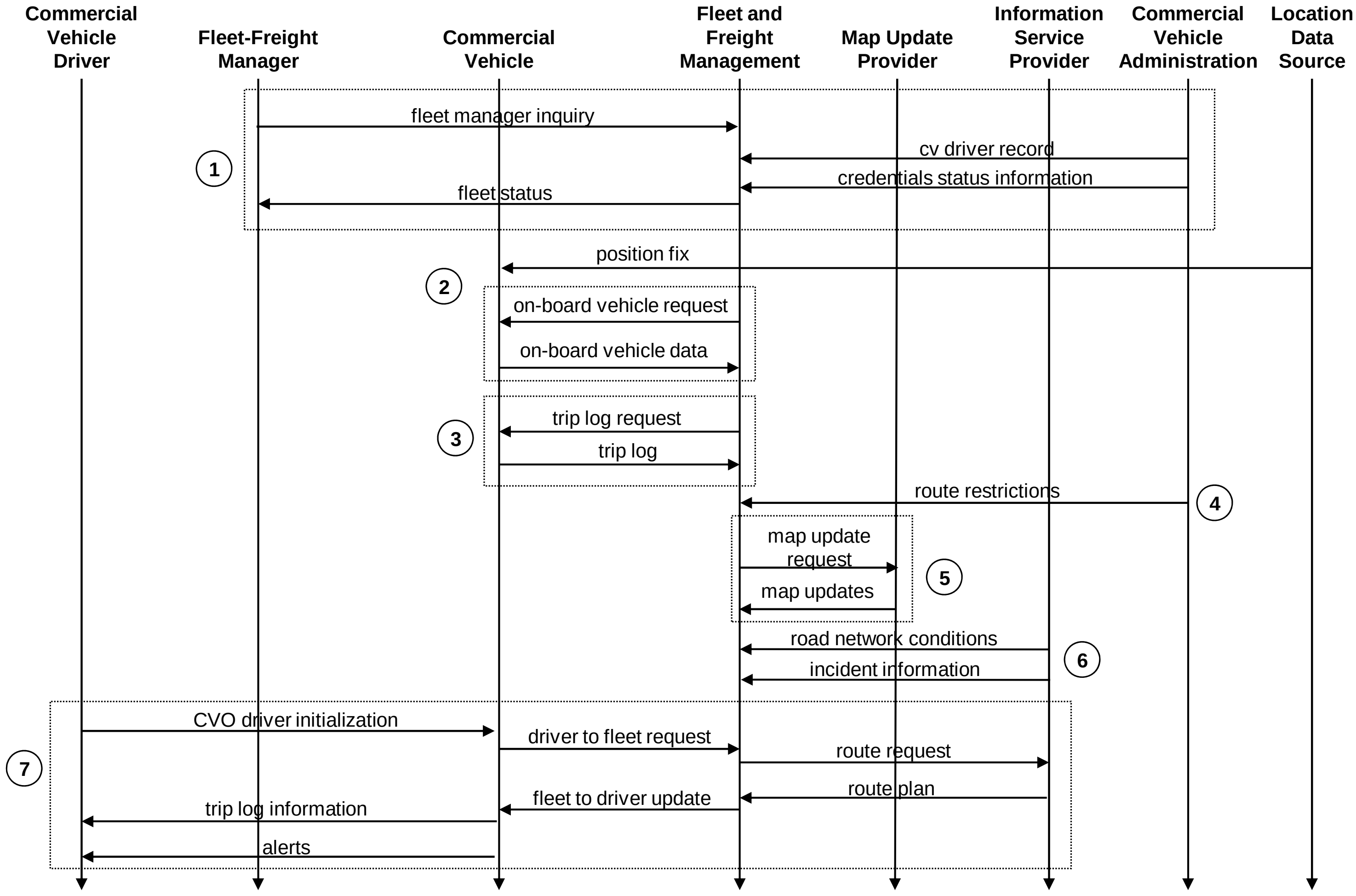
8. Based upon previously arranged routes for the commercial vehicle (and driver), via the *fleet to driver update* flow, the current route is monitored by the Commercial Vehicle Subsystem.

    - In addition, the route is also monitored by the Fleet and Freight Management Subsystem using the *on-board vehicle data*.
    - If the current location is off route or not according to the previously established itinerary, the Commercial Vehicle Subsystem sends an alert to the Commercial Vehicle Driver (*alerts*). The driver may then choose to provide a response to the Commercial Vehicle Subsystem alert indicating the reason for the deviation (*alert response*) which is forwarded to the Fleet and Freight Management Subsystem (*driver alert response*).
    - The Commercial Vehicle Subsystem will send a *route deviation alert* to the Fleet and Freight Management Subsystem with the driver's reason or without any reason if enough time has passed without driver response.

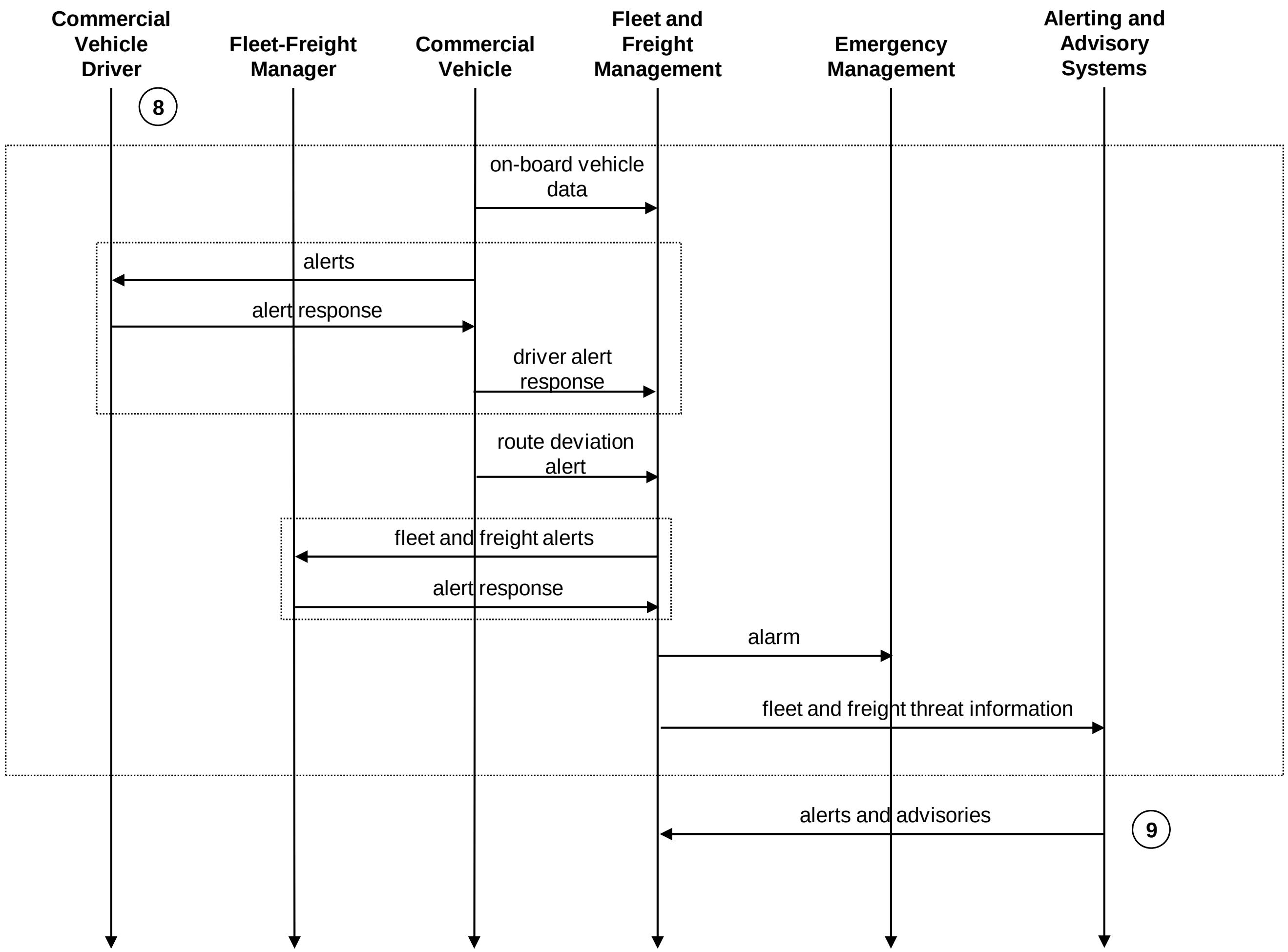
- Upon receipt of a *route deviation alert*, the Fleet and Freight Management Subsystem will notify the Fleet and Freight Manager of the deviation (*fleet and freight alerts*). The Fleet and Freight Manager can then determine if the deviation is acceptable and update the planned route/itinerary to reflect the deviation. If the deviation is unacceptable, the Fleet and Freight Manager would so indicate (*alert response*).
- If enough time has passed without a response from the Fleet and Freight Manager, or if the response indicates an unacceptable deviation, the Fleet and Freight Management Subsystem would send an *alarm* to the Emergency Management Subsystem.
- A deviation from planned route is also sent to the Alerting and Advisory Systems as *fleet and freight threat information*.

9. Periodically or asynchronously, the Alerting and Advisory Agency systems (e.g., Trucking Information Sharing and Analysis Center or ISAC) may send *alerts and advisories* to the Fleet and Freight Management Subsystem. The Fleet and Freight Management Subsystem may alter the routes chosen or contact the Fleet-Freight Manager and Commercial Vehicle Driver to alert them to the nature of the advisory.

CVO01: Carrier Operations and Fleet Management (1 of 2) (Typical Fleet Operations)



CVO01: Carrier Operations and Fleet Management (2 of 2)
(Fleet Operation Exceptions)



6.2 CVO02: Freight Administration

This service package tracks the movement of cargo and monitors the cargo condition. Interconnections are provided to intermodal freight shippers and intermodal freight depots for tracking of cargo from source to destination. In addition to the usual cargo monitoring required to insure that cargo gets from origin to destination, the Fleet and Freight Management subsystem monitors shipments to make sure that no tampering or breach of security occurs to the cargo on commercial vehicles. Any such tampering will be reported to the Fleet and Freight Management subsystem. In addition to exceptions (e.g., alerts) that are reported, on-going indications of the state of the various freight equipment are reported to the Fleet and Freight Management subsystem. The commercial vehicle driver is also alerted of any tampering or breach of cargo security. Freight managers may decide to take further action on the alerts and/or provide responses that explain that the alerts are false alarms. If no explanation is received, the Fleet and Freight Management subsystem may notify the Emergency Management subsystem. Commercial vehicle and freight security breaches may also be sent to the Commercial Vehicle Check subsystem.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. On an asynchronous basis, the Commercial Vehicle Driver may send driver and vehicle information to the Commercial Vehicle Subsystem (*CVO driver initialization*).

2. Periodically or asynchronously, the Fleet and Freight Management Subsystem may request updates from the Map Update Provider (*map update request*). Alternatively, via a subscription, the Map Update Provider may push updates to the Fleet and Freight Management Subsystem as changes occur. These *map updates* are used in determining the best routes for freight shipments.

3. The Fleet and Freight Management Subsystem can monitor the cargo by requesting on-board data from the Commercial Vehicle Subsystem (*on-board vehicle request*). The Commercial Vehicle Subsystem will collect data from the ITS equipment contained in the Freight Equipment (*freight equipment information*) and forward the information to the Fleet and Freight Management Subsystem (*on-board vehicle data*).

4. Freight information can be requested from the Commercial Vehicle Subsystem by the Vehicle Subsystem (*commercial vehicle data request*). This information would come from sensors indicating the composition and state of the cargo (including temperature, humidity, etc.). The Commercial Vehicle Subsystem will forward the cargo data to the Vehicle Subsystem (*commercial vehicle data*).

5. On an asynchronous basis, the Intermodal Freight Shipper and Intermodal Freight Depot may exchange information regarding cargo movement logs, routing information, and cargo ID's with the Fleet and Freight Management Subsystem (*freight transportation status*).

6. Periodically or asynchronously, the Alerting and Advisory Agency systems (e.g., Trucking Information Sharing and Analysis Center or ISAC) may send *alerts and advisories* to the Fleet and Freight Management Subsystem.

7. As a freight shipment assignment begins, the Fleet and Freight Management Subsystem prepares to monitor the security of the freight equipment: trailer, chassis, and cargo.

    - The Fleet and Freight Management Subsystem sends *freight monitoring parameters* to the Freight Equipment to configure the frequency of status reports on cargo locks as well as other on-board sensors.
    - According to the monitoring parameters, the Freight Equipment periodically sends *freight equipment information* to the Fleet and Freight Management Subsystem and/or to the Commercial Vehicle Subsystem. The Commercial Vehicle Subsystem relays any *freight equipment information* on to the Fleet and Freight Management Subsystem. The operational concept for the flow of this information depends upon the specific sensor, monitoring, and communication equipment deployed.

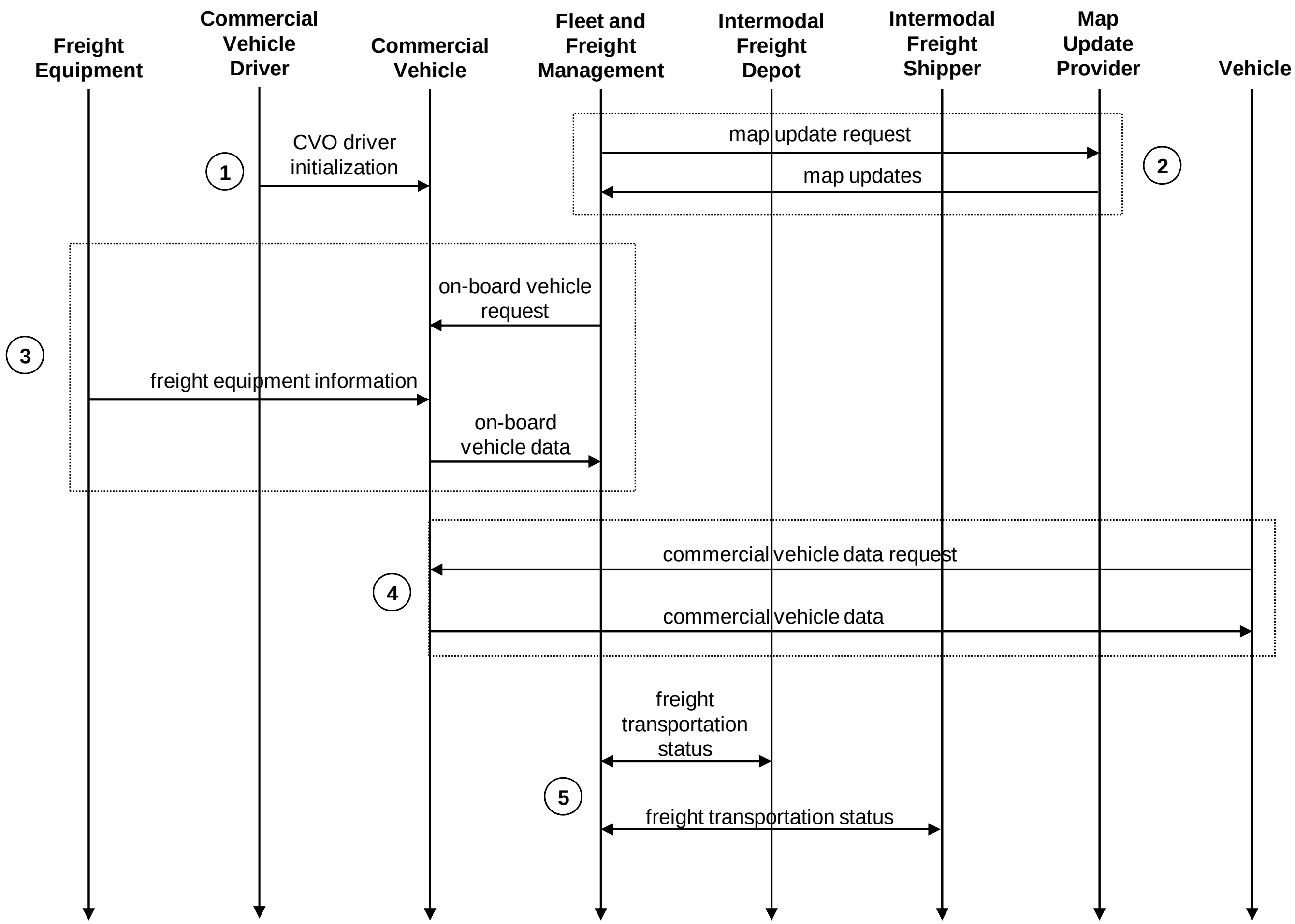
8. Whenever a security exception arises with freight, a series of information flows occurs as follows:

    - A notification of a security breach or tampering is sent from Freight Equipment to either or both the Fleet and Freight Management Subsystem and the Commercial Vehicle Subsystem as well as a Commercial Vehicle Check facility if located nearby (*freight breach*).
    - Whenever notified of a freight breach, the Commercial Vehicle Subsystem sends *alerts* to the Commercial Vehicle Driver and in doing so requests a response from the driver. If the driver is aware of the triggering event, then an *alert response* can indicate that it is possibly a false alarm or that there is in fact a security issue to be dealt with. It is possible that either the driver is not able to respond or has elected not to respond in the event a crime is being perpetrated.
    - If the Commercial Vehicle Subsystem receives a response from the driver, then the *driver alert response* is passed on to the Fleet and Freight Management Subsystem.
    - In addition, specific information about the freight equipment security issue is sent from the Commercial Vehicle Subsystem to the Fleet and Freight Management Subsystem. This would include the time and date and the specific breach type (e.g., lock opened, door opened, etc.) (*commercial vehicle breach*)
    - This same information (*commercial vehicle breach*) can also be transmitted to a Commercial Vehicle Check facility if one is located within range.
    - When the Fleet and Freight Management Subsystem receives indication of the breach from the Commercial Vehicle Subsystem along with any driver response, notification (*fleet and freight alerts*) is passed on to the Fleet-Freight Manager. Upon receipt of the notification, the Fleet-Freight Manager decides what course of action to take and indicates this with an *alert response*.
    - Since the cargo belongs to the shipper until it is received at its final destination, the Intermodal Freight Shipper is notified of the *freight breach*. The shipper can then decide what course of action to take and notifies the Fleet and Freight Management Subsystem with a *breach response*.
    - If enough time has passed without a response from the Fleet and Freight Manager and or from the Intermodal Freight Shipper, or if the response indicates an unacceptable situation

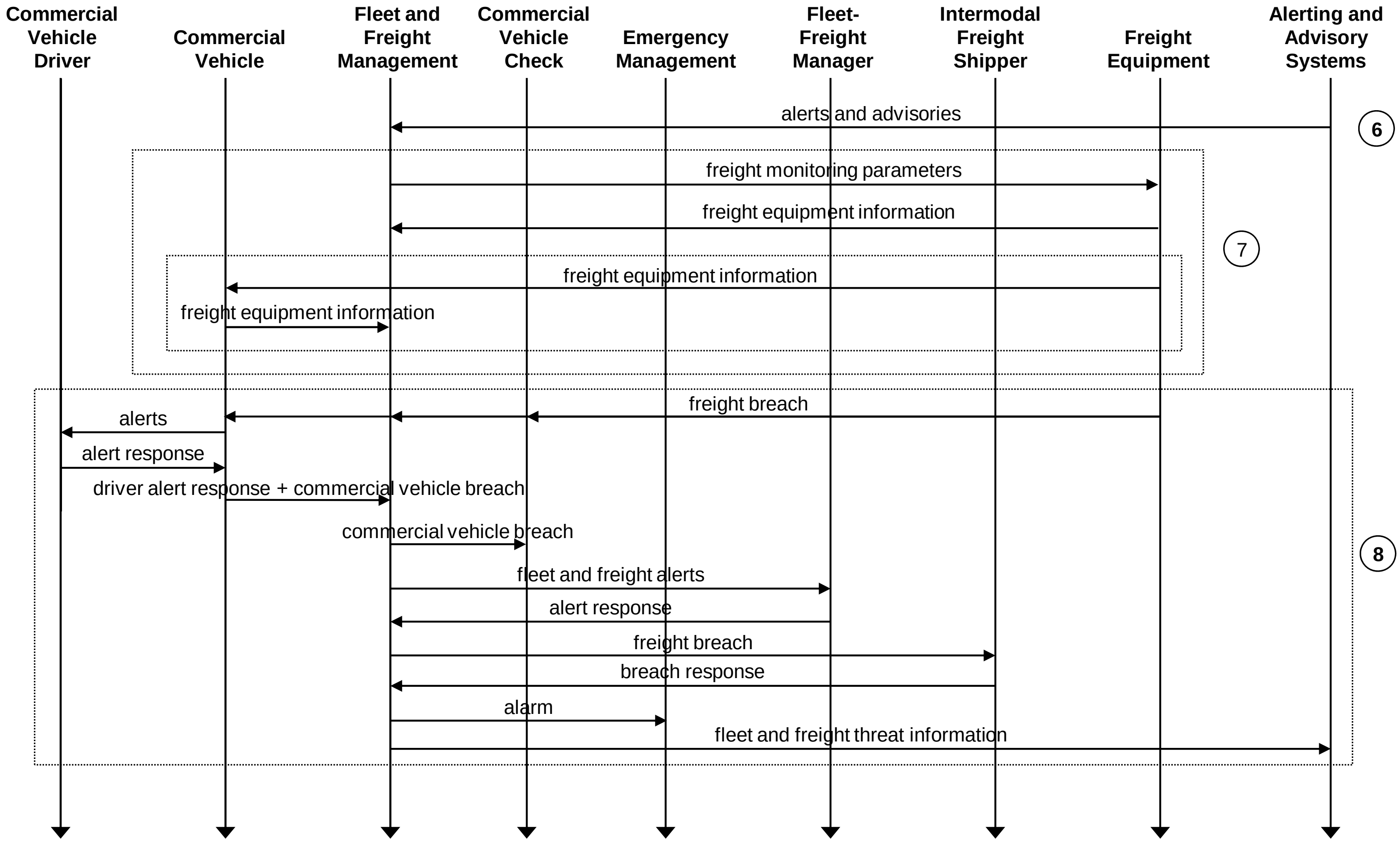
has occurred, the Fleet and Freight Management Subsystem sends an *alarm* to the Emergency Management Subsystem.

- A notification of security exception is also sent to the Alerting and Advisory Systems as *fleet and freight threat information*.

CVO02: Freight Administration (1 of 2)
(Typical Freight Operations)



CVO02: Freight Administration (2 of 2)
(Freight Operation Exceptions)



6.3 CVO03: Electronic Clearance

This service package provides for automated clearance at roadside check facilities. The roadside check facility communicates with the Commercial Vehicle Administration subsystem to retrieve infrastructure snapshots of critical carrier, vehicle, and driver data to be used to sort passing vehicles. This allows a good driver/vehicle/carrier to pass roadside facilities at highway speeds using transponders and Field-Vehicle Communications to the roadside. Results of roadside clearance activities will be passed on to the Commercial Vehicle Administration. The roadside check facility may be equipped with Automated Vehicle Identification (AVI), weighing sensors, transponder read/write devices and computer workstations.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Commercial Vehicle Administration Subsystem (CVAS) maintains the necessary credentials data and commercial driver license records in support of electronic clearance. CVAS can communicate with Other CVAS' in different jurisdictions to exchange *credentials information*. Then CVAS will send the *credentials information* to the Commercial Vehicle Check Subsystem (CVCS). CVAS will also send the *cv driver record* to support better access to up-to-date and accurate information in the field.

2. The Commercial Vehicle Administration Subsystem maintains the necessary credentials status data, better known as "snapshots", in support of electronic clearance. The Commercial Vehicle Administration Subsystem can communicate with the Other CVAS to exchange *credentials status information* with other jurisdictions. The Commercial Vehicle Administration Subsystem will send the *credentials status information* to the Commercial Vehicle Check Subsystem.

3. The CVAS maintains the necessary safety data in support of electronic clearance and can communicate with the Other CVAS to exchange *safety status information* with other jurisdictions. CVAS will send the *safety status information* to the CVCS. On an asynchronous basis, the CVCS will receive *information on violators* from the Enforcement Agency, as well as *alerts and advisories* from regional or national Alerting and Advisory Systems.

4. To support wireless roadside inspection activities, an Enforcement Agency will send a *targeted list* of carriers, drivers, and/or vehicles of interest for enforcement purposes to CVAS. CVAS will pass this information (*targeted list*) onto the appropriate CVCS stations in the field. Also on an asynchronous basis, the Commercial Vehicle Driver will send vehicle and driver information to the Commercial Vehicle Subsystem (*CVO driver initialization*).

5. The entire screening process is under the asynchronous monitoring (*CVO inspector information*) and control (*CVC override mode*) of the CVO Inspector.

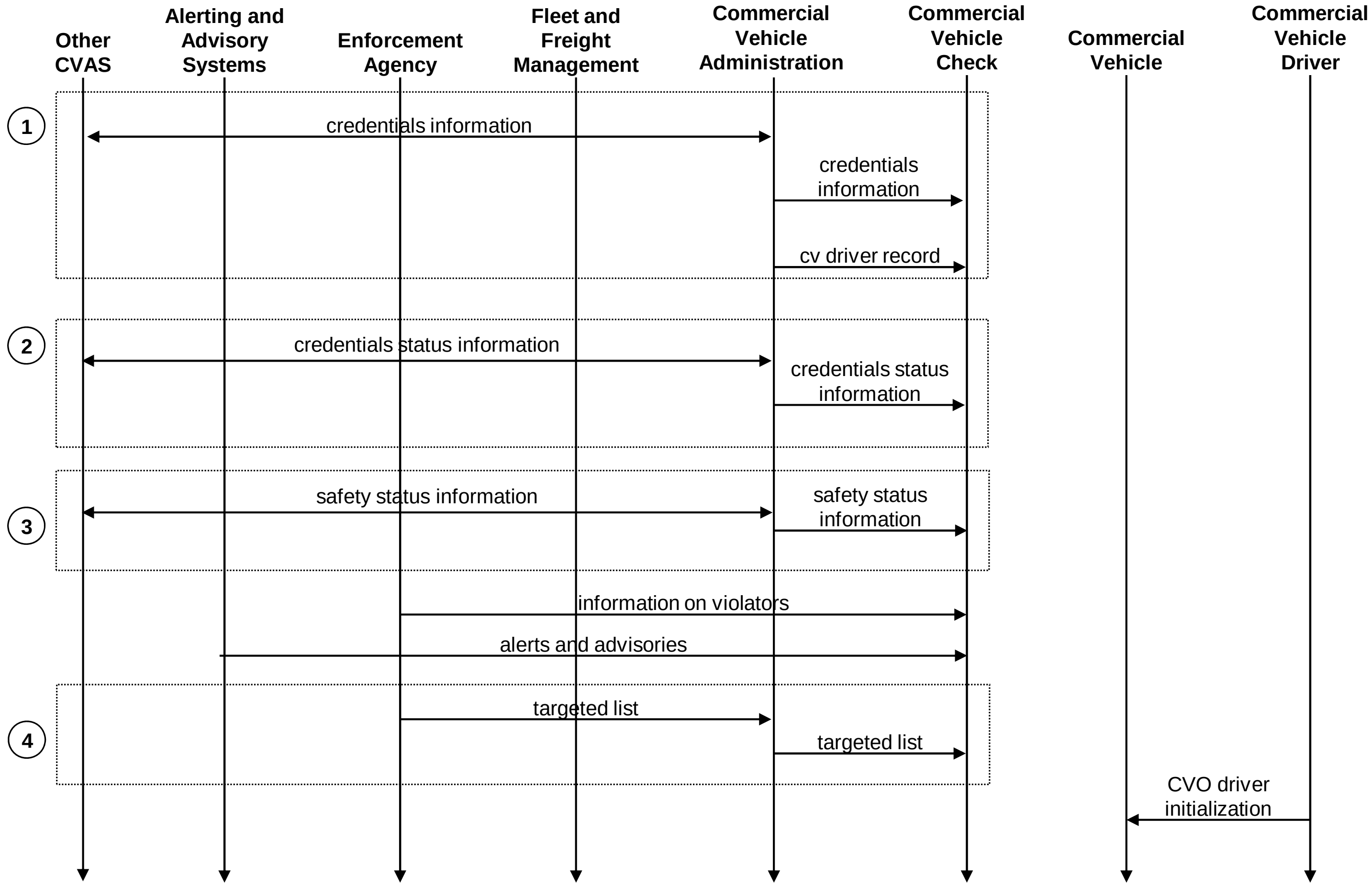
6. The Commercial Vehicle Check Subsystem (CVCS) can detect and identify the Basic Commercial Vehicle using non-ITS equipment to visually determine the identity the vehicle (USDOT number, license plate, etc.) (*identification information*). Alternately, CVCS can *request tag data* to retrieve identification information stored in the form of *tag data* from the Commercial Vehicle Subsystem

(CVS). For electronic clearance CVCS will send an *electronic screening request* to the CVS and it will respond to CVCS with the stored screening data (*screening event record*). Results of the screening process can be sent back to the CVS (*screening event record*) for future activities. To collect data for safety checks, CVS will provide the CVCS roadside facility with its *on-board safety data*. Also, if so equipped either the CVS or the Freight Equipment (container, trailer, chassis) with electronic tracking and safety monitoring devices may send *freight equipment information* to CVCS as one more data input.

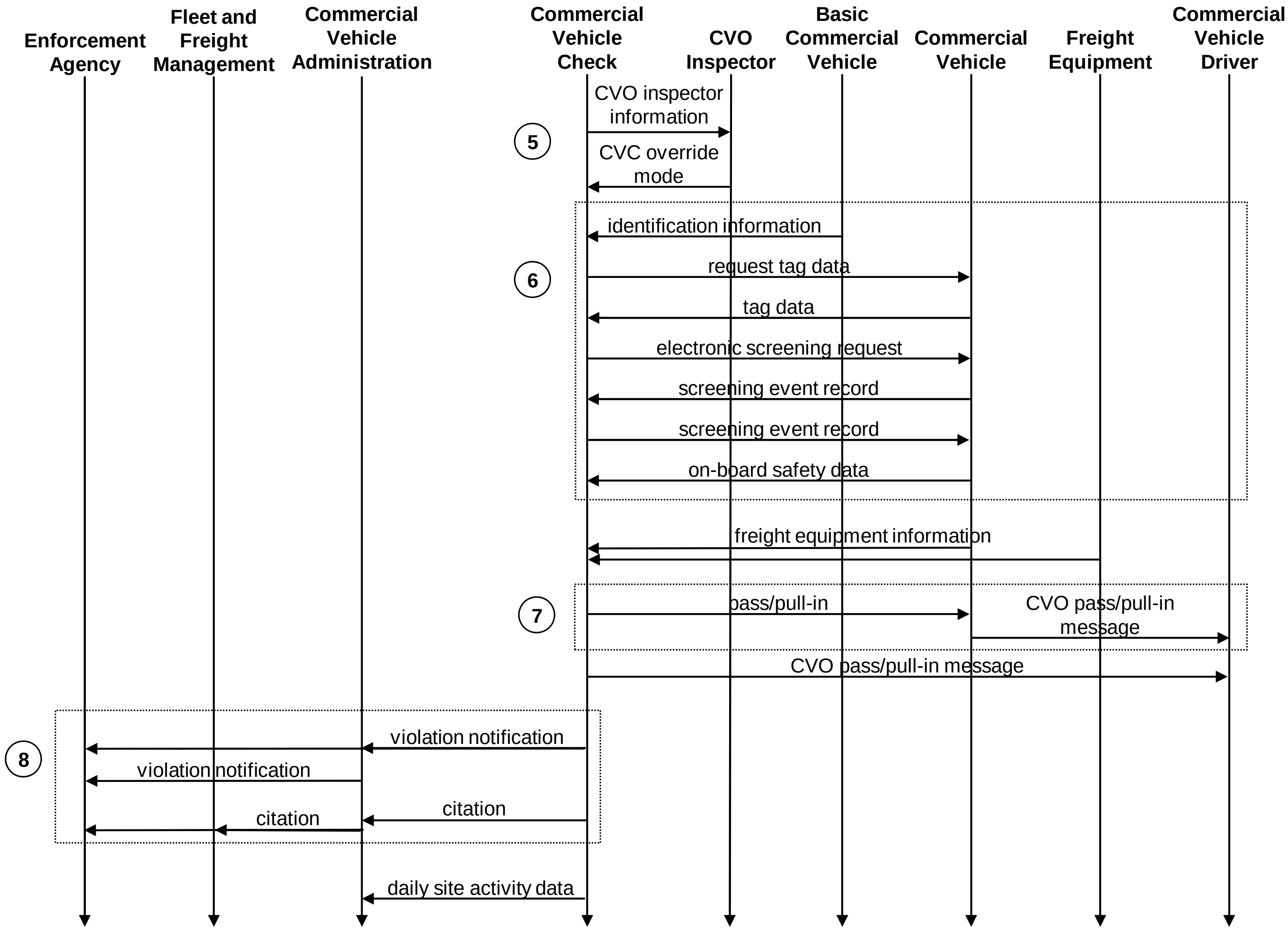
7. After analyzing the safety and credentials data, the CVCS makes a pass or pull-in decision. The CVCS can send the decision to the CVS (*pass/pull-in*), which will forward the data to the Commercial Vehicle Driver (*CVO pass/pull-in message*). Alternately, the CVCS can send the decision directly to the Commercial Vehicle Driver (*CVO pass/pull-in message*) by using a roadside sign.

8. Violation or citations information can be distributed to the proper authorities after a screening event. CVCS can send *violation notification* to the CVAS or directly to the Enforcement Agency. CVAS can also forward the *violation notification* to the Enforcement Agency. For citations, CVCS will send the *citation* to the CVAS, which will, in turn forward the *citation* information to the appropriate Enforcement Agency or Fleet and Freight Management Subsystem (FFMS) so the carrier has a record as well. On an asynchronous basis, CVCS can send a record of daily activities at commercial vehicle check stations including summaries of screening events and inspections to the CVAS (*daily site activity data*).

CVO03: Electronic Clearance (1 of 2) (Gathering Information)



CVO03: Electronic Clearance (2 of 2) (Daily Roadside Clearance Activity)



6.4 CVO04: CV Administrative Processes

This service package supports program administration and enrollment and provides for electronic application, processing, fee collection, issuance, and distribution of CVO credential and tax filing. Through this process, carriers, drivers, and vehicles may be enrolled in a variety of programs including electronic clearance and wireless inspection programs which allow commercial vehicles to be screened at mainline speeds. Through this enrollment process, current profile databases are maintained in the Commercial Vehicle Administration subsystem and snapshots of this data are made available to the roadside check facilities. Current program status is maintained and made available to carriers, drivers, and other authorized users of the data. Enrolled carriers are provided the option to review and challenge the collected data.

Commercial Vehicle Administration subsystems can share current program status and credential information with other Commercial Vehicle Administration subsystems, so that it is possible for any Commercial Vehicle Administration subsystem to have access to all credentials, credential fees, credentials status and safety status information. In addition, it is possible for one Commercial Vehicle Administration subsystem to collect HAZMAT route restrictions information from other Commercial Vehicle Administration subsystems and then act as a clearinghouse for this route restrictions information for Information Service Providers, Map Update Providers, and Fleet and Freight Management subsystems.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Before a credentials application is received, the Commercial Vehicle Administration Subsystem (CVAS) can collect the necessary information used in support of the approval process. On an asynchronous basis, CVAS can receive restrictions levied on transportation asset usage based on infrastructure design, surveys, tests, or analyses from the Maintenance and Construction Management Subsystem (*current asset restrictions*). The CVAS can also receive information about commercial vehicle violations from the Enforcement Agency (*information on violators*). The CVAS also receives driver *registration* information from Departments of Motor Vehicles (DMV). The CVAS can exchange safety (*safety status information*), credentials (*credentials status information*, *credentials information*) and fee (*credential fee coordination*) information with the Other CVAS (e.g. national clearinghouses) along with *accident report*, and *citation* information. CVAS can also exchange commercial driver license information with an Other CVAS (*cv driver record*).

2. The Fleet and Freight Management Subsystem (FFMS) can send a credential application to the CVAS (*credential application*). The CVAS will use the information obtained in item 1 above as a basis for granting CVO credentials and determining associated fees and taxes. After the CVAS receives authorization to pay all taxes and fees from the FFMS (*tax filing*), the CVAS will request payment from the Financial Institution (*payment request*). The Financial Institution will provide a payment status to the CVAS (*transaction status*). The FFMS will be notified when the process is complete (*credentials information*).

3. On an asynchronous basis, CVAS can send credentials data (*credentials status information*) and safety data (*safety status information*) to the FFMS. CVAS can also send a *compliance review report*, which contains the results of carrier compliance review. FFMS can send CVAS information to support a tax audit when necessary (*audit data*). CVAS will send FFMS the *cv driver record* in support of pre-hiring checks on the part of the carrier. There are occasions when a CVO Information Requester (e.g. insurance company) may request that data reported about a motor carrier or driver be reviewed for potential mis-assignment or other error (*request for data review*). CVAS can provide the CVO Information Requester with credentials data (*credentials information*, *credentials status information*), safety data (*safety status information*), and a commercial vehicle driver's records (*cv driver record*).

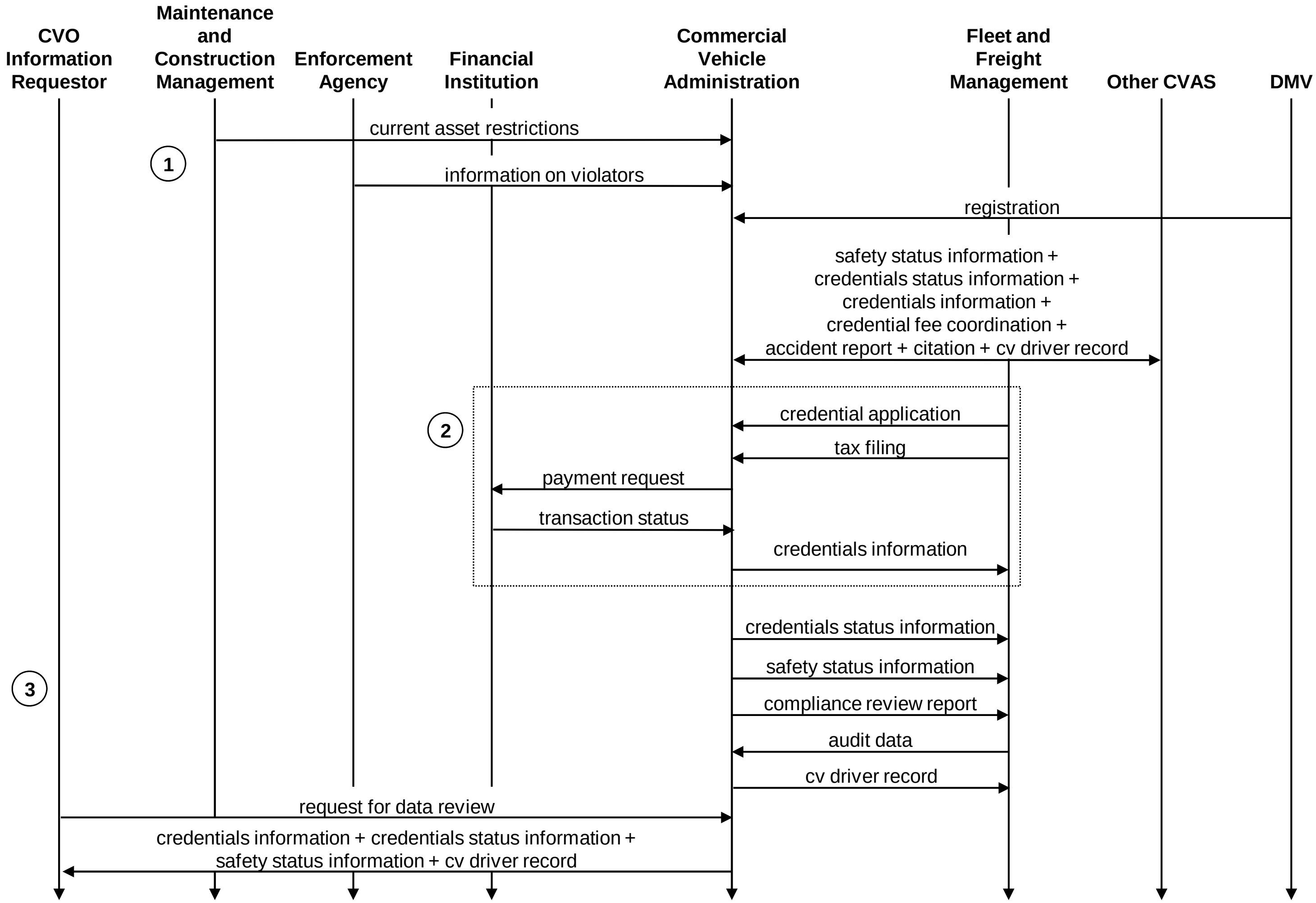
4. The CVAS can send *route restrictions* information about routes and areas that restrict height, weight, or hazmat cargoes to the Information Service Provider Subsystem (ISPS), Map Update Provider, and the Fleet and Freight Management Subsystem (FFMS). This information may also be exchanged with the Other CVAS.

5. The fleet operator can obtain data (*fleet status*) from the Fleet and Freight Management Subsystem (such as route information, preclearance data) either as a push or upon request (*fleet manager inquiry*).

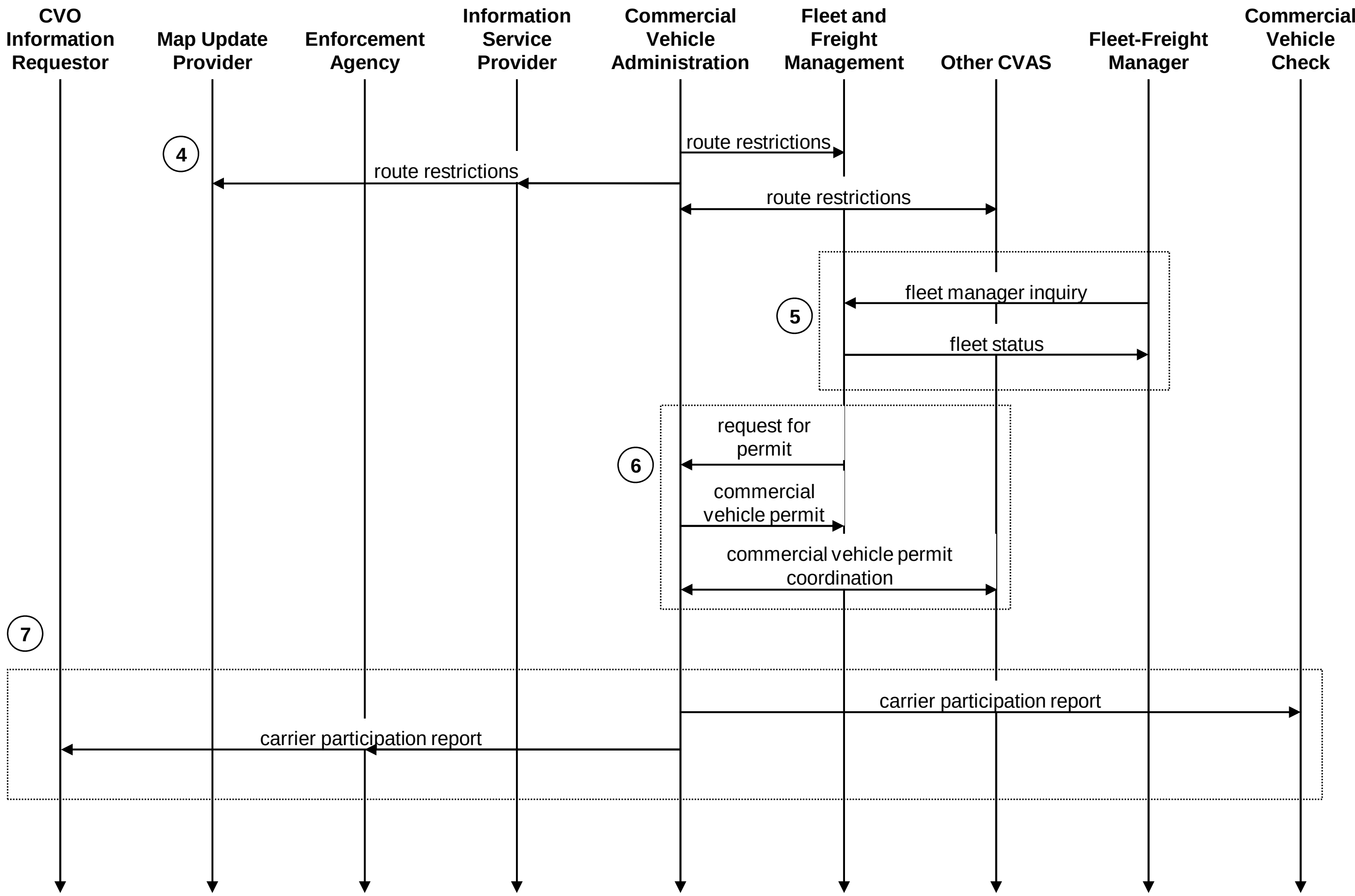
6. A Fleet and Freight Management Subsystem (FFMS) may also send a *request for permit* to a CVAS for an oversize, overweight, or hazmat permit. The CVAS will process the request and respond with the *commercial vehicle permit*. Supporting this process a CVAS may work with an Other CVAS and exchange permit information (*commercial vehicle permit coordination*) about carriers, vehicles, and drivers.

7. The CVAS can provide an Enforcement Agency, a Commercial Vehicle Check Subsystem (CVCS) facility, and a CVO Information Requester with information about motor carrier participation in CVO programs like wireless roadside inspections (*carrier participation report*) which could be used to identify the level of active participation and to report which enrolled carriers are not participating as expected.

CVO04: CV Administrative Processes (1 of 2)



CVO04: CV Administrative Processes (2 of 2)



6.5 CVO05: International Border Electronic Clearance

This service package provides for automated clearance at international border crossings. It augments the Electronic Clearance service package by allowing interface with border administration and border inspection related functions. This service package processes the entry documentation for vehicle, cargo, and driver, checks compliance with import/export and immigration regulations, handles duty fee processing, and reports the results of the crossing event to manage release of commercial vehicle, cargo, and driver across an international border. It interfaces with administrative systems used by customs and border protection, immigration, carriers, and service providers (e.g., brokers) and inspection systems at international border crossings to generate, process, and store entry documentation.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. On an asynchronous basis, the Commercial Vehicle Administration Subsystem (CVAS) can exchange credentials information (*credentials status information*) and safety information (*safety status information*) with Other CVAS', which may represent states along the borders or non-U.S. commercial vehicle operation authorities (Mexico and Canada).

2. Carriers represented by the Fleet and Freight Management Subsystem (FFMS) that wish to make shipments across an international border can submit an *expedited clearance registration* with the Border Inspection Administration Systems which will provide FFMS with a *client id* to be used for identification purposes for trans-border shipments. During the registration process, Border Inspection Administration may send an *expedited clearance status* to FFMS to update the company on the process which may also prompt a resubmittal of information from the carrier. Once the registration process is complete Border Inspection Administration will send *expedited clearance information* to FFMS. Upon request from the Border Inspection Administration Systems (*client verification request*), CVAS will provide trade transportation activity data concerning carriers, drivers, and shippers (*client verification information*).

3. To support the pre-processing of a shipment across an international border, the Fleet and Freight Management Subsystem (FFMS) will submit its *manifest data* to the Border Inspection Administration systems for processing and will respond with a *manifest receipt confirmation*. The Commercial Vehicle Administration Subsystem (CVAS) is notified of a pending commercial freight shipment into the U.S. by the Border Inspection Administration (*pre-arrival notification*). CVAS will analyze the available trade data and make a decision regarding the granting of permission for the freight shipment and pass the *border agency clearance results* to the Commercial Vehicle Check Subsystem (CVCS). Specific identifiers, including carrier, vehicle, and driver identification data, are extracted from the declaration information and forwarded to CVCS (*trip declaration identifiers*).

4. As part of the analysis, the Commercial Vehicle Administration Subsystem (CVAS) generates a transportation assessment, which is sent to the Commercial Vehicle Check Subsystem (CVCS) about the identification of the carrier, vehicle, driver, and expected cargo along with any risks that may be associated with the shipment (*transportation border clearance assessment*). The transportation

assessment may include directions for the commercial driver to proceed to nearest vehicle weigh and inspection station for further review. In addition, CVAS can send a copy of the transportation assessment to the Border Inspection Administration systems (*screening results*).

5. At the start of each trip, a unique load number is loaded into the Commercial Vehicle Subsystem (CVS) by the Fleet and Freight Management Subsystem (FFMS) or the Intermodal Freight Shipper (*trip identification number*). The Commercial Vehicle Driver may also be the one inserting the load number (*trip identification number input*).

6. As a Commercial Vehicle Subsystem (CVS) approaches an international border crossing, CVS will transmit *tag data* to the Border Inspection Systems, containing unique identifiers, an electronic manifest, and related vehicle and trip information. The Border Inspection Systems will use data concerning the carrier, driver, vehicle, or cargo including any pre-registered information to determine whether to allow the vehicle to proceed or to be pulled into a separate queue for further inspection. This *border pass/pull-in* message will be sent from the Border Inspection Systems to the CVS where it will be used to inform the driver. When complete with its determination or once it has completed any secondary inspections, the Border Inspection Systems will send a *clearance notification* to CVS allowing it to proceed. The Border Inspection Systems will alert the appropriate Commercial Vehicle Administration System that a particular vehicle has arrived at the border (*arrival notification*) and will provide a nearby Commercial Vehicle Check Subsystem with the *inspection results* that it may, in turn, use as part of its decision process.

7. On an asynchronous basis, the Commercial Vehicle Check Subsystem (CVCS) located near a border crossing detects and identifies the Basic Commercial Vehicle using non-ITS equipment to visually determine the identity of the vehicle (USDOT number, license plate, etc.) (*identification information*). Alternately, the CVCS can request vehicle tag information (*request tag data*) from the Commercial Vehicle Subsystem (CVS). CVS will respond with the *tag data* containing unique identifiers and related vehicle information. CVCS can request border crossing data from CVS (*border clearance data request*) which will respond with trip specific data regarding the movement of goods across the international border, which includes the trip identification number (*border clearance data*). Clearance event data regarding action taken at the border, including acceptance or override of system decision, and date/time stamp, can be sent to the CVS at the end of the border clearance process (*border clearance event*).

8. The Commercial Vehicle Check Subsystem can request data regarding presence and status of electronic cargo locks (*electronic lock data request*). If present, the Commercial Vehicle Subsystem will respond with presence and status of the cargo locks (*electronic lock data*). The Commercial Vehicle Subsystem monitors the status of the cargo locks and the status and condition of the cargo (*freight equipment information*).

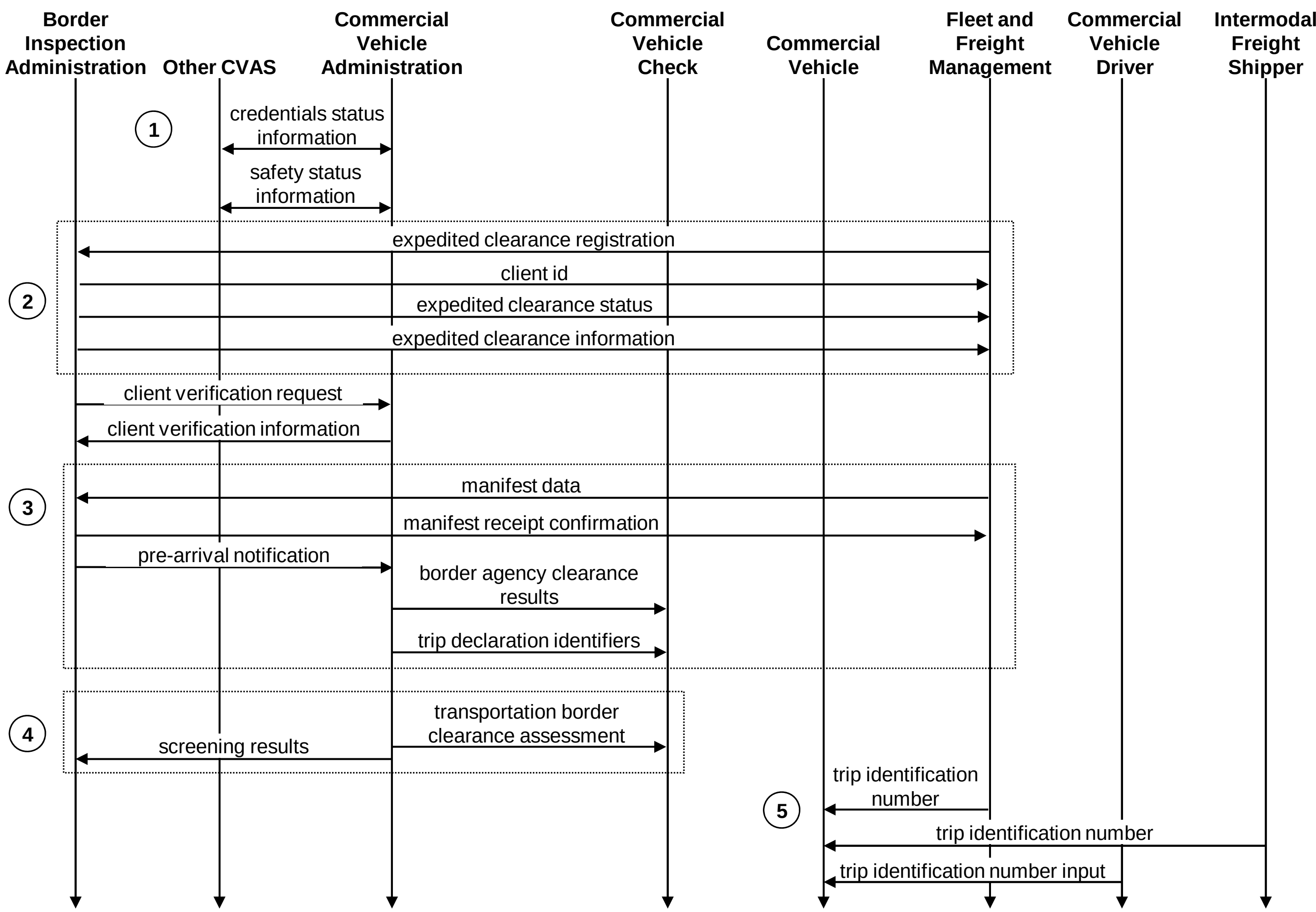
9. After all the data from the previous processes has been received, it is presented to the CVO Inspector for review (*CVO inspector information*). The CVO Inspector will make a determination whether to allow the vehicle to proceed or have it stop for further inspection (*CVC override mode*) and send the decision to the Commercial Vehicle Check subsystem.

10. The pass/pull-in decision can be sent from the Commercial Vehicle Check subsystem (CVCS) to the Commercial Vehicle Subsystem (*pass/pull-in*), which is forwarded to the Commercial Vehicle Driver

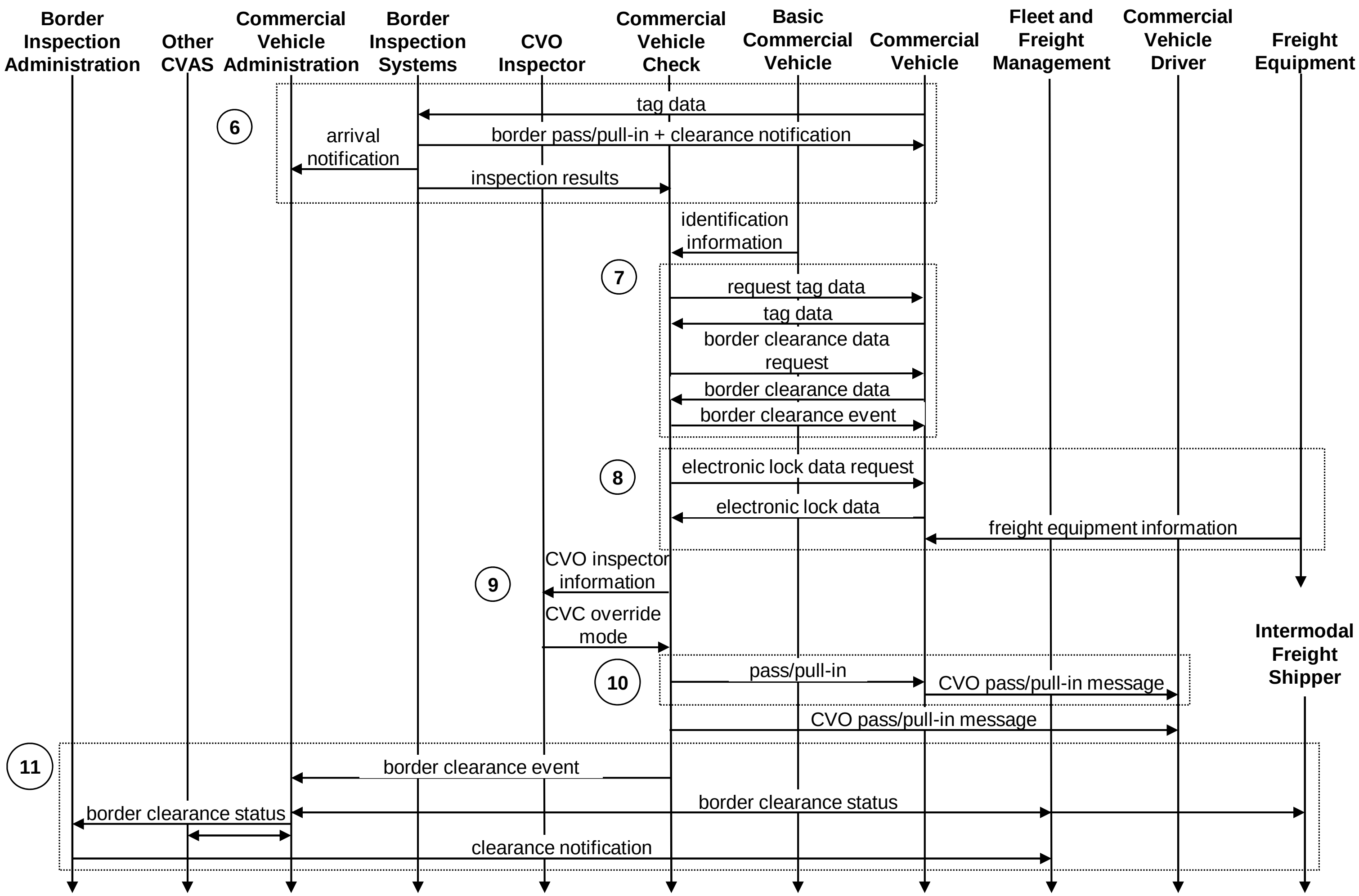
(*CVO pass/pull-in message*). Alternately it can be sent directly to the Commercial Vehicle Driver from CVCS using a roadside sign (*CVO pass/pull-in message*).

11. Clearance event data (*border clearance event*) regarding action taken at the border, including acceptance or override of system decision, and date/time stamp, can be sent to from the Commercial Vehicle Check Subsystem (CVCS) to the Commercial Vehicle Administration Subsystem (CVAS). CVAS can forward the *border clearance status* to the Fleet and Freight Management Subsystem (FFMS), the Border Inspection Administration, and the Intermodal Freight Shipper and exchange the information with Other CVAS. Once the vehicle has been processed at the border, behind the scenes the Border Inspection Administration systems can provide FFMS with a *clearance notification* regarding one of its vehicles.

CVO05: International Border Electronic Clearance (1 of 2) (Registration and Pre-Processing)



CVO05: International Border Electronic Clearance (2 of 2) (Inspection and Post-Processing)



6.6 CVO06: Weigh-In-Motion

This service package provides for high speed weigh-in-motion with or without Automated Vehicle Identification (AVI) capabilities. This service package provides the roadside equipment that could be used as a stand-alone system or to augment the Electronic Clearance (CVO03) service package.

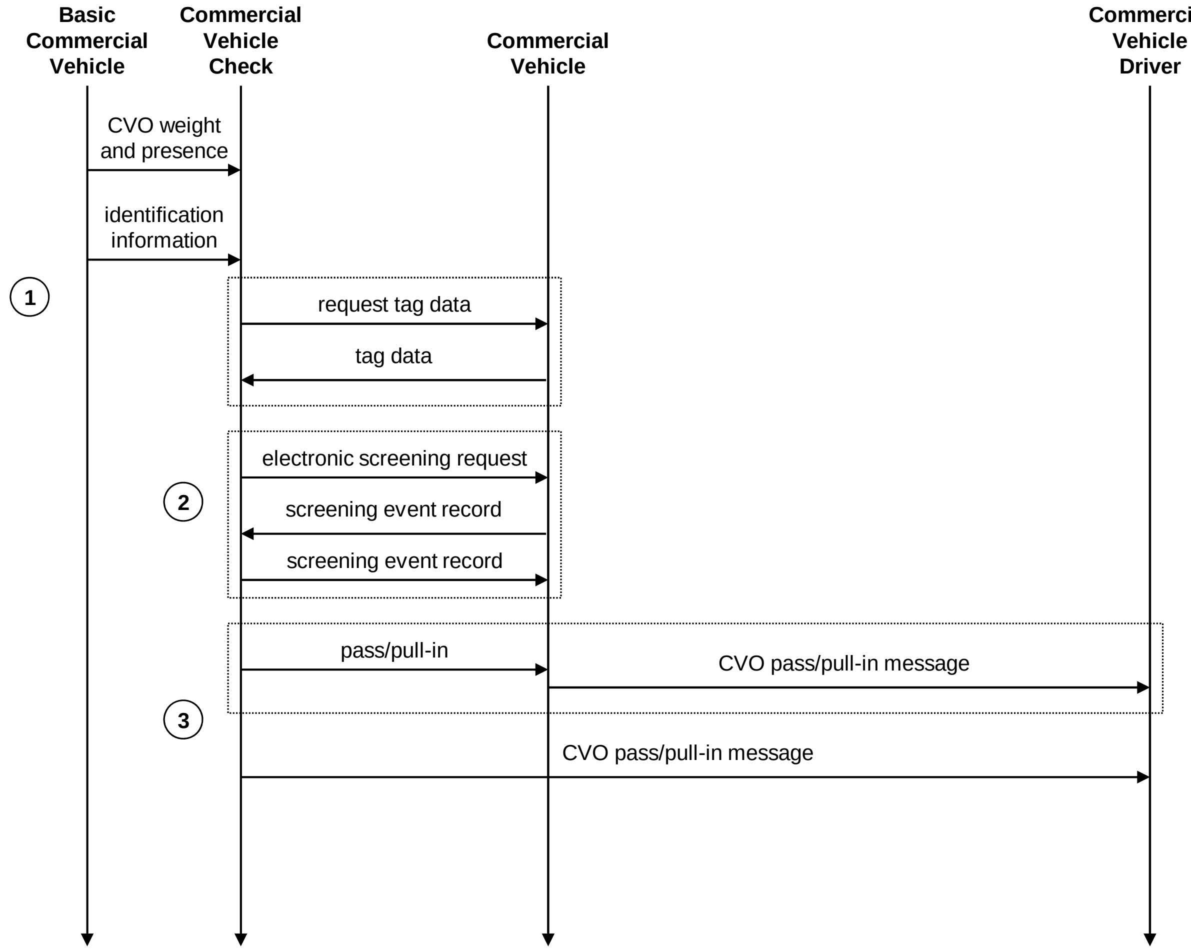
The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. On an asynchronous basis, the Basic Commercial Vehicle can pass a scale at mainline speeds and the weight information will be sent to the Commercial Vehicle Check Subsystem (*CVO weight and presence*). The Commercial Vehicle Check Subsystem can identify the Basic Commercial Vehicle using non-ITS equipment to visually determine the identity of the vehicle (USDOT number, license plate, etc.) (*identification information*). Alternately, the Commercial Vehicle Check Subsystem can request vehicle tag information from the Commercial Vehicle Subsystem (*request tag data*). The Commercial Vehicle Subsystem will respond with the unique tag ID and related vehicle information (*tag data*).

2. The Commercial Vehicle Check Subsystem can request screening data from the Commercial Vehicle Subsystem (*electronic screening request*). In response, the Commercial Vehicle Subsystem will send the results of a prior screening activity (*screening event record*). The results of the current Commercial Vehicle Check Subsystem activity can be sent to the Commercial Vehicle Subsystem (*screening event record*) at the completion of the process.

3. After the data has been reviewed, a decision is made in the Commercial Vehicle Check Subsystem to either allow the vehicle to pass or require it to be stopped. The Commercial Vehicle Check Subsystem can send the message to the Commercial Vehicle Subsystem (*pass/pull-in*), which is forwarded to the Commercial Vehicle Driver (*CVO pass/pull-in message*). Alternately the Commercial Vehicle Check Subsystem can send the message directly to the Commercial Vehicle Driver using a roadside sign (*CVO pass/pull-in message*).

CVO06: Weigh-In-Motion



6.7 CVO07: Roadside CVO Safety

This service package provides for automated roadside safety monitoring and reporting. It automates commercial vehicle safety inspections at the roadside check locations. The capabilities for performing the safety inspection are shared between this service package and the On-board CVO and Freight Safety & Security (CVO08) service package which enables a variety of implementation options. The basic option, directly supported by this service package, facilitates safety inspection of vehicles that have been pulled off the highway, perhaps as a result of the automated screening process provided by the Electronic Clearance (CVO03) service package. In this scenario, only basic identification data and status information is read from the electronic tag on the commercial vehicle. The identification data from the tag enables access to additional safety data maintained in the infrastructure which is used to support the safety inspection, and may also inform the pull-in decision if system timing requirements can be met. More advanced implementations, supported by the On-board CVO and Freight Safety & Security (CVO08) service package, utilize additional on-board vehicle safety monitoring and reporting capabilities in the commercial vehicle to augment the roadside safety check.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Commercial Vehicle Administration Subsystem (CVAS) maintains the required safety reports in support of a roadside safety inspection. CVAS can communicate with Other CVAS' to exchange safety inspection reports (*safety inspection report*) with other jurisdictions. CVAS will send the *safety inspection report* to the Commercial Vehicle Check Subsystem (CVCS) and the Enforcement Agency. On an asynchronous basis, the Enforcement Agency can provide CVCS with information about commercial vehicle violations (*information on violators*). In addition, regional or national Alerting and Advisory Systems can provide both CVAS and CVCS with *alerts and advisories*.

2. The Commercial Vehicle Administration Subsystem (CVAS) maintains the required safety status, the safety portion of the CVISN "snapshot", in support of a roadside safety inspection. CVAS can communicate with Other CVAS' to exchange *safety status information* with other jurisdictions. CVAS will make *safety status information* available to the Commercial Vehicle Check Subsystem (CVCS) to ensure it has the most up-to-date information to support the roadside safety inspections. To further support the safety inspections, CVAS can also provide CVCS with *accident report*s and *citation* data that it has collected as well as providing the most recent updates of the *credentials information* and *credentials status information*. CVAS will also send information about a carrier's involvement in enforcement programs (*carrier participation report*) and commercial drivers licensing to the roadside (*cv driver record*).

3. On an asynchronous basis, the Commercial Vehicle Driver can send driver and vehicle information to the Commercial Vehicle Subsystem (*CVO driver initialization*).

4. The entire process is under the asynchronous monitoring (*CVO inspector information*) and control (*CVC Override Mode*) of the CVO Inspector.

5. On an asynchronous basis, the Commercial Vehicle Check Subsystem (CVCS) can detect and identify the Basic Commercial Vehicle using non-ITS equipment to visually determine the identity of the vehicle (USDOT number, license plate, etc.) (*identification information*) and the vehicle characteristics (size, number of axles, use of trailer, etc.) (*CVO weight and presence*). Alternately the CVCS can request data from CVS to be transmitted electronically, including identity and credentials data (*request tag data*), safety information (*safety inspection request*), or information concerning the freight or cargo (*electronic lock data request*). The commercial vehicle driver's credentials can be read directly from an electronic Driver Identification Card (*cv driver credential*) and CVS will send the identity/credentials data it maintains on-board including *tag data*, inspection data (*safety inspection record*), or cargo data (*electronic lock data*). At the end of the inspection, CVCS can send the results back to the CVS (*safety inspection record*).

6. After analyzing the safety data, a decision is made to either allow the vehicle to pass or require it to be stopped. The Commercial Vehicle Check Subsystem can send the decision to the Commercial Vehicle Subsystem (*pass/pull-in*), which will forward the data to the Commercial Vehicle Driver (*CVO pass/pull-in message*). Alternately the Commercial Vehicle Check Subsystem can send the decision directly to the Commercial Vehicle Driver (*CVO pass/pull-in message*) using a roadside sign.

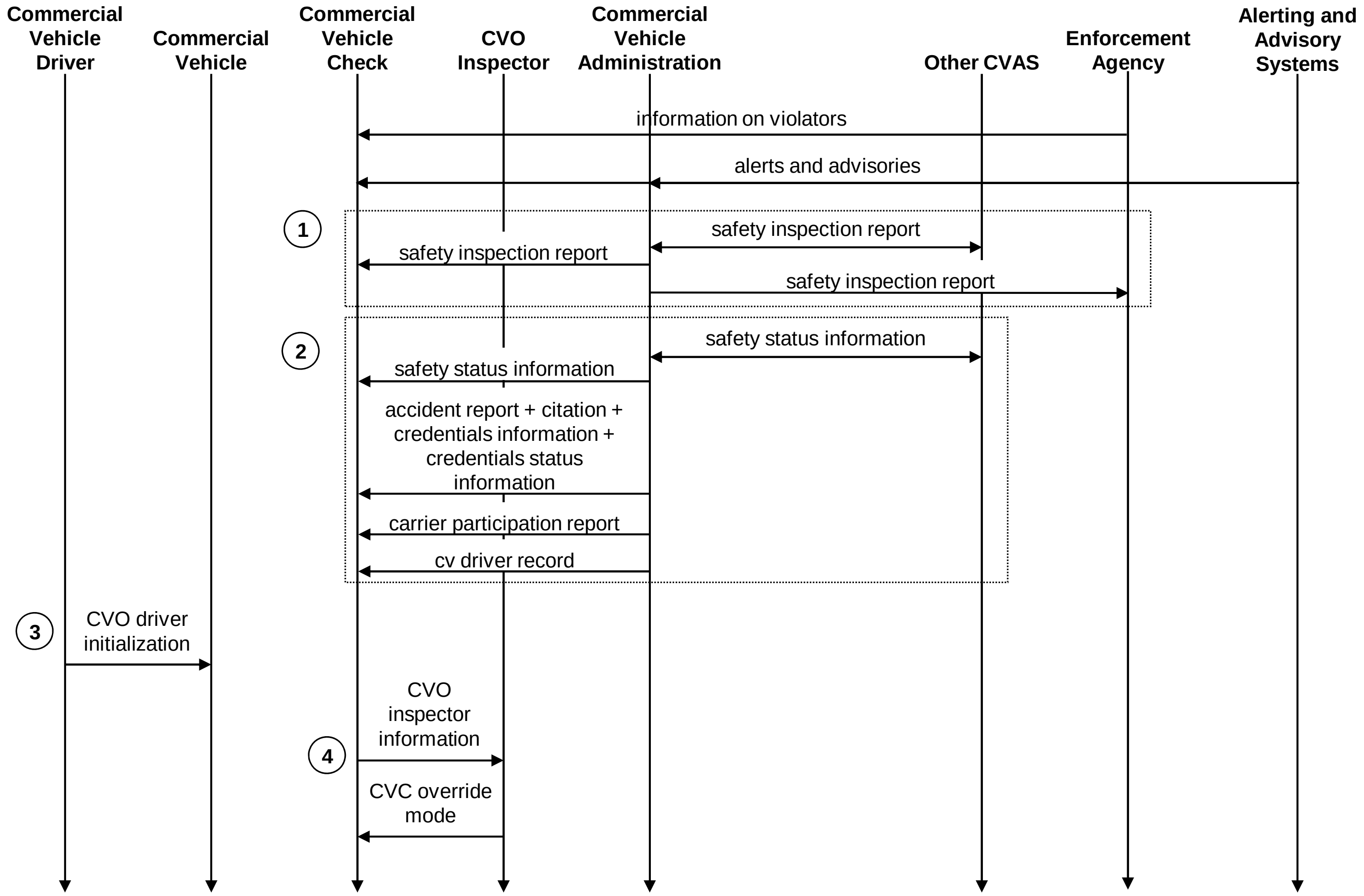
7. If the commercial vehicle was pulled-in for inspection, the CVO Inspector can perform a safety inspection and send the results to CVCS, *CVO inspector input*. After the safety inspection, CVCS can send the report to CVAS (*safety inspection report*), which can be sent to the Fleet and Freight Management Subsystem (FFMS), *safety inspection report*. FFMS will take the necessary actions and submit a *cv repair status* to CVAS to indicate what maintenance items were performed.

8. If any statutes or regulations were violated, the Commercial Vehicle Check Subsystem can send information on violators to the Commercial Vehicle Administration Subsystem and Enforcement Agency (*violation notification*). CVAS will also forward the notices to the Enforcement Agency (*violation notification*).

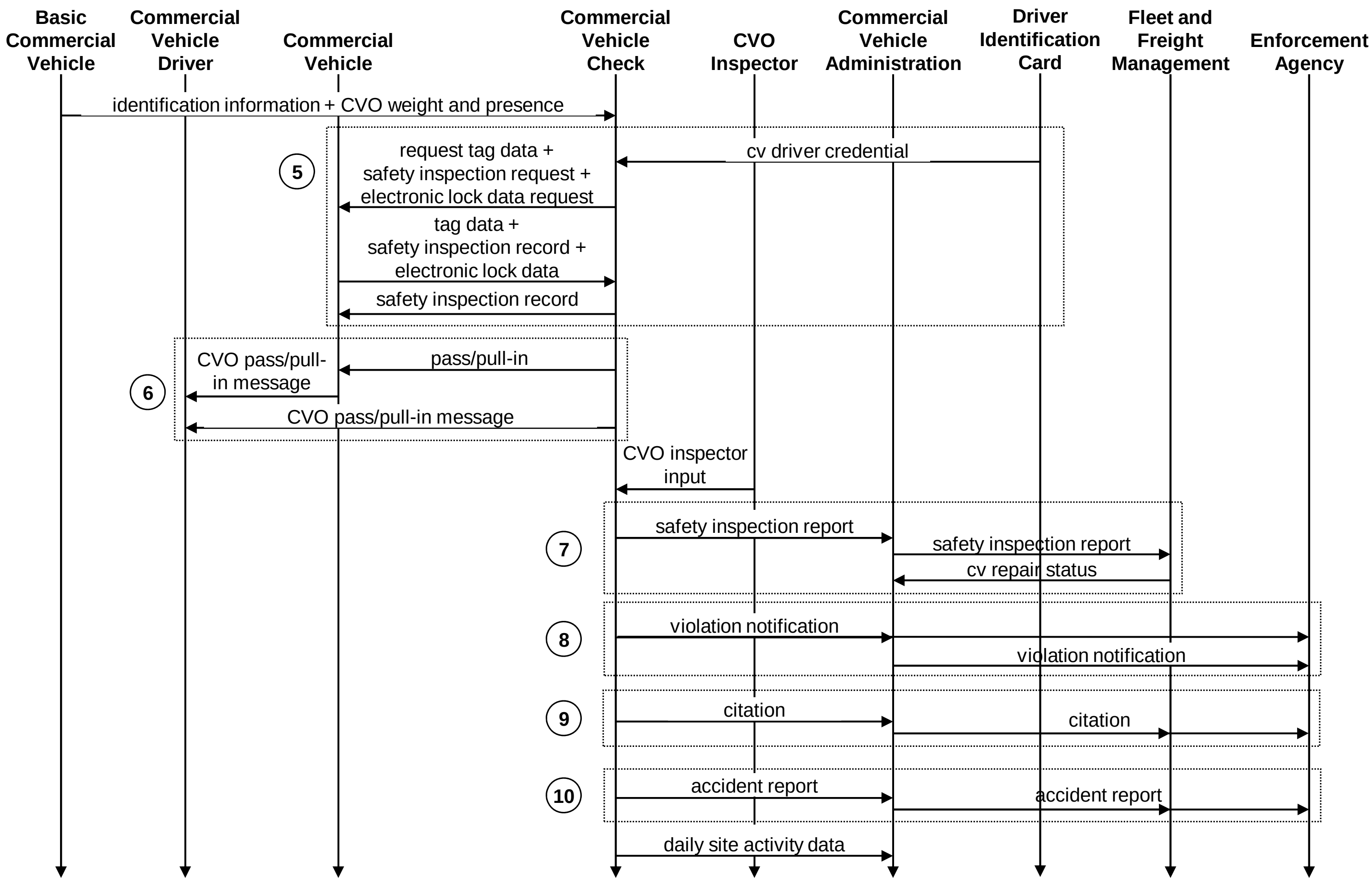
9. Similarly, if a citation was issued during the inspection process, the Commercial Vehicle Check Subsystem can send this data to the Commercial Vehicle Administration Subsystem (*citation*) for distribution to the Enforcement Agency (*citation*) and the Fleet and Freight Management Subsystem (*citation*).

10. Similarly, if an accident report was generated during the inspection process, the Commercial Vehicle Check Subsystem can send this data to the Commercial Vehicle Administration Subsystem (*accident report*) for distribution to the Enforcement Agency (*accident report*) and the Fleet and Freight Management Subsystem (*accident report*). On an asynchronous basis, the Commercial Vehicle Check Subsystem will update the Commercial Vehicle Administration Subsystem with a record of daily activities, including summaries of screening events and inspections (*daily site activity data*).

CVO07: Roadside CVO Safety (1 of 2)
(Pre Safety Check)



CVO07: Roadside CVO Safety (2 of 2)
(Safety Check and Post Safety Check)



6.8 CVO08: On-board CVO Safety

This service package provides for on-board commercial vehicle safety monitoring and reporting. It is an enhancement of the Roadside CVO Safety Service Package and includes support for collecting on-board safety data via transceivers or other means. The on-board safety data are assessed by an off-board system. In some cases the monitoring and safety assessment may occur remotely (i.e., not at a roadside site). Following the assessment, safety warnings are provided to the driver, the Commercial Vehicle Check roadside elements, and carrier. This service package allows for the Fleet and Freight Management subsystem to have access to the on-board safety data.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Throughout this process a Fleet and Freight Management Subsystem (FFMS) that is the carrier's operations system managing the fleet of vehicles will send information to the Fleet-Freight Manager (*fleet status*) automatically, or in response to a *fleet manager inquiry*.

2. The Commercial Vehicle Subsystem (CVS) receives the *cv driver credential* from the Driver Identification Card and *CVO driver initialization* inputs from the Commercial Vehicle Driver that represent the driver's interaction with on-board equipment including setup, configuration, and initiation of self-tests, and entry of carrier, driver, vehicle, and route information. FFMS may provide a copy of the *driver log* that it has maintained to load into the CVS on-board computer - either as part of the initialization when a driver may be switching vehicles or to develop a safety data message for reporting later.

3. The Commercial Vehicle Subsystem (CVS) will receive *position fix* readings from a Location Data Source that will be used to support various safety and navigation functions on board including a trigger of safety data message transmission when required. On an asynchronous basis, the Basic Commercial Vehicle can send vehicle safety and security information measured by non-ITS equipment to the Commercial Vehicle Subsystem (*commercial vehicle measures*) and instrumented Freight Equipment, including the chassis, trailer, container, or cargo area can provide *freight equipment information* to the CVS equipment. The Commercial Vehicle Subsystem will process this data and forward any safety related warnings to the Commercial Vehicle Driver (*alerts*) to which the driver may respond with *alert response* to acknowledge the alert or initiate another action.

4. An Enforcement Agency will define a geographic area, time frame, and other parameters that will govern the collection of commercial vehicle safety data and will send the *trigger area definition* to the Commercial Vehicle Administration Subsystem (CVAS). CVAS will, in turn, publicize the *trigger area* configuration data to the Fleet and Freight Management Subsystems (FFMS). FFMS will then pass this information onto its fleet of commercial vehicles also (*trigger area*).

5. When it is time to start the collection process with the predefined trigger areas, the Enforcement Agency will notify the Commercial Vehicle Administration Subsystems (CVAS) to begin collecting data from vehicles within the trigger areas (*trigger control*). CVAS will send *trigger control* commands to the Commercial Vehicle Check Subsystem (CVCS) components located in the field.

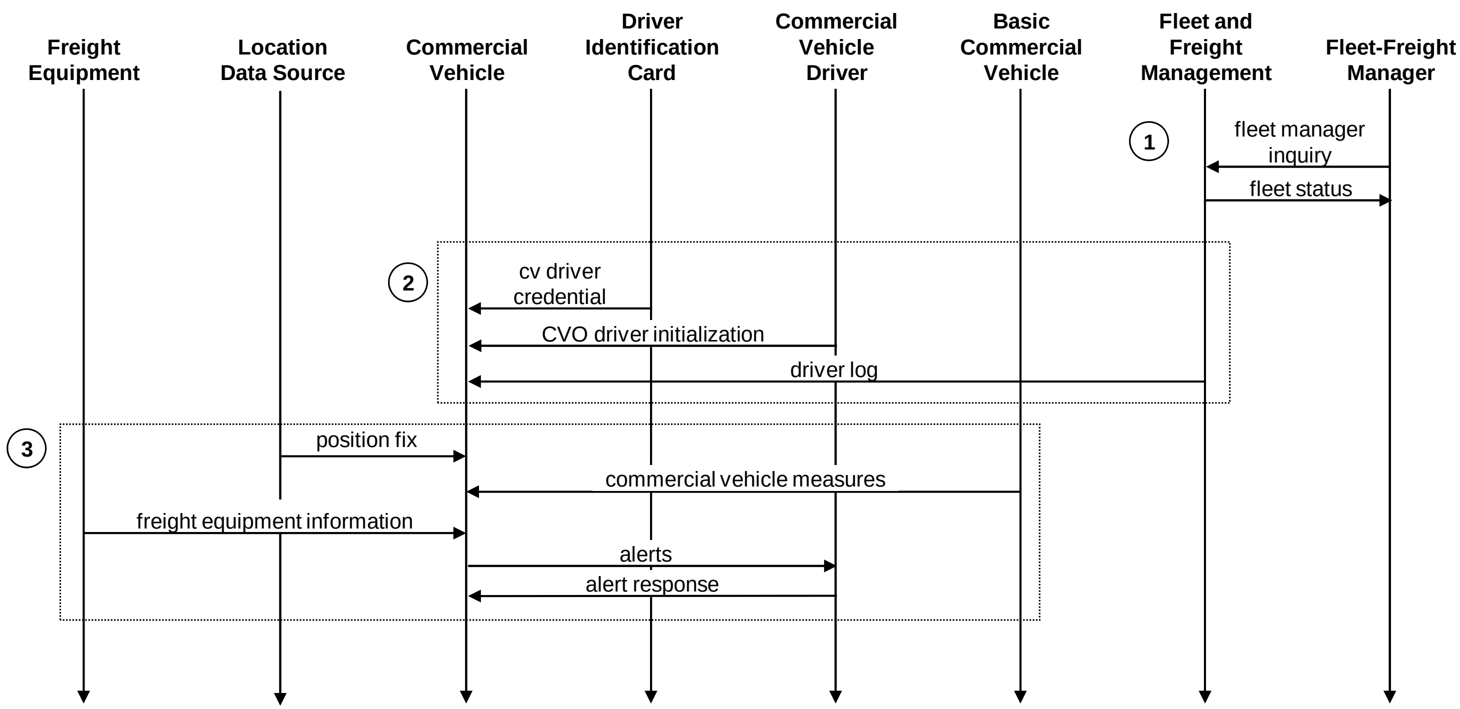
Commercial Vehicle Operations (CVO) Inspectors may also provide a *CVO inspector input* to control the CVCS equipment locally. CVAS will also inform the Fleet and Freight Management Subsystems (FFMS) that data collection has begun so the enrolled carriers can inform their vehicles (*trigger area notification*). Commercial Vehicle Subsystem (CVS) on-board equipment may also receive a *trigger area notification* signal directly from the CVCS at or along the roadside.

6. The Commercial Vehicle Check Subsystem (CVCS) will read *identification information* data from passing commercial vehicles and the equipped Commercial Vehicle Subsystems (CVS) that are within range of a CVCS will provide their daily log indicating the hours of service for the current driver (*driver log*) and information about the vehicle, vehicle components, cargo, and driver (*on-board safety data*). CVCS will provide the collected set of vehicle date up to the Commercial Vehicle Administration Subsystem (CVAS) to analyze the results (*driver log* and *on-board safety data*).

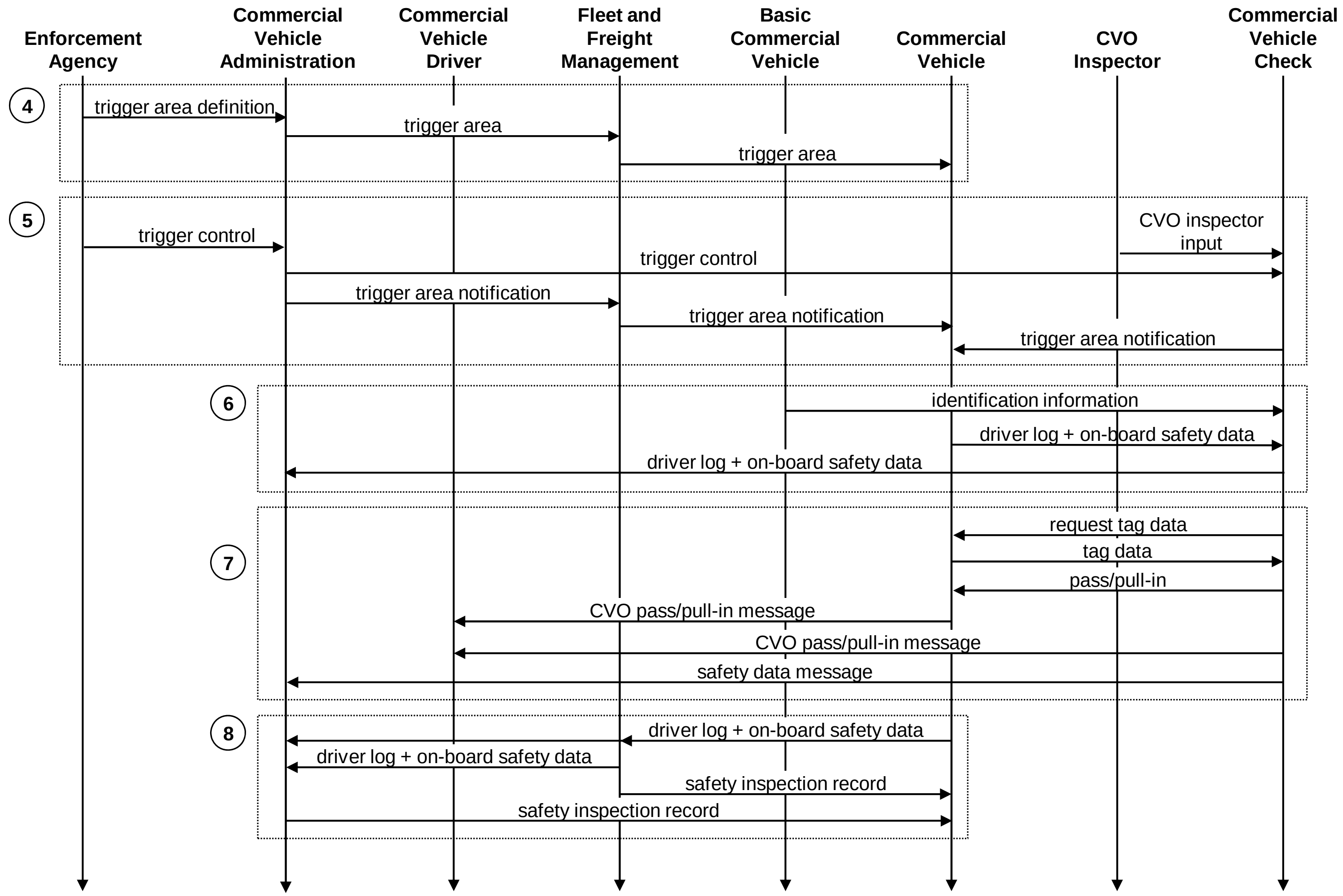
7. The Commercial Vehicle Check Subsystem (CVCS) can request identity and credentials data stored electronically on-board (*request tag data*). This data will be provided by the Commercial Vehicle Subsystem (CVS) on-board equipment to the CVCS (*tag data*). After analyzing the data provided by the CVS, a decision is made to either allow the vehicle to pass or require it to be stopped. CVCS can send the decision to the CVS (*pass/pull-in*), which will provide an indicator to the Commercial Vehicle Driver (*CVO pass/pull-in message*). Alternately, the CVCS can send the decision directly to the Commercial Vehicle Driver using a (*CVO pass/pull-in message*). Once the data has been collected and analyzed and any subsequent detailed inspections have been complete, the CVCS will send the completed *safety data message* for the vehicle onto the Commercial Vehicle Administration Subsystem (CVAS) for filing and storage.

8. Commercial Vehicle Subsystem (CVS) on-board equipment may also be able to use the positioning information it has from step 3 above to know that it is within a trigger area and to begin sending its *driver log* and *on-board safety data* to the Fleet and Freight Management Subsystem (FFMS) or directly on to the Commercial Vehicle Administration Subsystem (CVAS). FFMS will provide the collected set of *driver log* and *on-board safety data* inputs from its fleet of vehicles to the CVAS. Either CVAS or the carrier (FFMS) can provide a record of the safety inspection data that it has collected back down to the on-board equipment in the CVS (*safety inspection record*).

CVO08: On-board CVO Safety (1 of 2) (On-board and Fleet Processing)



CVO08: On-board CVO Safety (2 of 2)
(Wireless Roadside Inspection Activities)



6.9 CVO09: CVO Fleet Maintenance

This service package supports maintenance of CVO fleet vehicles with on-board monitoring equipment and Automated Vehicle Location (AVL) capabilities within the Fleet and Freight Management Subsystem. Records of vehicle mileage, repairs, and safety violations are maintained to assure safe vehicles on the highway.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

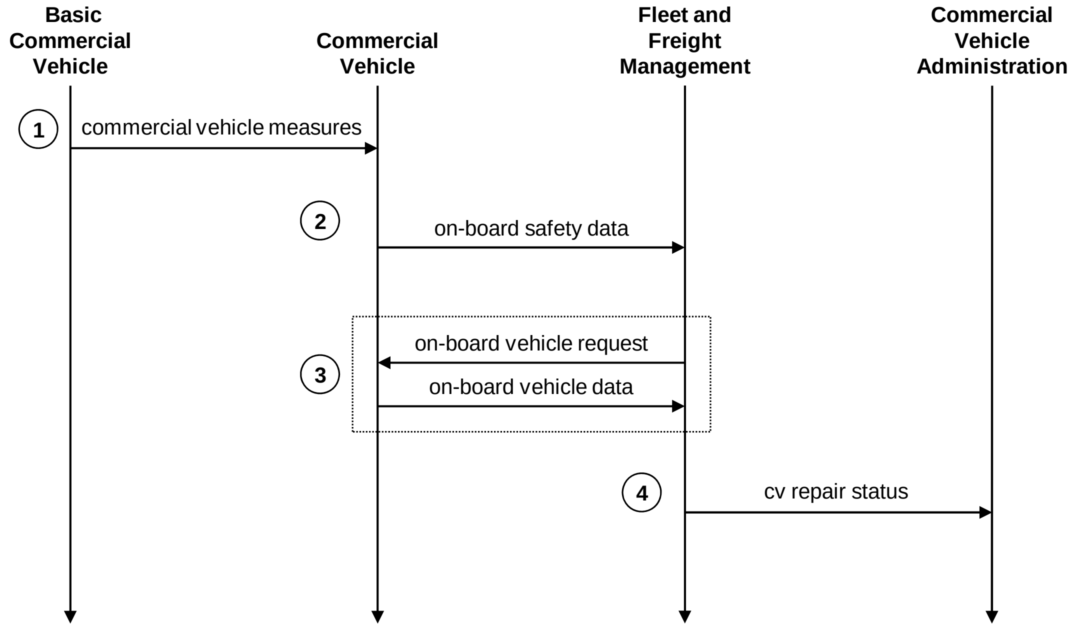
1. On an asynchronous basis, the on-board monitoring equipment in the Basic Commercial Vehicle sends commercial vehicle and cargo safety status to the Commercial Vehicle Subsystem (*commercial vehicle measures*).

2. The Fleet and Freight Management Subsystem can make a request to the Commercial Vehicle Subsystem for on-board safety data (*on-board safety request*). The Commercial Vehicle Subsystem will respond with information about the vehicle, vehicle components, cargo, and driver (*on-board safety data*).

3. The Commercial Vehicle Subsystem will send its on-board vehicle data to the Fleet and Freight Management Subsystem with *on-board vehicle data* for maintenance purposes, gate access, cargo status, lock status, etc.

4. The Fleet and Freight Management Subsystem will send maintenance logs including the status of repairs, *cv repair status*, made to its fleet to the Commercial Vehicle Administration Subsystem to support credentialing and tracking of a fleet's compliance with regulations and to clear any citations.

CVO09: CVO Fleet Maintenance



6.10 CVO10: HAZMAT Management

This service package integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem. The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response. The response is tailored based on information that is provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Either periodically or as hazmat cargo is loaded/unloaded, the Freight Equipment container, chassis or trailer can report the hazmat elements of the bill-of-lading included (*freight equipment information*) to the Commercial Vehicle Subsystem. In turn, the Commercial Vehicle Subsystem provides this information to the Fleet and Freight Management Subsystem. Alternatively, the Freight Equipment can independently report the information directly to the Fleet and Freight Management Subsystem.

2. On an asynchronous basis, current vehicle location is monitored by the Commercial Vehicle Subsystem (*position fix*).

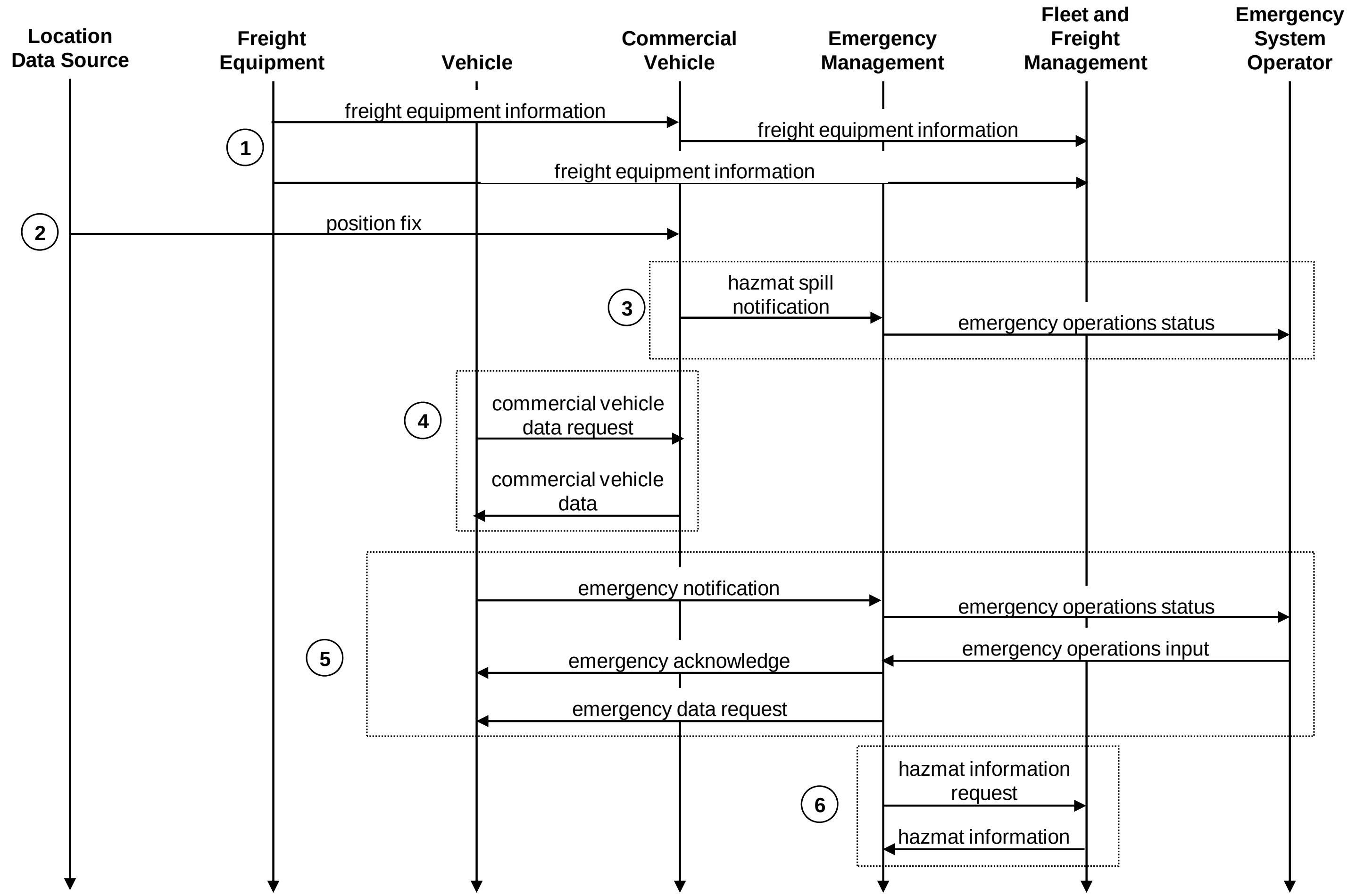
3. The Commercial Vehicle Subsystem can send a HAZMAT message, which includes vehicle location data, to the Emergency Management Subsystem (*hazmat spill notification*). The information is forwarded to the Emergency System Operator (as part of *emergency operations status*).

4. Alternately, HAZMAT information can be requested by the Vehicle Subsystem (*commercial vehicle data request*) from the Commercial Vehicle Subsystem. In response to the previous request, the Commercial Vehicle Subsystem will send HAZMAT information to the Vehicle Subsystem (*commercial vehicle data*). However, the Commercial Vehicle Subsystem can alternatively send HAZMAT information to the Vehicle Subsystem on an asynchronous basis (*commercial vehicle data*).

5. If the Vehicle Subsystem determines a HAZMAT incident has occurred, it will send a request for emergency assistance to the Emergency Management Subsystem (*emergency notification*). The request will be forwarded to the Emergency System Operator (as part of *emergency operations status*). The Emergency System Operator will initiate a response to the request for emergency assistance (as part of *emergency operations inputs*. The Emergency Management Subsystem will acknowledge this request for emergency assistance and provide additional details regarding actions and verification requirements (*emergency acknowledge*). In certain circumstances, the Emergency Management Subsystem can request additional information from the Vehicle Subsystem (*emergency data request*). The Commercial Vehicle Subsystem will respond with the specified information (as a part of *emergency notification*).

6. To obtain additional HAZMAT information, the Emergency Management Subsystem can request (*hazmat information request*) information about the HAZMAT load from the Fleet and Freight Management Subsystem, which may include the nature of the load and unloading instructions (*hazmat information*)

CVO10: HAZMAT Management



6.11 CVO11: Roadside HAZMAT Security Detection and Mitigation

This service package provides the capability to detect and classify security sensitive HAZMAT on commercial vehicles using roadside sensing and imaging technology. Credentials information can be accessed to verify if the commercial driver, vehicle and carrier are permitted to transport the identified HAZMAT. If the credentials analysis and sensed HAZMAT information do not agree, the vehicle can be signaled to pull off the highway, and if required, an alarm can be sent to Emergency Management to request they monitor, traffic stop or disable the vehicle.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Commercial Vehicle Check subsystem (located at the roadside) detects the presence and possibly weight of a commercial vehicle passing the station (*CVO weight and presence*).

2. The Commercial Vehicle Check subsystem collects *identification information* from the vehicle (e.g. vehicle ID, carrier ID and driver ID).

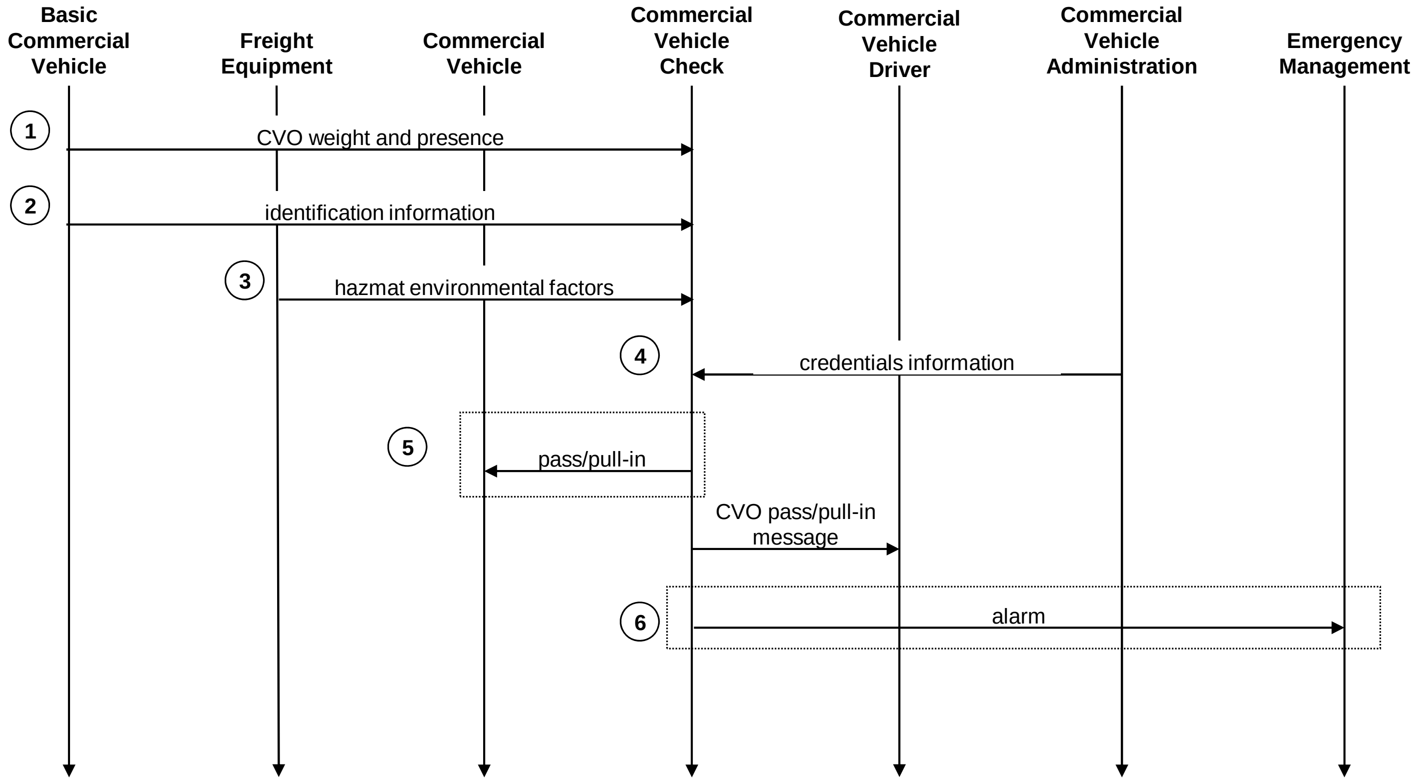
3. The Commercial Vehicle Check subsystem uses roadside sensors to monitor for and detect physical evidence of security sensitive HAZMAT coming from the vehicle's Freight Equipment (*hazmat environmental factors*). This could be, for example, radiation from the Freight Equipment (cargo, trailer, container, or chassis) or traces of ammonia (indicating a possible explosive) emanating from the cargo area or imaging and image analysis of the freight equipment using various imaging technologies.

4. The Commercial Vehicle Check subsystem collects the commercial vehicle’s *credentials information*, received from the Commercial Vehicle Administration subsystem. These credentials might be collected before the detection of the commercial vehicle being examined (and stored locally) or in real time after the identification information is received.

5. Based on the information collected, the Commercial Vehicle Check subsystem determines if security sensitive hazmat material has been detected, and if so, is it associated with a permitted activity. If security sensitive hazmat is detected, and it is not associated with a permitted activity, then the Commercial Vehicle Check subsystem issues a message to the commercial vehicle to stop at the inspection station. This message can be sent via the Commercial Vehicle Subsystem for in-vehicle signage (*pass/pull-in*) and/or directly to the Commercial Vehicle Driver as a dynamic message sign (*CVO pass/pull-in message*).

6. If the vehicle does not stop, or in the case of a positive identification of an un-permitted security sensitive hazmat cargo, then a message (*alarm*) is sent from the Commercial Vehicle Check subsystem to the Emergency Management agency with jurisdiction, e.g. local or state police, to coordinate a traffic stop or some other action with respect to the offending commercial vehicle.

CVO11: Roadside HAZMAT Security Detection and Mitigation



6.12 CVO12: CV Driver Security Authentication

This service package provides the ability for Fleet and Freight Management to detect when an unauthorized commercial vehicle driver attempts to drive their vehicle based on stored driver identity information. If an unauthorized driver has been detected, Fleet and Freight Management can activate commands to safely disable the commercial vehicle. Alarms can also be sent to emergency management to inform them of a potential commercial vehicle hijacking or theft and potential hazardous situation. In addition, Emergency Management can request Fleet and Freight Management to disable a specific vehicle in their fleet.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

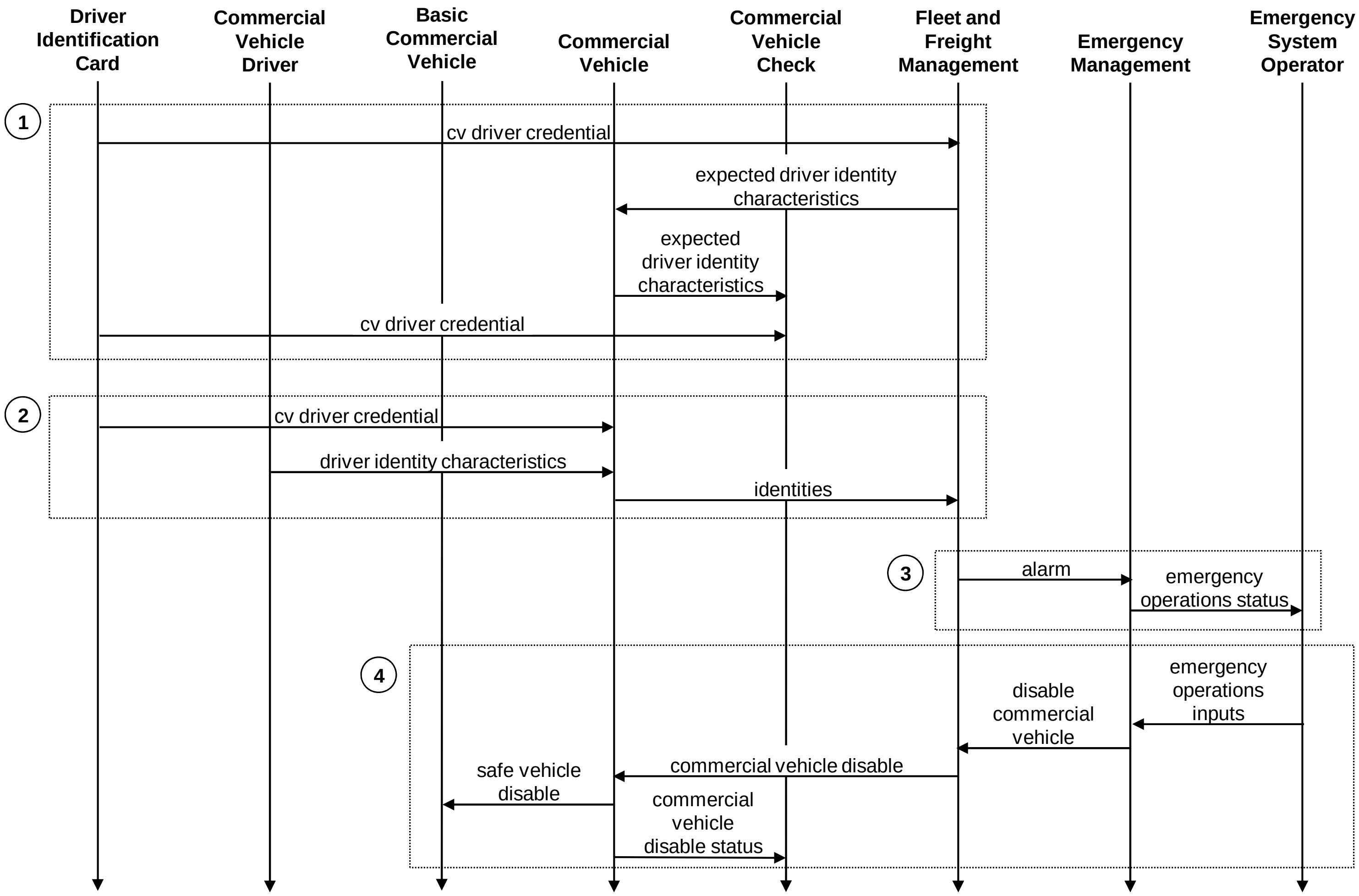
1. The Fleet and Freight Management Subsystem (FFMS), representing an operations center for a fleet of commercial vehicles, collects the *cv driver credential* data from the Driver Identification Cards for its staff. FFMS will then send one or more expected driver identities to each Commercial Vehicle Subsystem (CVS). This may be sent on a regular basis or any time there is a change in the expected set of drivers. The list (*expected driver identity characteristics*) can include driver identification information such as Personal Identification Numbers (PINs) for each driver ID card (that might be swiped or read at the vehicle), and/or particular biometric measurements for individual drivers e.g. finger or handprint parameters, retina pattern parameters. The CVS will then send the *expected driver identity characteristics* to the Commercial Vehicle Check Subsystem (CVCS) in the field when passing a wireless roadside inspection facility. The *cv driver credential* from the Driver Identification Card may also be read directly by the CVCS equipment in the field.

2. When a driver wishes to operate a vehicle, their *cv driver credential* data is read from their Driver Identification Card and they provide their personal identification information to the vehicle (*driver identity characteristics*). The vehicle equipment analyzes the submitted characteristics and/or information, and based on the expected characteristics, identifies the driver (or that the driver is unidentified) and sends that information to the fleet operations center (*identities*).

3. If a non-expected driver is attempting to operate the commercial vehicle (possible or likely vehicle hijacking), a message can be issued to the police function with appropriate jurisdiction (*alarm*). The alarm is provided to the Emergency System Operator (as part of *emergency operations status*) so that orders can be issued to stop the vehicle or take some other appropriate action.

4. Disabling a commercial vehicle with an invalid driver can be initiated at any of three levels: by the vehicle (*safe vehicle disable*) when the driver fails the identity test, by the commercial vehicle operations center with a message from FFMS to the vehicle (*commercial vehicle disable*), or by an Emergency Management (EM) subsystem, i.e., law enforcement agency, with jurisdiction via the FFMS or commercial vehicle operations center (*disable commercial vehicle*). In the case of the law enforcement agency initiating the disable, the action is originated by the appropriate system operator (the Emergency System Operator as part of *emergency operations inputs*). The Commercial Vehicle Subsystem will also provide the CVCS with an indication that it is being disabled and its status (*commercial vehicle disable status*).

CVO12: CV Driver Security Authentication



6.13 CVO13: Freight Assignment Tracking

This service package provides for the planning and tracking of three aspects of commercial vehicle shipments. For each shipment, the commercial vehicle, the freight equipment, and the commercial vehicle driver are monitored for consistency with the planned assignment. Any unauthorized changes are determined by the Fleet and Freight Management subsystem and then the appropriate people and subsystems are notified. Data collected by the On-board CV and Freight Safety & Security and the On-board Driver Authentication equipment packages used in other service packages are also used to monitor the three aspects of assignment for this service package. In addition to this service package, Fleet and Freight Managers may also monitor routes and itineraries and this capability is included in Fleet Administration.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Periodically or asynchronously, the Alerting and Advisory Agency systems (e.g., Trucking Information Sharing and Analysis Center or ISAC) may send *alerts and advisories* to the Fleet and Freight Management Subsystem.

2. Periodically the Basic Commercial Vehicle sends measurements (*commercial vehicle measures*) to the Commercial Vehicle Subsystem regarding the brake status, the mileage traveled, the location of the vehicle, the state of the driver and ability to drive, and the vehicle identity and its safety status.

Shipments are initiated with the cooperation of several entities and information flows are exchanged to notify all vested agencies of the plan for the goods movement. This process is part of the Typical Freight Operations of CVO02: Freight Administration.

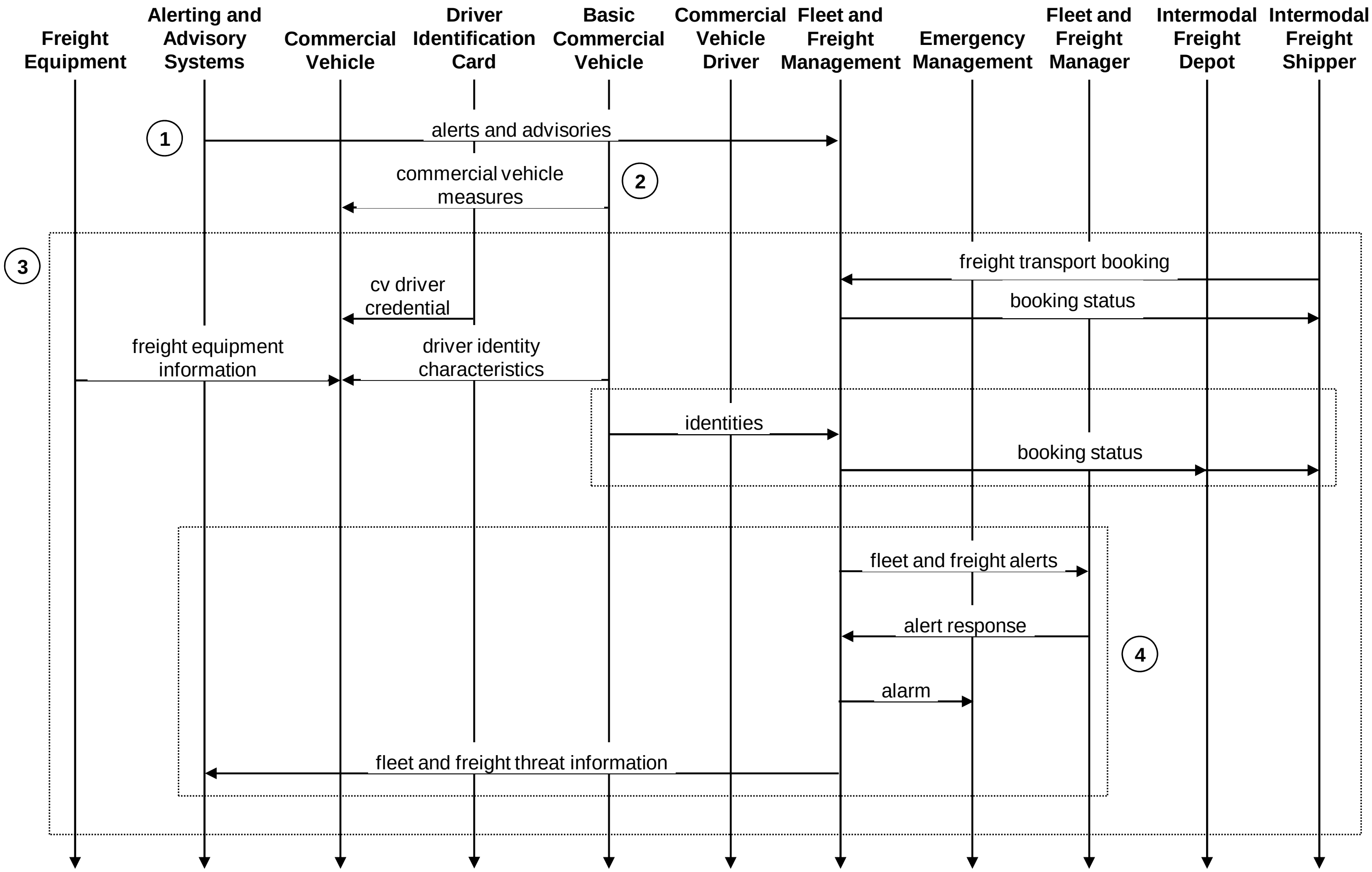
3. Once a shipment has been initiated (*freight transport booking*), the plan for shipment (i.e., booking) is sent back to the Intermodal Freight Shipper (*booking status*) and then monitored throughout is course, from origin to destination. Several steps are involved in this monitoring:

    - Whenever a Commercial Vehicle Driver enters the Commercial Vehicle, his *driver identity characteristics* are sent to the Commercial Vehicle Subsystem (CVS) and the *cv driver credential* is read by the CVS from the Driver Identification Card.
    - Similarly, whenever cargo is loaded onto a trailer and/or the trailer/chassis is connected to the commercial vehicle, the identification of the Freight Equipment is sent to the Commercial Vehicle Subsystem (*freight equipment information*).
    - Periodically and continually during the shipment, the *identities* of the driver, the freight equipment (and consequently the freight itself), and the vehicle are sent to the Fleet and Freight Management Subsystem from the Basic Commercial Vehicle. This information (*booking status*) is also forwarded from the Fleet and Freight Management Subsystem to both the Intermodal Freight Shipper and the Intermodal Freight Depot so that all vested agencies are aware of the status of the goods movement.

4. The tracking of the booking continues throughout the shipment. If no exceptions arise then nothing else occurs and the goods arrive at their destination according to the booking. However, should any unplanned changes occur during the tracking, a series of steps is initiated:

    - Initially, the exception is sent from the Fleet and Freight Management Subsystem to the Fleet and Freight Manager (*fleet and freight alerts*).
    - The Fleet and Freight Manager analyses the exception and determines if this is acceptable and reasonable and possibly updates the booking. Alternatively, the Fleet and Freight Manager may decide that there is something wrong and that further action must be taken to abort the shipment and prevent further adverse outcomes. In either case, the *alert response* is sent from the Fleet and Freight Manager back to the Fleet and Freight Management Subsystem.
    - If enough time has passed without a response from the Fleet and Freight Manager, or if the response indicates an unacceptable situation has occurred, the Fleet and Freight Management Subsystem would send an *alarm* to the Emergency Management Subsystem.
    - A notification of assignment exception is also sent to the Alerting and Advisory Systems as *fleet and freight threat information*.

CVO13: Freight Assignment Tracking



7 Maintenance and Construction Operations

This section provides the Theory of Operations for the Maintenance and Construction Operations Service Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each service package section) to identify these service packages is MCO—Maintenance and Construction Operations.

7.1 MC01: Maintenance and Construction Vehicle and Equipment Tracking

This service package will track the location of maintenance and construction vehicles and other equipment to ascertain the progress of their activities. These activities can include ensuring the correct roads are being plowed and work activity is being performed at the correct locations.

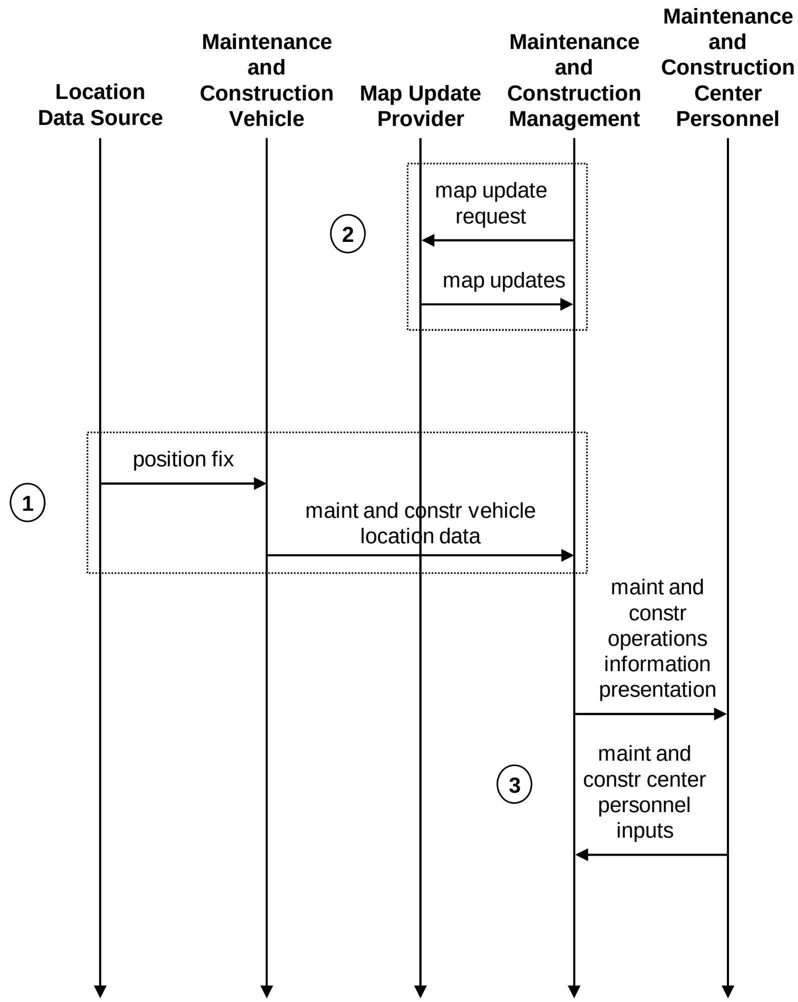
The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Maintenance and Construction Vehicle Subsystem (MCVS) tracks its current position (*position fix*) and that vehicle location information is passed along to the Maintenance and Construction Management Subsystem (MCMS) (*maint and constr vehicle location data*).

2. As part of vehicle tracking the MCMS will convert the location data received from the MCVS into some map-based representation. An interface to a Map Update Provider is available to keep this map-based representation of the transportation network current. The implied operation of this interface is for the MCMS to request a map update (*map update request*), and the Map Update Provider to electronically provide the update (*map updates*).

3. The entire process is under the asynchronous monitoring (*maint and constr operations information presentation*) and control (*maint and constr center personnel inputs*) of Maintenance and Construction Center Personnel.

MC01: Maintenance and Construction Vehicle and Equipment Tracking



7.2 MC02: Maintenance and Construction Vehicle Maintenance

This service package performs vehicle maintenance scheduling and manages both routine and corrective maintenance activities on vehicles and other maintenance and construction equipment. It includes on-board sensors capable of automatically performing diagnostics for maintenance and construction vehicles, and the systems that collect this diagnostic information and use it to schedule and manage vehicle maintenance.

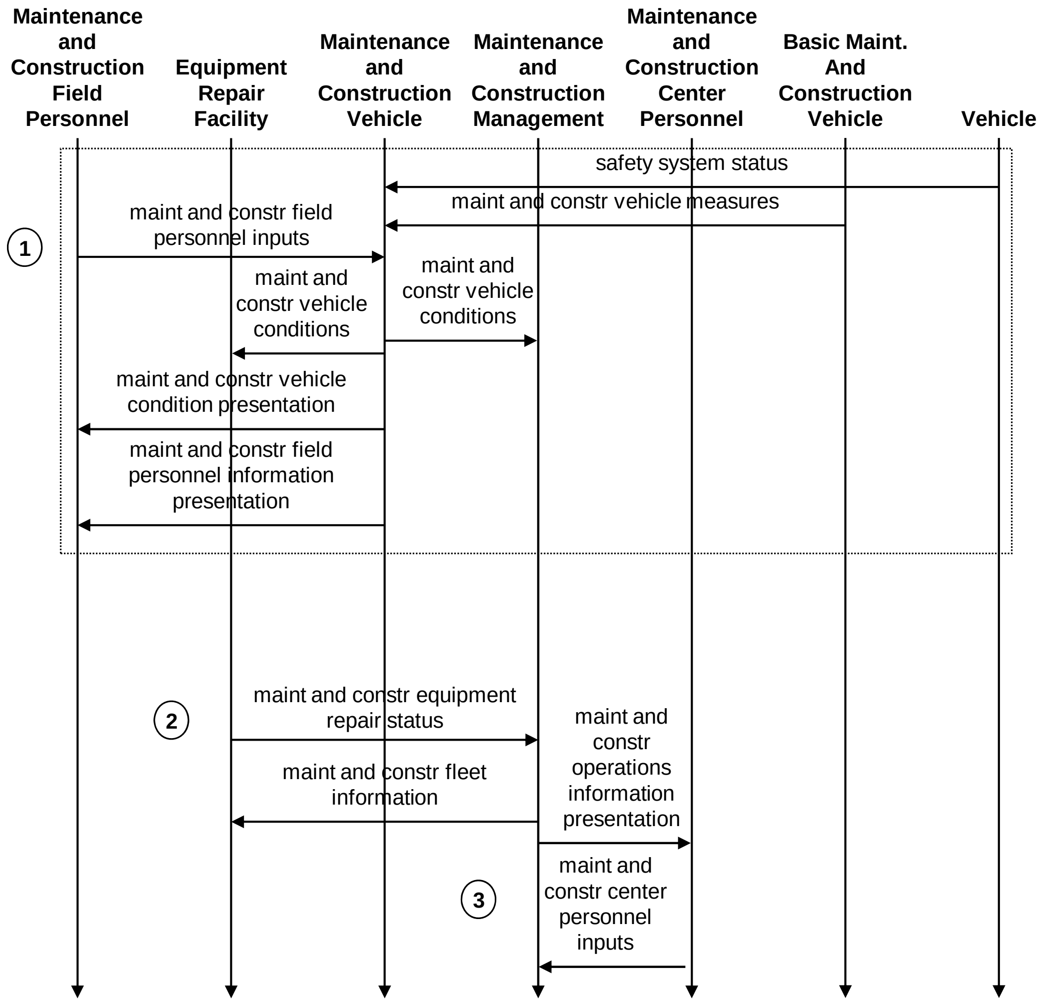
The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Maintenance and Construction Vehicle Subsystem (MCVS) receives data from advanced safety systems on board the vehicle (*safety system status*) and data from operational systems on-board the vehicle (*maint and constr vehicle measures*). This latter set of data could include the outputs of general non-ITS sensors providing vehicle information such as engine temperature. The latter set of data could also include data from maintenance-specific systems such as a materials spreader or snow plow equipment. In addition, equipment status can be entered by Maintenance and Construction Field Personnel (*maint and constr field personnel inputs*). This data (*maint and constr vehicle conditions*) could then be automatically transferred to the Maintenance and Construction Management Subsystem (MCMS) or the Equipment Repair Facility where this diagnostic information is then used to schedule and manage vehicle maintenance. In addition to sending the data to the centers, it could also be displayed to the Maintenance and Construction Field Personnel (*maint and constr vehicle condition presentation*). Finally, specific instruction (such as to cease operating a machine or to take the machine to maintenance immediately) could be presented to the Maintenance and Construction Field Personnel (*maint and constr field personnel information presentation*).

2. The Equipment Repair Facility can provide to the MCMS current maintenance and repair status of the maintenance and construction vehicle fleet and other support equipment, including a record of all maintenance and repair activities performed (*maint and constr equipment repair status*). The MCMS provides fleet information to the Equipment Repair Facility such as status and diagnostic information, vehicle utilization, and coordination of when vehicles will be available for preventative and corrective maintenance (*maint and constr fleet information*).

3. The entire process is under the asynchronous monitoring (*maint and constr operations information presentation*) and control (*maint and constr center personnel inputs*) of Maintenance and Construction Center Personnel.

MC02: Maintenance and Construction Vehicle Maintenance



7.3 MC03: Road Weather Data Collection

This service package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway (or guideway in the case of transit related rail systems). In addition to fixed sensor stations at the roadside, sensing of the roadway environment can also occur from sensor systems located on Maintenance and Construction Vehicles. The collected environmental data is used by the Weather Information Processing and Distribution service package to process the information and make decisions on operations. The collected environmental data may be aggregated, combined with data attributes and sent to meteorological systems for data qualification and further data consolidation. The service package may also request and receive qualified data sets from meteorological systems.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Maintenance and Construction Management Subsystem (MCMS) can control (*environmental sensors control*) and monitor (*environmental sensor data*) road and weather condition sensors at the Roadway. The (*environmental conditions*) architecture flow represents the road conditions that are measured by an environmental sensor at the Roadway. The MCMS may pass *environmental conditions data* along to the Weather Service or Surface Transportation Weather Service. The Weather Service is used to represent the Clarus System, which performs quality checks on the sensor data received, formats and consolidates data from multiple sources, and then can send it back to the MCMS as *qualified environmental conditions data*. The Weather Service can also provide back to the MCMS information on the data quality of the sensor information provided by the center (*environmental conditions data status*).

2. Within the MCMS the above process is under the asynchronous monitoring (*maint and constr operations information presentation*) and control (*maint and constr center personnel inputs*) of Maintenance and Construction Center Personnel.

3. The Traffic Management Subsystem (TMS) can also control (*environmental sensors control*) and monitor (*environmental sensor data*) road and weather condition sensors at the Roadway. The TMS may pass *environmental conditions data* along to the Weather Service or Surface Transportation Weather Service, or share it bidirectionally with the MCMS. The Weather Service is used to represent the Clarus System, which performs quality checks on the sensor data received, formats and consolidates data from multiple sources, and then can send it back to the MCMS as *qualified environmental conditions data*. The Weather Service can also provide back to the MCMS information on the data quality of the sensor information provided by the center (*environmental conditions data status*).

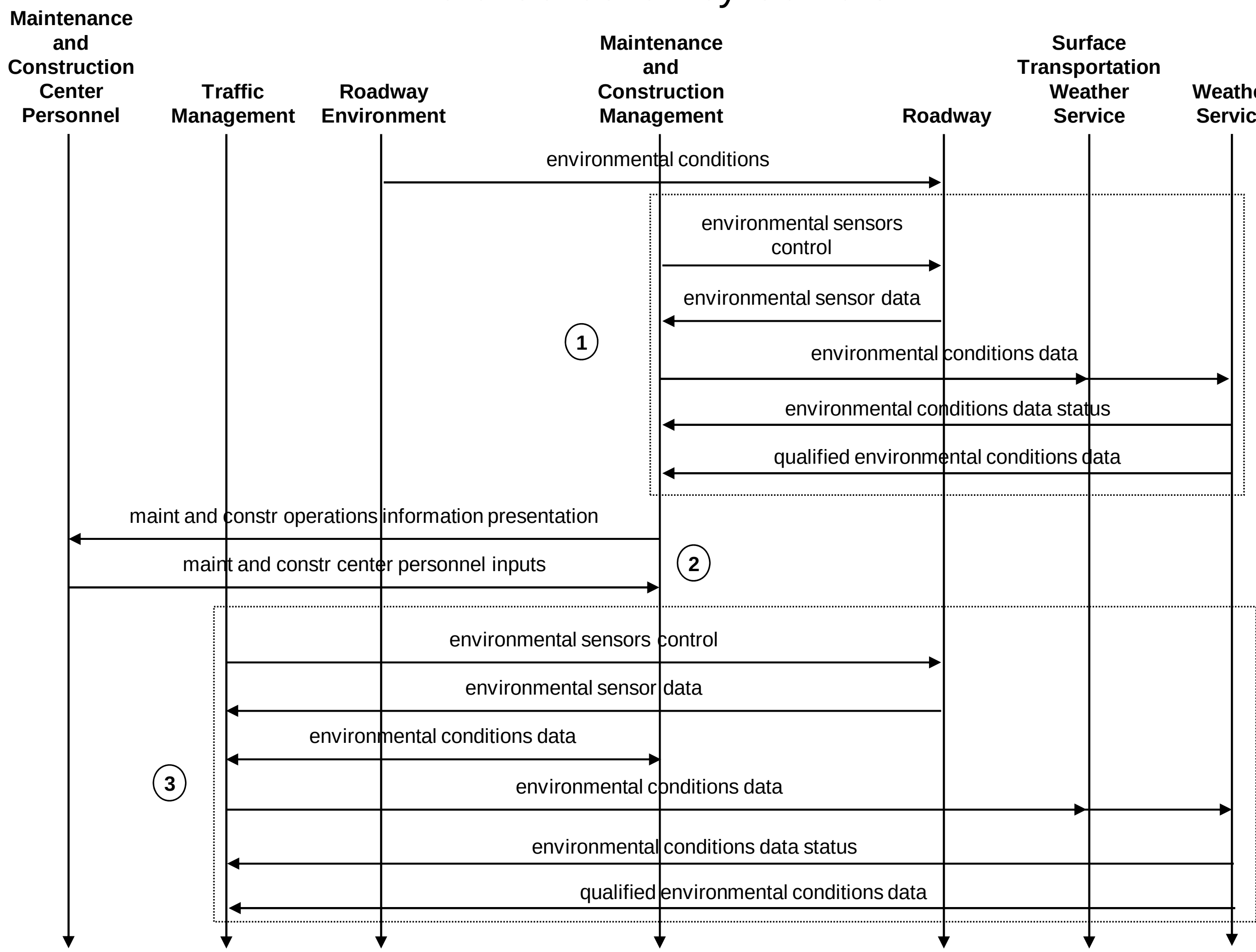
4. In some cases the Weather Service is the entity that manages these environmental sensors. In this case the Weather Service would control (*environmental sensors control*) and monitor (*environmental sensor data*) the road and weather condition sensors at the Roadway. When the Weather Service terminator is used to represent the Clarus System, it can provide *qualified environmental conditions data* to the MCMS, TMS, and the Information Service Provider (ISP).

5. In other cases the Surface Transportation Weather Service is the entity managing the environmental sensors. In this case the Surface Transportation Weather Service would control (*environmental sensors control*) and monitor (*environmental sensor data*) the road and weather condition sensors at the Roadway. The Surface Transportation Weather Service may then pass this (*environmental conditions data*) along either to the MCMS or the TMS (or both).

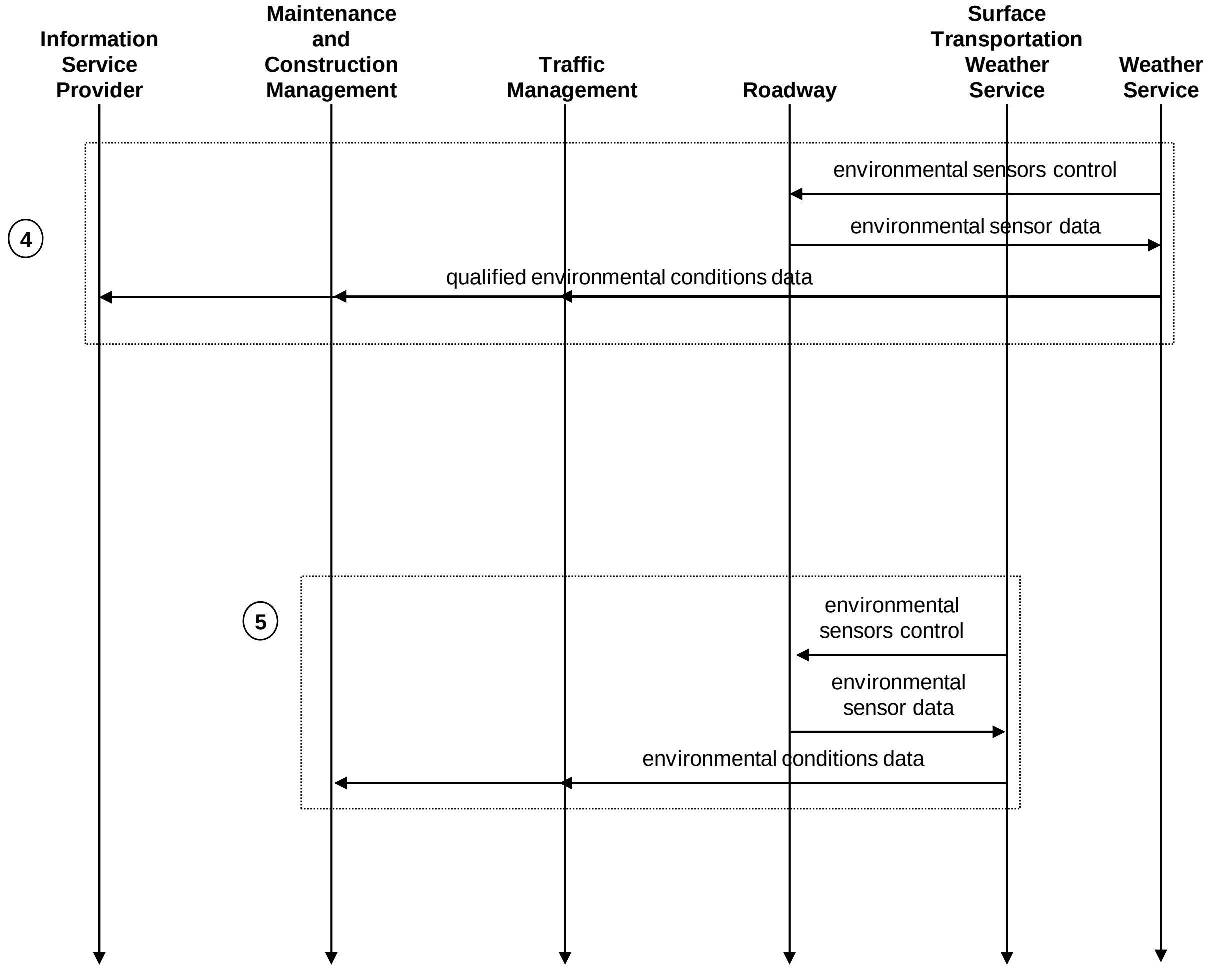
6. This data collection alternative covers the case where the environmental sensors are on-board the Maintenance and Construction Vehicle Subsystem (MCVS). The (*environmental conditions*) architecture flow represents the road conditions that are measured by an environmental sensor on the vehicle. The on-board sensor can be managed by the MCMS. In this case the MCMS controls (*environmental sensors control*) and monitors (*environmental sensor data*) the road and weather condition sensors on board the vehicle. Alternately the control could originate with the Maintenance and Construction Field Personnel on-board the vehicle (*maint and constr field personnel inputs*) and the sensor data would be presented to them (*maint and constr field personnel information presentation*). Note the control by Field Personnel is not explicitly shown in the diagram, but would certainly be an option.

7. This data collection alternative involves control (*environmental sensors control*) and monitoring (*environmental sensor data*) of sensors at the Roadway from the MCVS. The control begins with the Maintenance and Construction Field Personnel on-board the vehicle (*maint and constr field personnel inputs*) and passes from the MCVS to the Roadway (*environmental sensors control*). The sensor data is monitored by the MCVS (*environmental sensor data*), who could then send it along to the MCMS as described in item 6 above. In addition, the data from on-board sensors can be sent via a wireless link to devices that are part of the Roadway Subsystem for aggregation with other field or vehicle based sensors. This interface between the Roadway and MCVS sensors systems can also be used to support calibration of one system by the other.

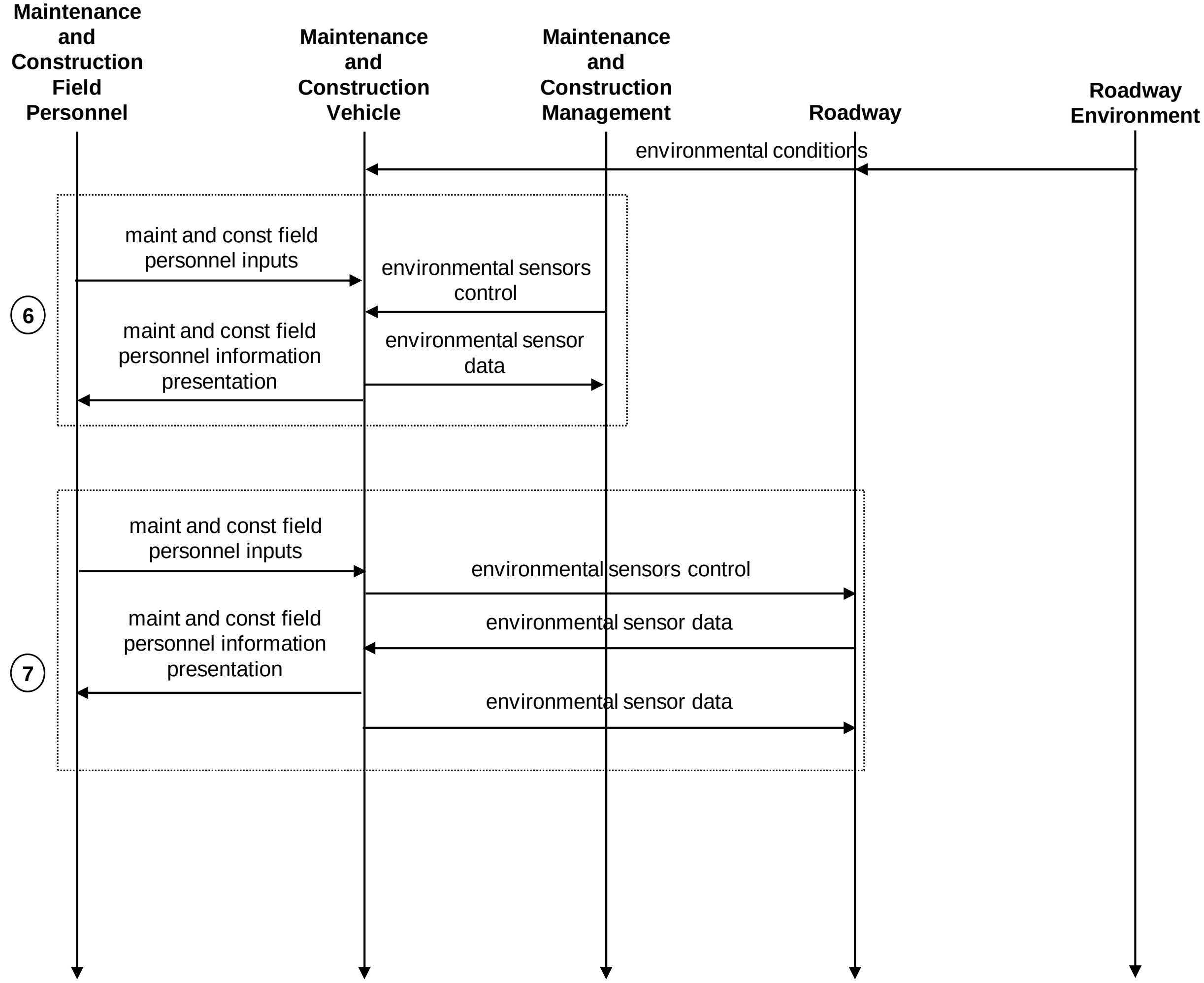
MC03: Road Weather Data Collection (1 of 3)
Data Collection by Centers



MC03: Road Weather Data Collection (2 of 3)
Data Collection by Weather Entities



MC03: Road Weather Data Collection (3 of 3)
Data Collection from Vehicles



7.4 MC04: Weather Information Processing and Distribution

This service package processes and distributes the environmental information collected from the Road Weather Data Collection service package. This service package uses the environmental data to detect environmental hazards such as icy road conditions, high winds, dense fog, etc. so system operators and decision support systems can make decision on corrective actions to take. The continuing updates of road condition information and current temperatures can be used by system operators to more effectively deploy road maintenance resources, issue general traveler advisories, issue location specific warnings to drivers using the Traffic Information Dissemination service package, and aid operators in scheduling work activity.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Weather Service is a primary source of weather information, both current observations and forecasts. In the National ITS Architecture, *weather information* is provided by the Weather Service to the following center subsystems:

    - Emergency Management
    - Information Service Provider
    - Maintenance and Construction Management
    - Traffic Management
    - Transit Management

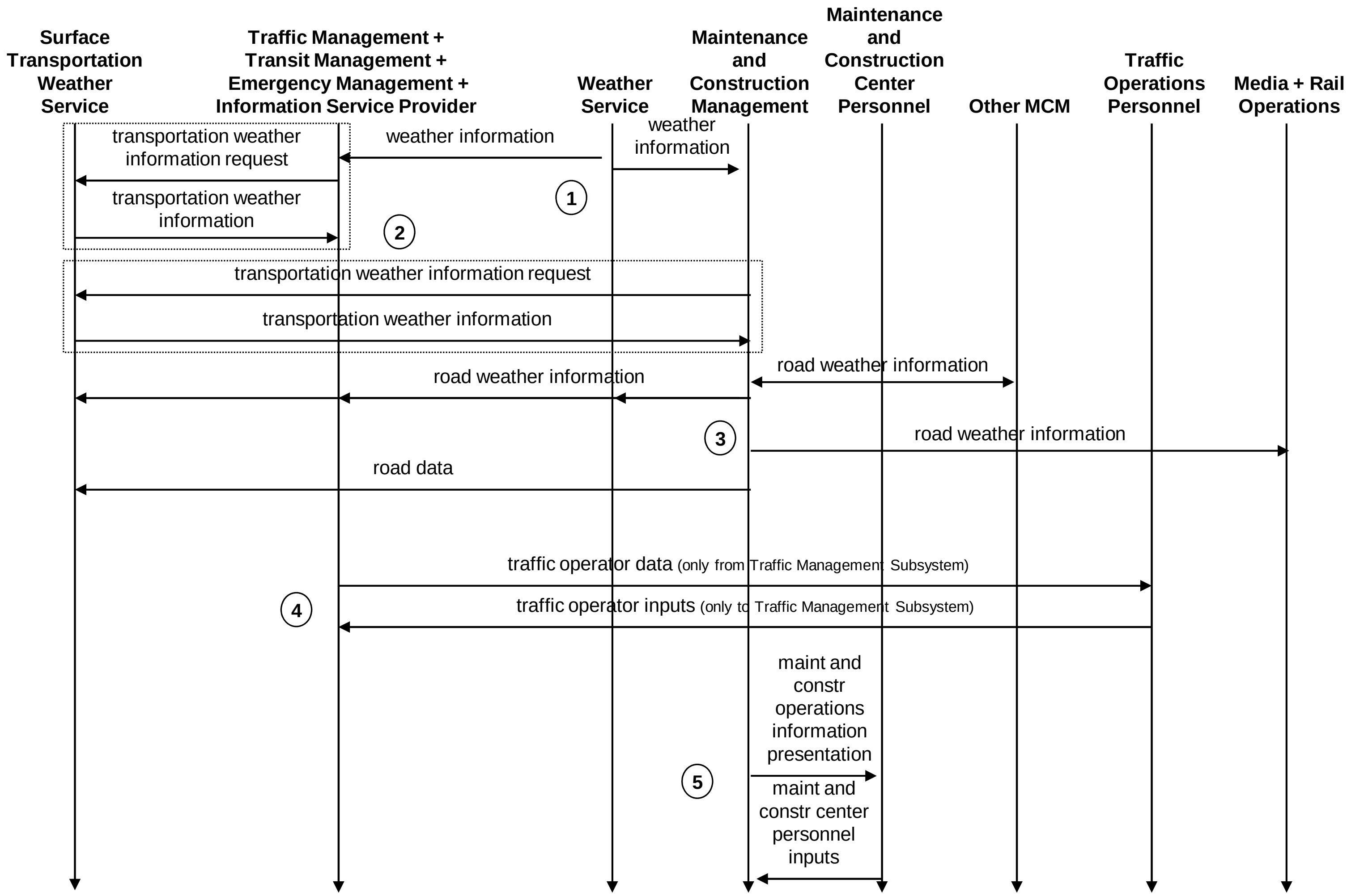
2. The Surface Transportation Weather Service provides tailored weather products to the transportation community. Because the products could be tailored to different transportation entities, each of the previous five centers sends a *transportation weather information request* to identify the type of information they require. The Surface Transportation Weather Service would then send *transportation weather information* including observations and forecasts tailored to the recipient's needs.

3. The MCMS takes its sensor inputs (from the MC03 Road Weather Data Collection service package) along with the inputs above to create road conditions and weather information that are made available by road maintenance operations to other transportation system operators (*road weather information*). The MCMS can also receive *road weather information* from maintenance operations centers in adjacent geographic areas (the Other MCM terminator). In addition, on an asynchronous basis the MCMS provides road facility and treatment information that supports road conditions forecasts (*road data*) to the Surface Transportation Weather Service to assist that entity in creating tailored weather products.

4. On an asynchronous basis, the weather information collected by the TMS is provided to the Traffic Operations Personnel (*traffic operator data*), who exert control over the collection and processing of the data (*traffic operator inputs*).

5. On an asynchronous basis, the weather information collected by the MCMS is provided to the Maintenance and Construction Center Personnel (*maint and constr operations information presentation*), who exert control over the collection and processing of the data (*maint and constr center personnel inputs*).

MC04: Weather Information Processing and Distribution



7.5 MC05: Roadway Automated Treatment

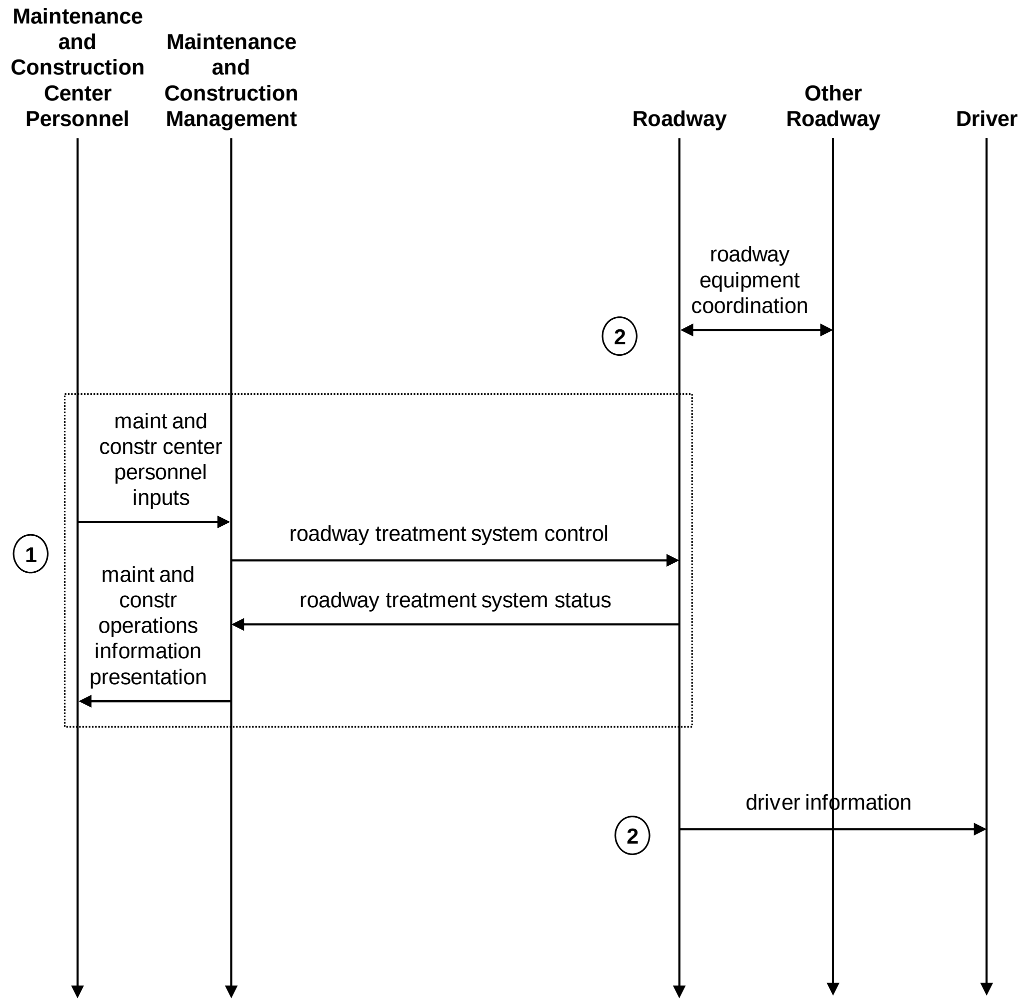
This service package automatically treats a roadway section based on environmental or atmospheric conditions. Treatments include fog dispersion, anti-icing chemicals, etc. The service package includes the environmental sensors that detect adverse conditions, the automated treatment system itself, and driver information systems (e.g., dynamic message signs) that warn drivers when the treatment system is activated.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Maintenance and Construction Center Personnel can initiate control of the automated roadway treatment system (*maint and constr center personnel inputs*) and send a control signal to the Roadway Subsystem (*roadway treatment system control*). They also monitor the status of the system (*roadway treatment system status*, *maint and constr operations information presentation*).

2. The automated roadway treatment system may contain environmental sensors, or sensors at the Roadway that provides the environmental data (*roadway equipment coordination*) from Other Roadway to the Roadway Subsystem. In addition, the system could provide *driver information* to Drivers by including an electronic sign (such as a Dynamic Message Sign) or the system could interface with a separate device that performs this function (*roadway equipment coordination*).

MC05: Roadway Automated Treatment



7.6 MC06: Winter Maintenance

This service package supports winter road maintenance including snow plow operations, roadway treatments (e.g., salt spraying and other anti-icing material applications), and other snow and ice control activities. This package monitors environmental conditions and weather forecasts and uses the information to schedule winter maintenance activities, determine the appropriate snow and ice control response, and track and manage response operations.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. In order to support its operational activities, the Maintenance and Construction Management Subsystem (MCMS) inputs information regarding weather and the state of the road network. The information comes from the Surface Transportation Weather Service (*transportation weather information request*, *transportation weather information*), from the Weather Service (*weather information*), and from the Traffic Management Subsystem (TMS) (*road network conditions* and *traffic images*), which can include traffic information, incident information, and road weather conditions determined by the TMS.

2. One of the activities of the MCMS is to respond to resource requests from other center subsystems. The Emergency Management Subsystem (EM) or the TMS make a request (*maint and constr resource request*) for maintenance resources (possibly in support of incident management). This request is forwarded to the Maintenance and Construction Center Personnel (*maint and constr operations information presentation*). The center personnel initiate a response to the request (*maint and constr center personnel inputs*) and that response is returned to the originating center subsystem (*maint and constr resource response*). The actions the Maintenance and Construction Center Personnel take to respond to the request would most likely involve fleet activities that are covered below, or under the MC07: Roadway Maintenance and Construction description.

3. The MCMS can request information on equipment or materials (*storage facility request*) from the Storage Facility, which would respond regarding *equipment availability* or *maintenance materials storage status*. In this Winter Maintenance service package, the status of available roadway treatment materials such as sand or salt would be a key issue.

4. As part of its overall operational activities, the MCMS provides *roadway maintenance status* to the TMS, ISP, EM, Transit Management Subsystem, Media, and Other MCM (maintenance organizations in other geographic areas). In addition, the MCMS receives *roadway maintenance status* from these other maintenance organizations.

5. The MCMS has several administrative functions that it supports. The MCMS can provide overall work performance information (*maint and constr work performance*) to the Maintenance and Construction Administrative Systems to support contract administration.

6. In addition the MCMS makes requests (*maint and constr administrative request*) for administrative information or services. An example of services requested might be the reordering of additional

road treatment materials. The Maintenance and Construction Administrative Systems responds with the information or status requested (*maint and constr administrative information*).

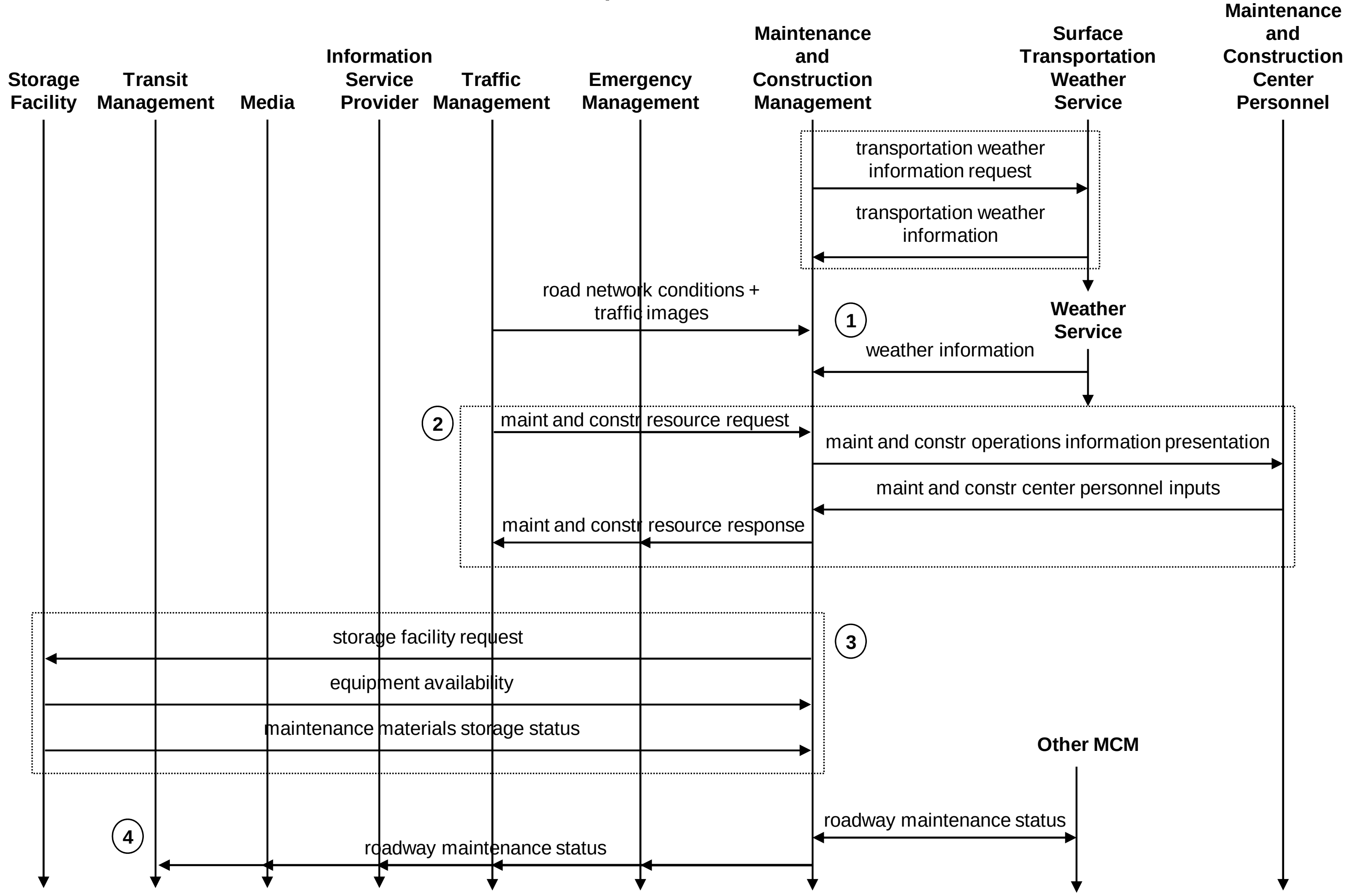
7. As part of winter maintenance operations, the MCMS will potentially use a map-based representation of the area where it is providing road treatment to track treatment application and snow plow progress. An interface to a Map Update Provider is available to keep this map-based representation of the transportation network current. The MCMS requests a map update (*map update request*) and the Map Update Provider electronically provides the update (*map updates*).

8. The Maintenance and Construction Vehicle Subsystem (MCVS) has several ITS systems (such as environmental sensors and dynamic message signs) that can be controlled and monitored either remotely from the MCMS (*maint and constr vehicle system control*) or directly from on board the MCVS. The same control flow from the MCMS can also control non-ITS systems on board the actual vehicle (e.g. materials spreader). For the non-ITS systems the control (*maint and constr vehicle control*) is passed to the Basic Maintenance and Construction Vehicle (i.e. the part of the actual vehicle that is not considered an ITS element). One of the key items of information the Basic Maintenance and Construction Vehicle provides back to the MCVS (*maint and constr material information*) is the remaining quantity and current application rate of materials on the vehicle. In addition the maintenance and construction vehicle tracks its position (*position fix*) and advanced *safety system status* (such as lane following) sent from the VS to the MCVS. The *roadway characteristics* flow represents the "inputs" to the sensors that perform the advanced safety functions. All of the status and information regarding ITS and non-ITS systems on the vehicle is provided to the Maintenance and Construction Field Personnel (*maint and constr vehicle condition presentation*) and to the MCMS (*maint and constr vehicle operational data*) where it eventually is presented to the Maintenance and Construction Center Personnel.

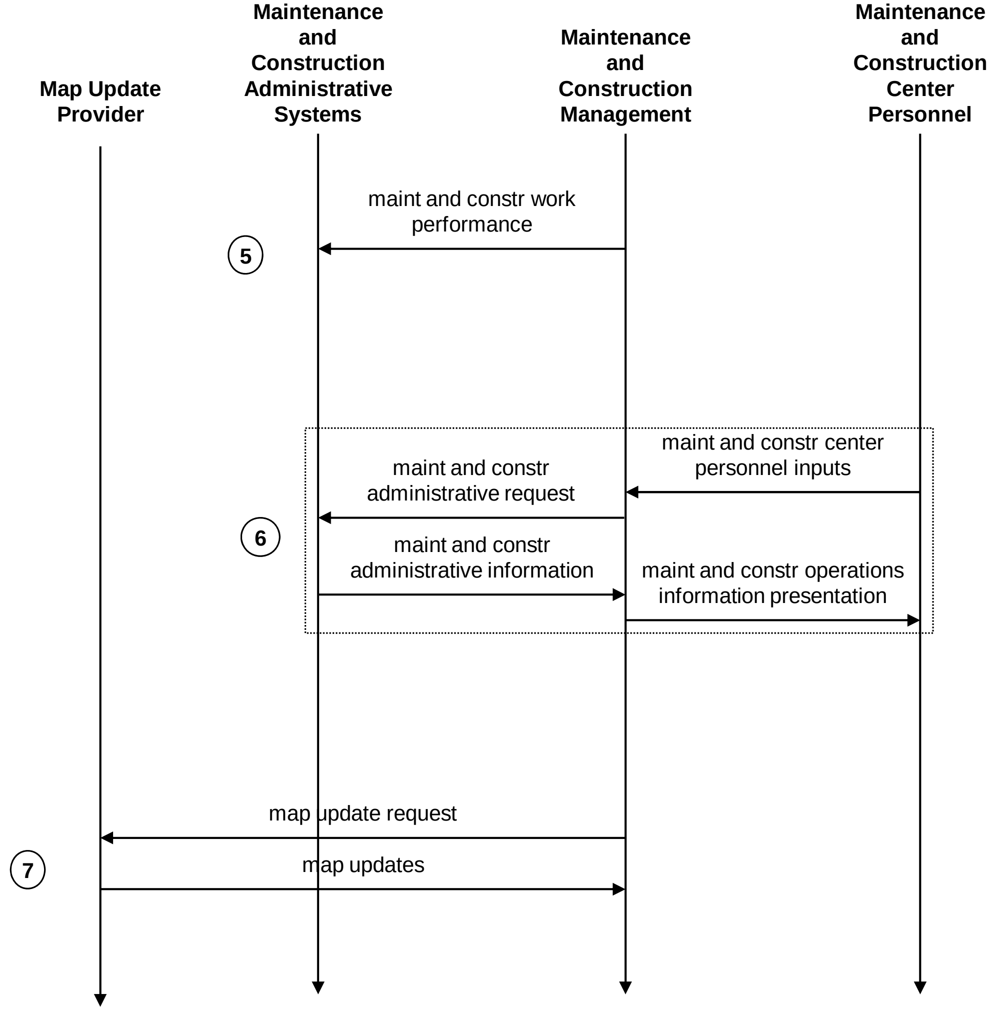
9. Coordination of an MCVS with another maintenance and construction vehicle (Other MCV) takes place to share operational status of the vehicles. For example, the Other MCV initiates an information exchange (*maint and constr vehicle status coordination*). The information is passed to the Maintenance and Construction Field Personnel (*maint and constr field personnel information presentation*). The field personnel can respond back to the Other MCV or append additional information to send to the MCMS (*maint and constr field personnel inputs*). The vehicle's operational status is sent to the MCMS (*maint and constr vehicle operational data*). Information can also be passed from the MCVS back to the Other MCV (*maint and constr vehicle status coordination*).

10. One of the key fleet activities of the MCMS is to dispatch the fleet vehicles. This *maint and constr dispatch information*, which can include routing and winter-specific dispatch instructions, is sent to the MCVS, and presented to the Maintenance and Construction Field Personnel (*maint and constr field personnel information presentation*). The field personnel can acknowledge the dispatch request, provide updates on their dispatch status, operator status, crew status, vehicle status, and equipment status (*maint and constr field personnel inputs*). This information is forwarded to the MCMS (*maint and constr dispatch status*).

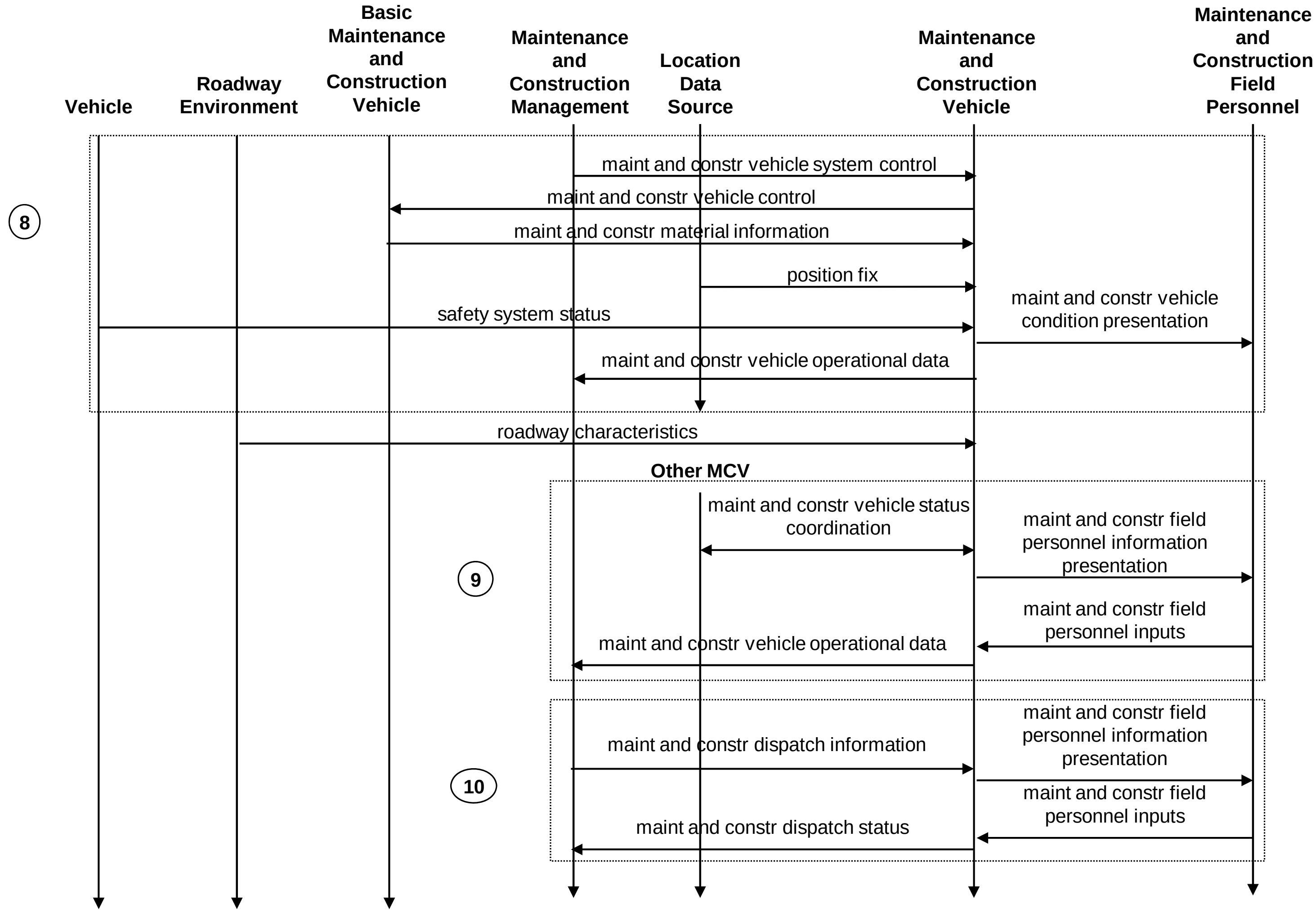
MC06: Winter Maintenance (1 of 3)
Non-Fleet Operational Activities



MC06: Winter Maintenance (2 of 3)
Administrative Activities



MC06: Winter Maintenance (3 of 3)
Fleet Activities



7.7 MC07: Roadway Maintenance and Construction

This service package supports numerous services for scheduled and unscheduled maintenance and construction on a roadway system or right-of-way. Maintenance services would include landscape maintenance, hazard removal (roadway debris, dead animals), routine maintenance activities (roadway cleaning, grass cutting), and repair and maintenance of both ITS and non-ITS equipment on the roadway (e.g., signs, traffic controllers, traffic detectors, dynamic message signs, traffic signals, CCTV, etc.). Environmental conditions information is also received from various weather sources to aid in scheduling maintenance and construction activities.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. In order to support its operational activities, the Maintenance and Construction Management Subsystem (MCMS) inputs information regarding weather and the state of the road network. The information comes from the Surface Transportation Weather Service via the request/ response pair of architecture flows (*transportation weather information request*) and (*transportation weather information*), and from the Weather Service (*weather information*).

2. In order to maintain secure ITS infrastructure, it is imperative that security field equipment (e.g., surveillance equipment and other sensors) be in operational condition. To support this normal working status, periodically and on an exception basis, the Emergency Management Subsystem (EM) sends (*security field equipment status*) to the MCMS so that inoperable security equipment can be restored to working order. Following the maintenance actions the *security equipment maintenance status* is sent from the MCMS back to EM.

3. Another key activity of the MCMS is the maintenance of ITS and non-ITS field equipment. Fault indications from field devices are monitored directly by the MCMS (*field device status*) from the Roadway Subsystem (RS), or the fault information (*field equipment status*) could be sent from the Traffic Management Subsystem (TMS) or from the Information Service Provider (ISP) that manages its own set of equipment. Following the maintenance actions the *equipment maintenance status* is sent from the MCMS to the TMS and ISP. A local interface is provided to Maintenance and Construction Field Personnel to make a *field device status request* for local monitoring and diagnostics (*field device status presentation*), supporting field maintenance, repair, and replacement of field devices.

4. The Maintenance and Construction Management Subsystem can request information on equipment or materials (*storage facility request*) from the Storage Facility, which responds regarding *equipment availability* or *maintenance materials storage status*. In this service package the status of available materials might include sand (for treatment of spills) or herbicide (for spraying of the vegetation along the roadside).

5. The administrative functions of the MCMS include exchanging information with the Asset Management entity and Maintenance and Construction Administrative Systems. Asset Management provides *asset inventory* information, which could include static information about the

assets (e.g. location, installation information, and materials information) as well as information that has been collected about the assets (e.g. video logs and current maintenance status). Asset Management sends *asset restrictions* to the MCMS, which could include height, width, or weight restrictions to various assets. *Maintenance and repair needs* are also sent by Asset Management to the MCMS for scheduling of repairs. The MCMS provides back to Asset Management changes to the status of pavement, bridges, signs and other assets resulting from maintenance or construction activities (*asset status update*). Another administrative function the MCMS supports is to provide overall work performance information (*maint and constr work performance*) to the Maintenance and Construction Administrative Systems to support contract administration.

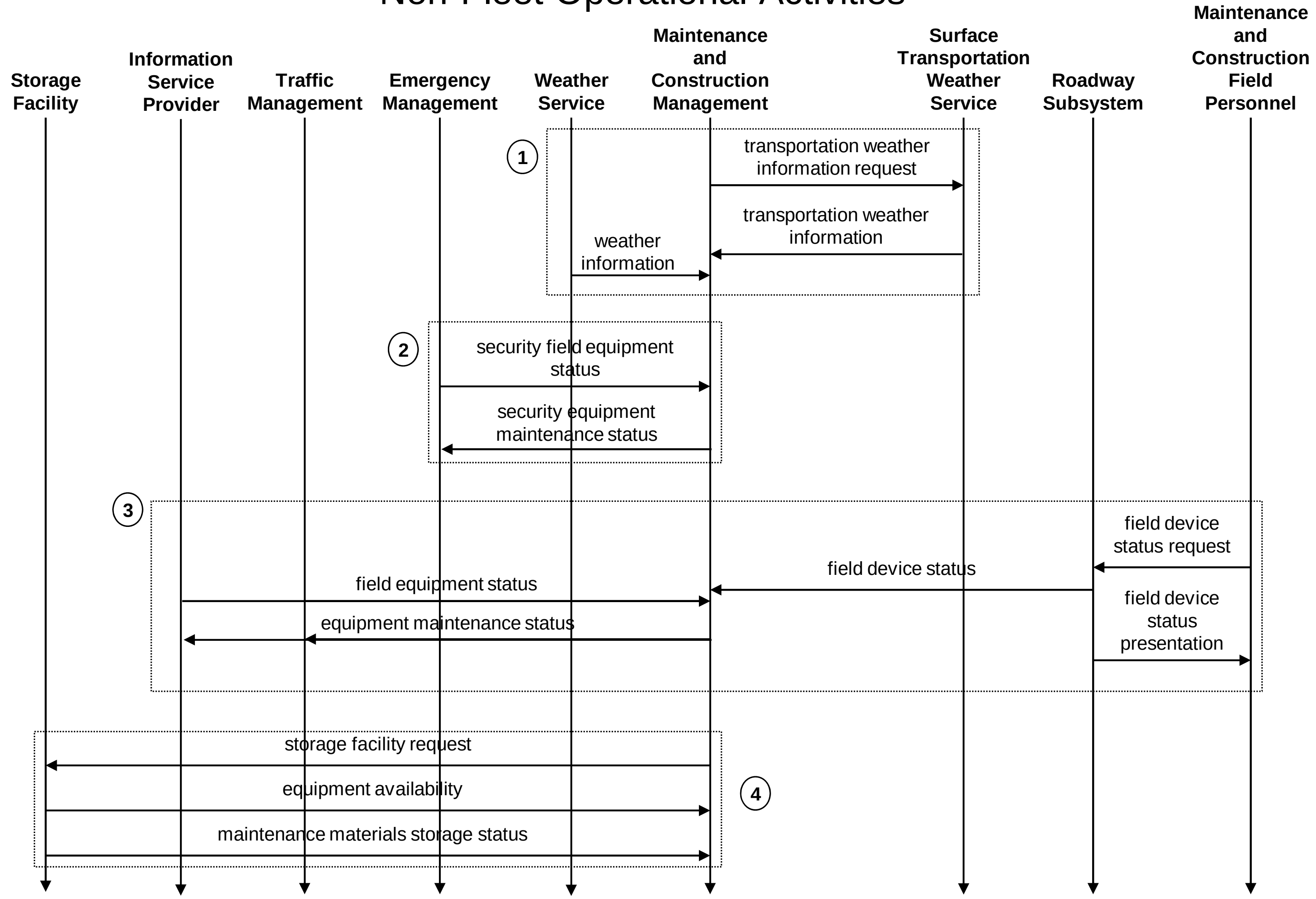
6. Based on inputs from the Maintenance and Construction Center Personnel (*maint and constr center personnel inputs*), the MCMS makes requests (*maint and constr administrative request*) for administrative information or services. An example of services requested might be the reordering of additional road treatment materials. The Maintenance and Construction Administrative Systems responds with the information or status requested (*maint and constr administrative information*). The information is then presented to the center personnel (*maint and constr operations information presentation*).

7. As part of its maintenance operations and to help track its maintenance vehicles, the MCMS will potentially use a map-based representation of the area that it is maintaining. An interface to a Map Update Provider is available to keep this map-based representation of the transportation network current. The MCMS requests a map update (*map update request*), and the Map Update Provider electronically provides the update (*map updates*).

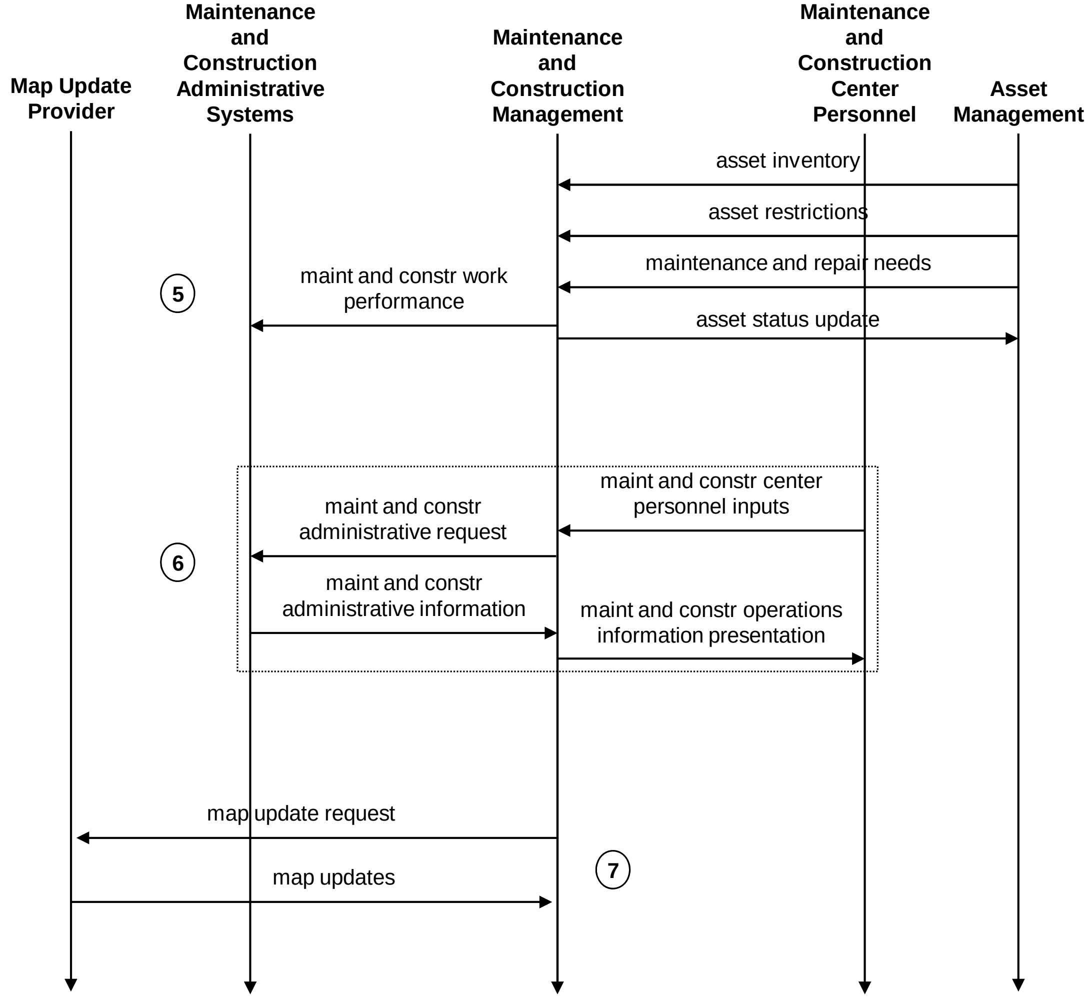
8. The Maintenance and Construction Vehicle Subsystem (MCVS) has several ITS systems (such as environmental sensors and dynamic message signs) that can be controlled and monitored either remotely from the MCMS (*maint and constr vehicle system control*) or directly from on board the MCVS. The same control flow from the MCMS can also control non-ITS systems on board the actual vehicle (e.g. materials spreader). For the non-ITS systems, the control (*maint and constr vehicle control*) is passed to the Basic Maintenance and Construction Vehicle (i.e. the part of the actual vehicle that is not considered an ITS element). One of the key items of information the Basic Maintenance and Construction Vehicle provides back to the MCVS (*maint and constr material information*) is the remaining quantity and current application rate of materials on the vehicle. In addition the maintenance and construction vehicle tracks its own location (*position fix*) and advanced safety system features such as lane following (*safety system status*). All of the status and information regarding ITS and non-ITS systems on the vehicle is provided to the Maintenance and Construction Field Personnel (*maint and constr vehicle condition presentation*) and to the MCMS (*maint and constr vehicle operational data*).

9. One of the key fleet activities of the MCMS is to dispatch the fleet vehicles. This *maint and constr dispatch information*, which can include routing, is sent to the MCVS, and presented to the Maintenance and Construction Field Personnel (*maint and constr field personnel information presentation*). The field personnel can acknowledge the dispatch request and provide inputs on their dispatch status as well as operator status, crew status, vehicle status, and equipment status (*maint and constr field personnel inputs*). This information is forwarded to the MCMS (*maint and constr dispatch status*).

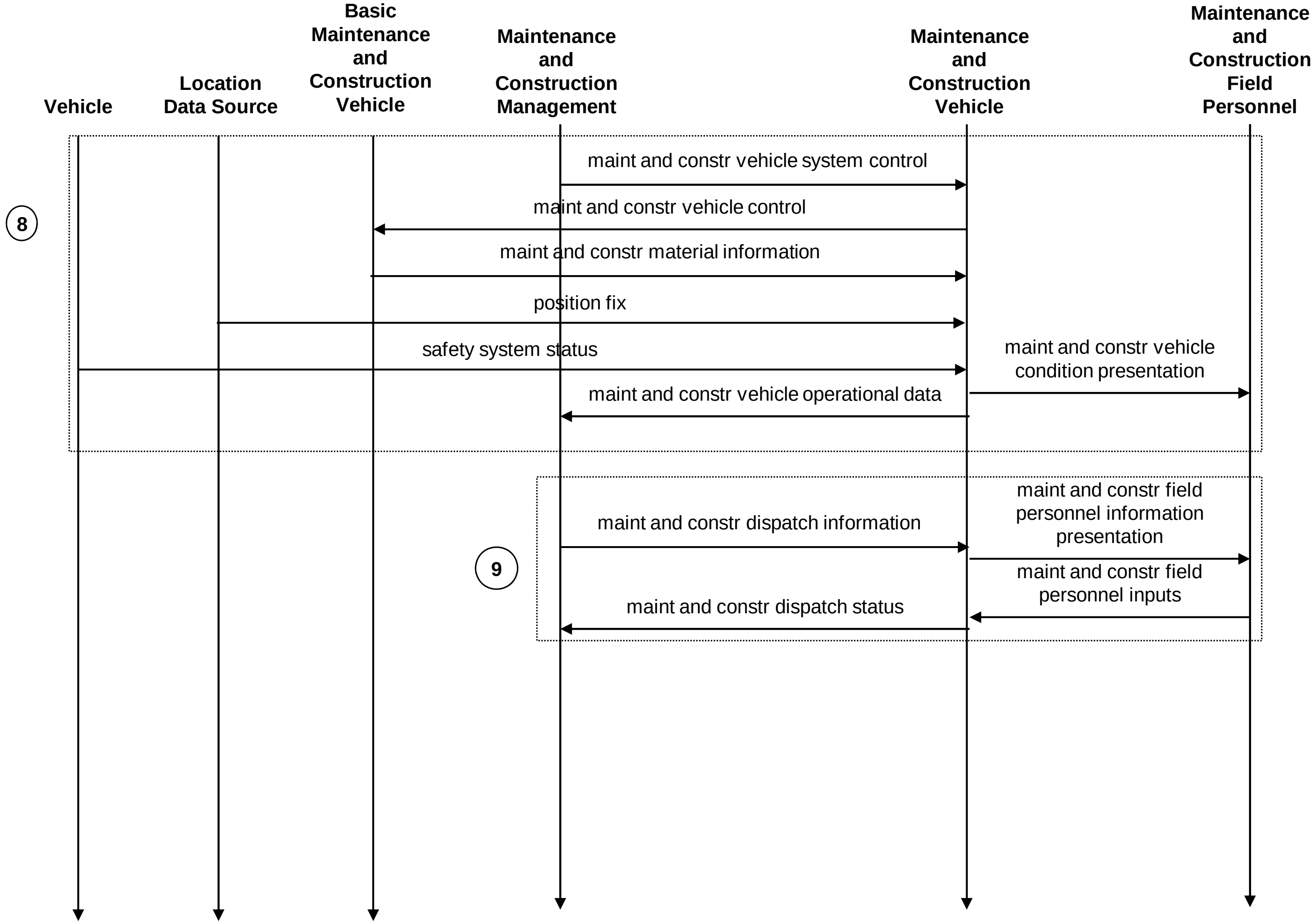
MC07: Roadway Maintenance and Construction (1 of 3)
Non-Fleet Operational Activities



MC07: Roadway Maintenance and Construction (2 of 3)
Administrative Activities



MC07: Roadway Maintenance and Construction(3 of 3)
Fleet Activities



7.8 MC08: Work Zone Management

This service package manages work zones, controlling traffic in areas of the roadway where maintenance, construction, and utility work activities are underway. Traffic conditions are monitored using CCTV cameras and controlled using dynamic message signs (DMS), Highway Advisory Radio (HAR), gates and barriers. Work zone information is coordinated with other groups (e.g., ISP, traffic management, other maintenance and construction centers). Work zone speeds and delays are provided to the motorist prior to the work zones. This service package provides control of field equipment in all maintenance and construction areas, including fixed, portable, and truck-mounted devices supporting both stationary and mobile work zones.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Work zone status (*work zone status*) inputs start from the Maintenance and Construction Field Personnel, who enter the information into a system in the Maintenance and Construction Vehicle Subsystem, MCVS (*maint and constr field personnel inputs*). Then (*work zone status*) is forwarded to the Maintenance and Construction Management Subsystem (MCMS). The Maintenance and Construction Center Personnel add their inputs to this information (*maint and constr center personnel inputs*) and provide (*work zone information*) to the following centers and terminators:

   - Traffic Management
   - Transit Management
   - Emergency Management
   - Information Service Provider
   - Media
   - Other MCM (another maintenance or construction organization) - information is bidirectional on this interface with *work zone information* being provided to MCMS and sent from the MCMS.

Maintenance and Construction Field Personnel can get information from their vehicle regarding traffic information, road restrictions, environmental information, decision support information, maintenance schedules, dispatch instructions, maintenance personnel assignments, vehicle maintenance information, work zone status information, and corrective actions. This information is available asynchronously (*maint and constr field personnel information presentation*).

2. The MCMS can also control surveillance devices at the Roadway within a work zone, specifically CCTVs (*video surveillance control*) that send (*traffic images*) back to the MCMS.

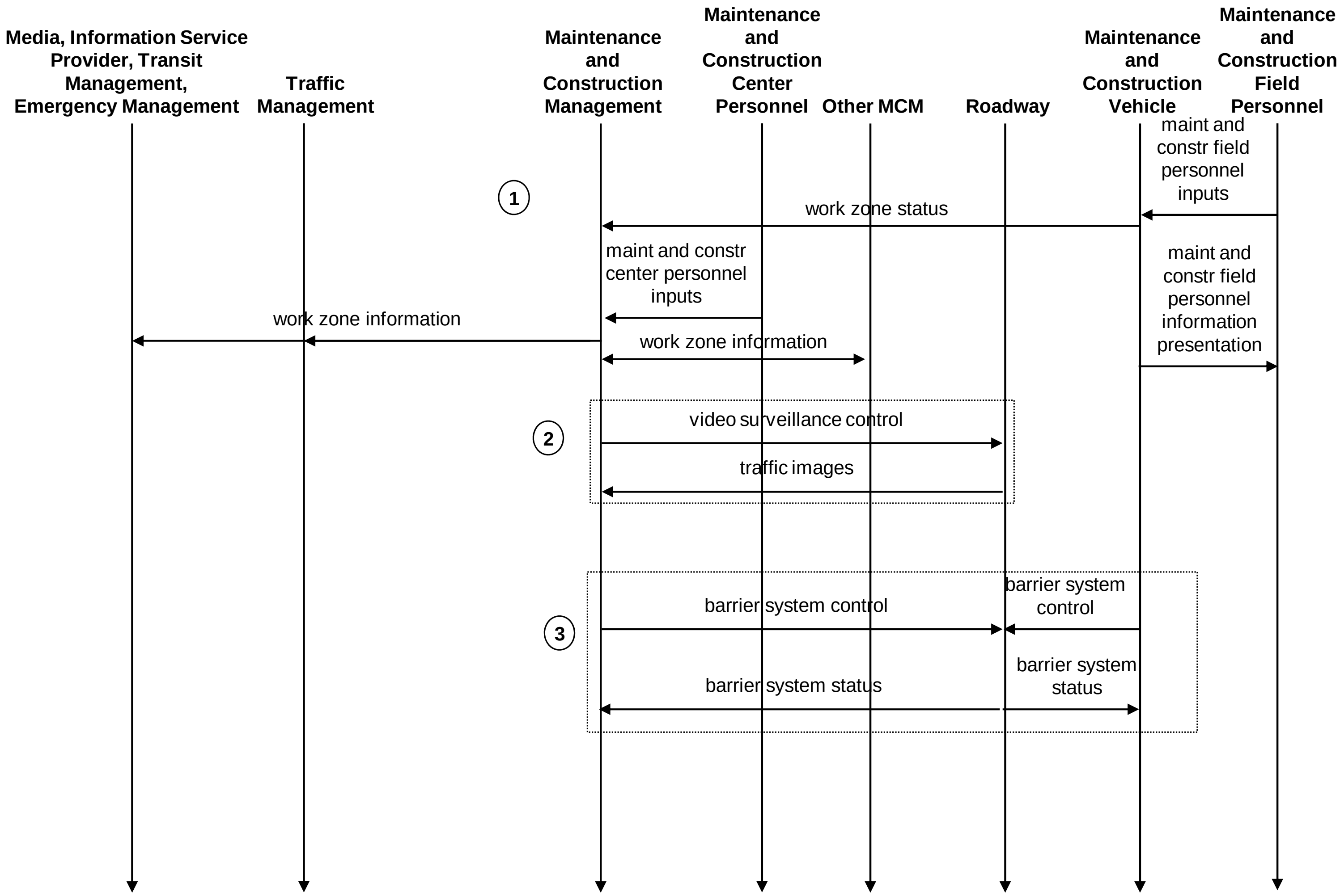
3. The MCMS can also control barrier systems at the Roadway within a work zone (*barrier system control*), which can send (*barrier system status*) back to the MCMS. In addition, the MCVS can provide control of barrier systems and receive status back from these systems.

4. In addition to sending work zone information to other transportation centers, the MCMS or TMS provides information directly to Drivers affected by the work zone activity using (*roadway information system data*), which controls output to dynamic message signs or Highway Advisory Radio. The information is provided to the drivers as part of *driver information*. Additionally, the MCMS monitors the roadway information device to ensure its correct operation (*roadway information system status*).

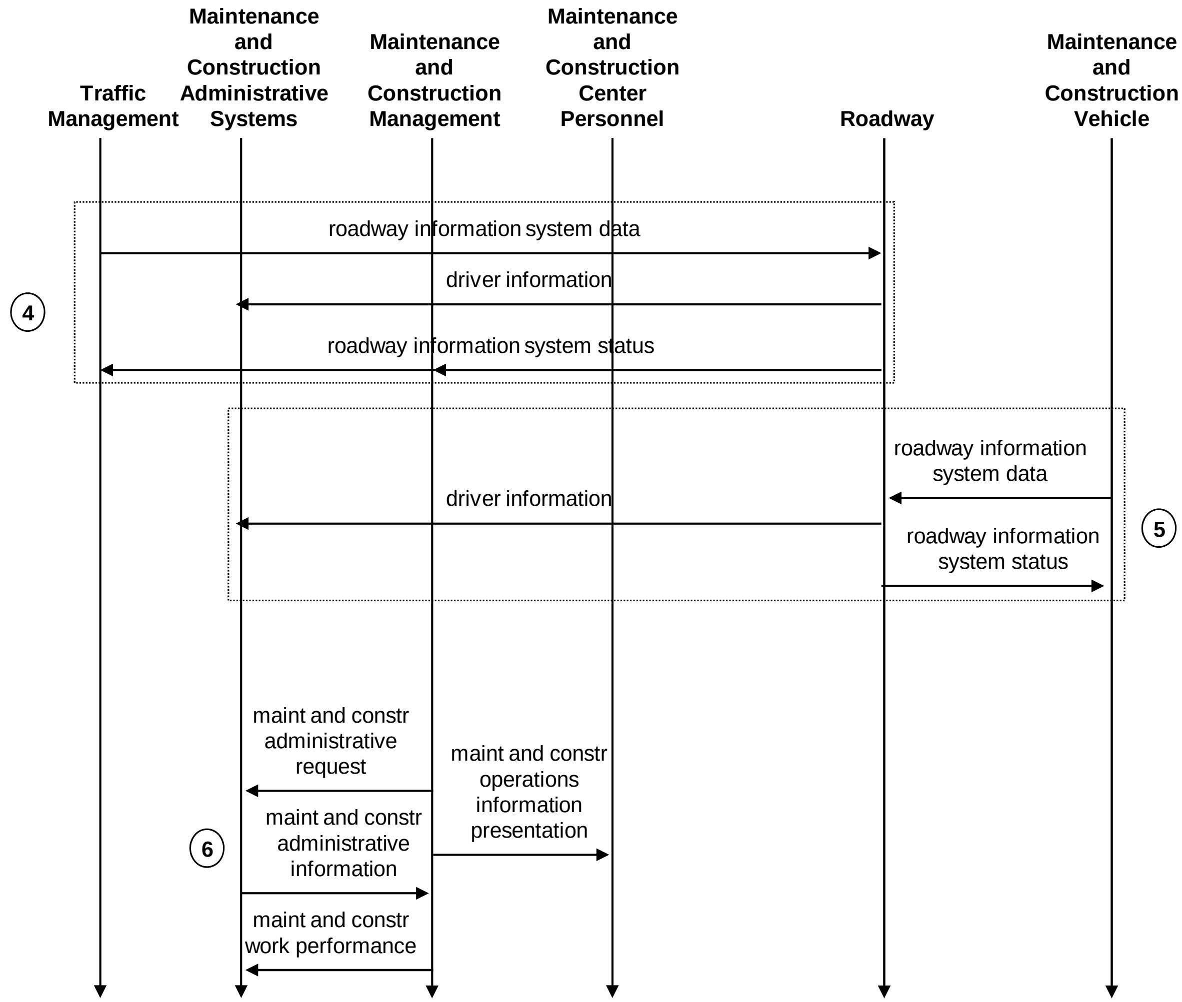
5. The roadway information devices may also be controlled (*roadway information system data*) and monitored (*roadway information system status*) by the Field Personnel inside the MCVS.

6. Based upon inputs from the field, the MCMS may place a request to the Maintenance and Construction Administrative Systems (*maint and constr administrative request*) for administrative information or services. Requests include: requests to purchasing for equipment and consumables, resupply, and requests to human resources that manage training and special certification for field crews and other personnel. The Maintenance and Construction Administrative Systems responds with the information or status requested (*maint and constr administrative information*). This information is presented to the Maintenance and Construction Center Personnel (*maint and constr operations information presentation*). An additional administrative function the MCMS supports is to provide overall work performance information (*maint and constr work performance*) to the Maintenance and Construction Administrative Systems (MCAS) for contract administration.

MC08: Work Zone Management (1 of 2)



MC08: Work Zone Management (2 of 2)



7.9 MC09: Work Zone Safety Monitoring

This service package includes systems that improve work crew safety and reduce collisions between the motoring public and maintenance and construction vehicles. This service package detects vehicle intrusions in work zones and warns crew workers and drivers of imminent encroachment or other potential safety hazards. Crew movements are also monitored so that the crew can be warned of movement beyond the designated safe zone. The service package supports both stationary and mobile work zones. The intrusion detection and alarm systems may be collocated or distributed, allowing systems that detect safety issues far upstream from a work zone (e.g., detection of over dimension vehicles before they enter the work zone).

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. On an asynchronous basis, the Maintenance and Construction Management Subsystem (MCMS) controls work zone warning devices that are at the Roadway (*work zone warning device control*), and will monitor both these devices (*work zone warning status*) and similar warning devices that are placed on Maintenance and Construction Vehicle Subsystems (*work zone warning status*).

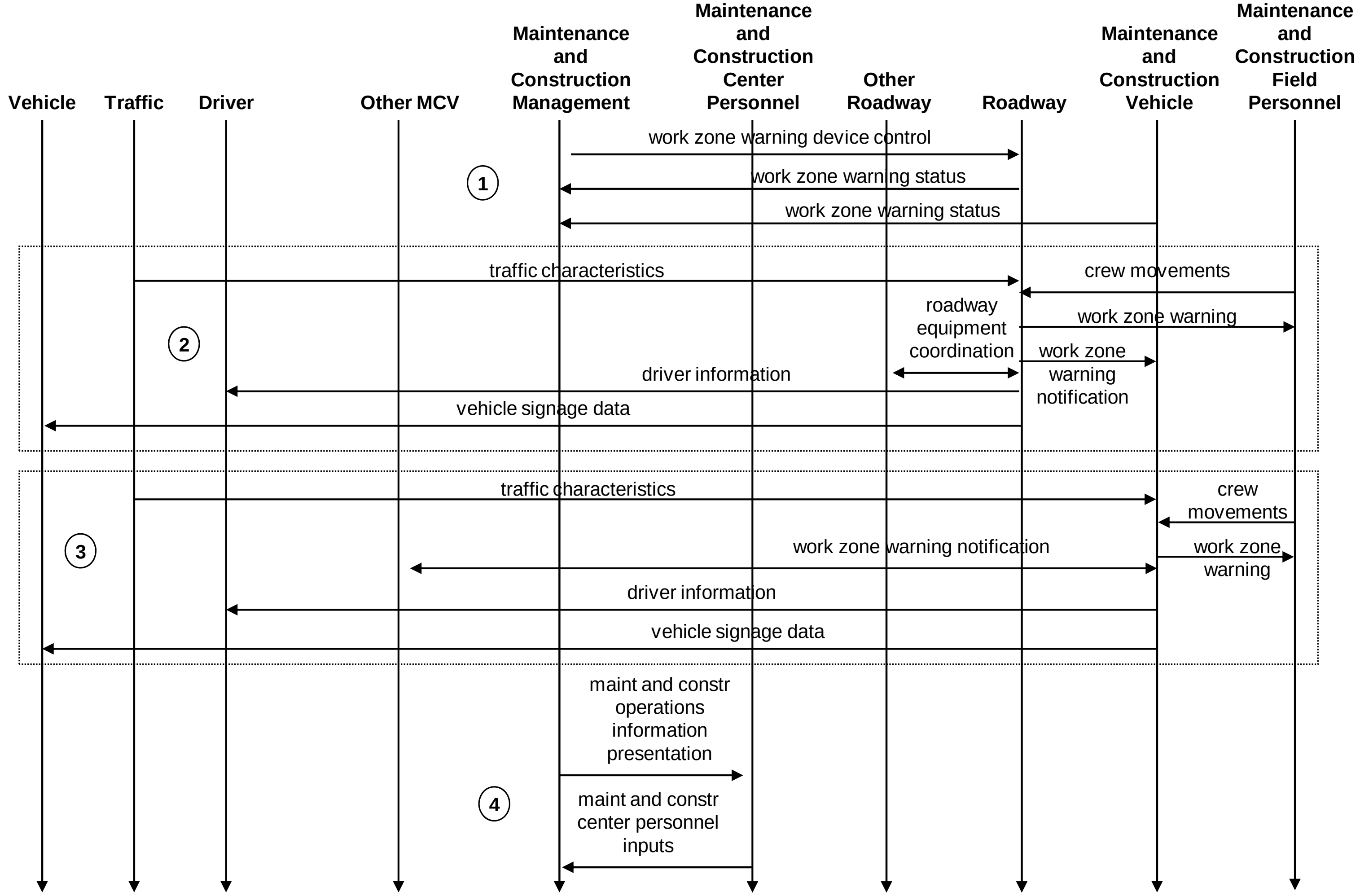
2. A work zone intrusion detection and alert device located at the Roadway might have the following operation. *Traffic characteristics* and *crew movements* of the Maintenance and Construction Field Personnel are monitored by the device. When an intrusion is detected, a general work zone warning is given to the Maintenance and Construction Vehicle Subsystem, MCVS (*work zone warning notification*) or to the Maintenance and Construction Field Personnel directly (*work zone warning*). An alternative mode of operation would be that warnings are provided based on knowledge of the crew's movements, rather than a general area warning. It is also possible that the intrusion detection device is separate from the alerting device, with data passing across the Roadway Subsystem to Other RS interface (*roadway equipment coordination*). Once an intrusion is detected an alert to the driver of the intruding vehicle is provided via a roadside information display (*driver information*) or via an in-vehicle signage display (*vehicle signage data*).

3. A work zone intrusion warning and alert device located on an MCVS would have a similar operation as that described above. *Traffic characteristics* and *crew movements* of the Maintenance and Construction Field Personnel are monitored by the device. When an intrusion is detected, a general *work zone warning* is given to the Maintenance and Construction Field Personnel directly. An alternative mode of operation would be that warnings are provided based on knowledge of the crew's movements, rather than a general area warning. It is also possible that a *work zone warning notification* could be sent to another maintenance and construction vehicle (the Other MCV entity). Once an intrusion is detected an alert to the driver of the intruding vehicle could be provided via a roadside information display (*driver information*) or via an in-vehicle signage display (*vehicle signage data*).

4. To support the first two sequences described above, the Maintenance and Construction Center Personnel can provide the device control information (*maint and constr center personnel inputs*) and

can get an indication of work zone intrusions that have occurred and what alerts were provided (*maint and constr operations information presentation*).

MC09: Work Zone Safety Monitoring



7.10 MC10: Maintenance and Construction Activity Coordination

This service package supports the dissemination of maintenance and construction activity to centers that can utilize it as part of their operations, or to the Information Service Providers who can provide the information to travelers.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Asset Management provides *asset restrictions* to the Maintenance and Construction Management Subsystem (MCMS). The restrictions may include standard height, width, and weight restrictions by facility and special restrictions such as spring weight restrictions and temporary bridge weight restrictions. These *current asset restrictions* are provided to the following center subsystems:

    - Commercial Vehicle Administration
    - Emergency Management
    - Information Service Provider
    - Traffic Management
    - Transit Management

Some of the possible uses of this information by the receiving subsystems are: route selection and CVO clearances for too large or oversized vehicle limits.

2. One of the key functions of the MCMS is to plan maintenance and construction activity. These *maint and constr work plans* are then disseminated to the following center subsystems and other key terminators:

    - Emergency Management
    - Information Service Provider
    - Media
    - Multimodal Transportation Service Provider
    - Rail Operations
    - Traffic Management
    - Transit Management

It is expected that the following entities will provide *work plan feedback* to the MCMS:

- Emergency Management
- Rail Operations
- Traffic Management

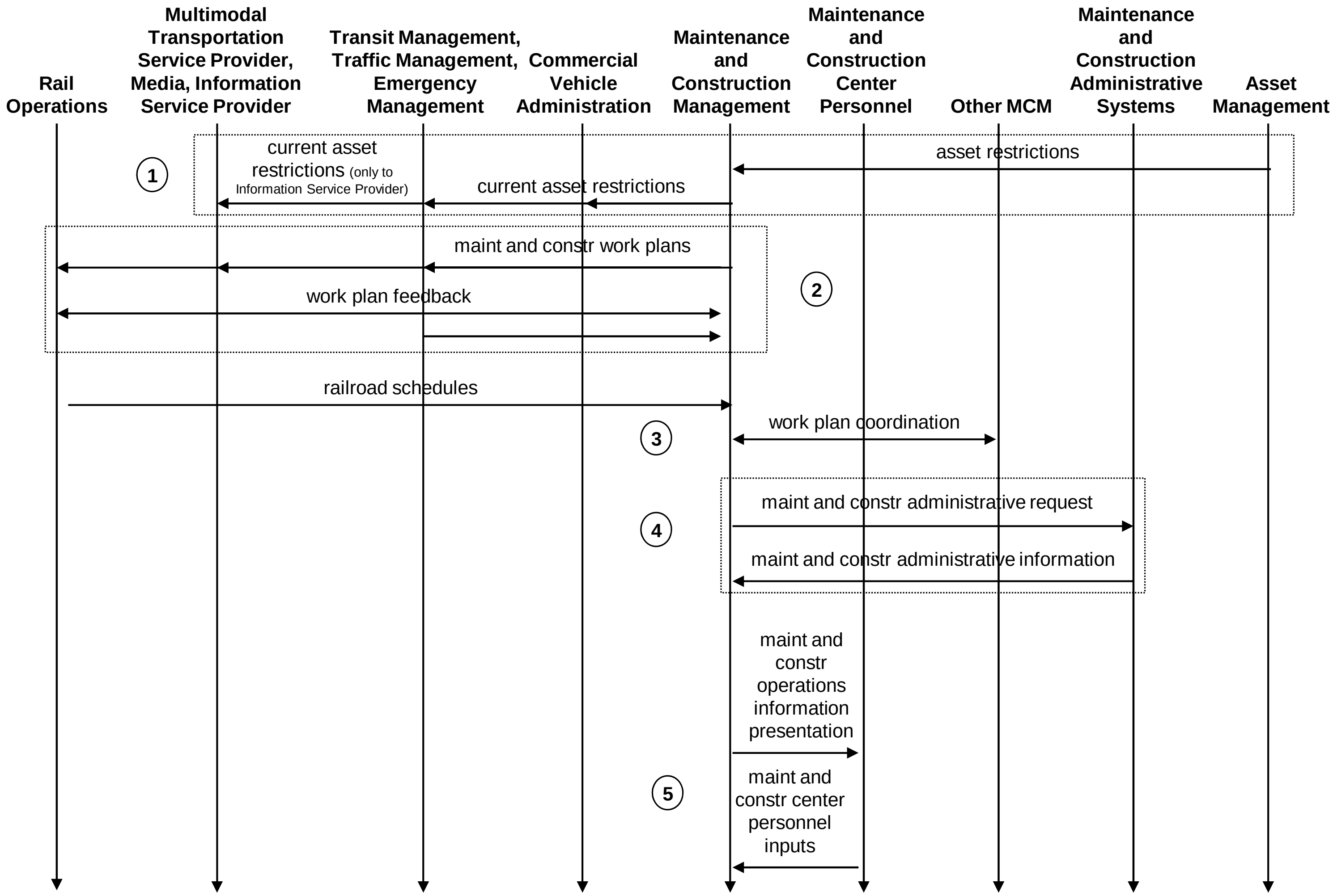
- Transit Management

3. In addition to providing feedback on the MCMS work plans, Rail Operations provides its own *railroad schedules* to the MCMS to inform it of planned maintenance activities of the rail network that may impact the road maintenance activities. Also, an MCMS must coordinate its work plans with maintenance organizations in adjoining geographic areas (Other MCM). This *work plan coordination* includes sharing work plans and providing feedback to work plans received.

4. As a part of coordination activities, the MCMS makes requests of the Maintenance and Construction Administrative Systems (*maint and constr administrative request*), which would respond with information such as equipment and consumables, re-supply purchase request status, personnel qualifications including training and special certifications, environmental regulations and rules that may impact maintenance activities, and requests and project requirements from contract administration (*maint and constr administrative information*).

5. To support the sequences described above, the Maintenance and Construction Center Personnel provides inputs on work plan scheduling and provides feedback to other schedules received (*maint and constr center personnel inputs*). They can also receive the work plans of Rail Operations or other maintenance and construction management centers (Other MCM) and can receive the feedback on work plans they have disseminated to other entities (*maint and constr operations information presentation*).

MC10: Maintenance and Construction Activity Coordination



7.11 MC11: Environmental Probe Surveillance

This service package collects data from vehicles in the road network that can be used to directly measure or infer current environmental conditions. It leverages vehicle on-board systems that measure temperature, sense current weather conditions (rain and sun sensors) and also can monitor aspects of the vehicle operational status (e.g., use of headlights, wipers, and traction control system) to gather information about local environmental conditions. It includes the on-board vehicle systems that collect and report environmental probe data, the infrastructure equipment that collects the probe data and the centers that aggregate and share the collected probe data.

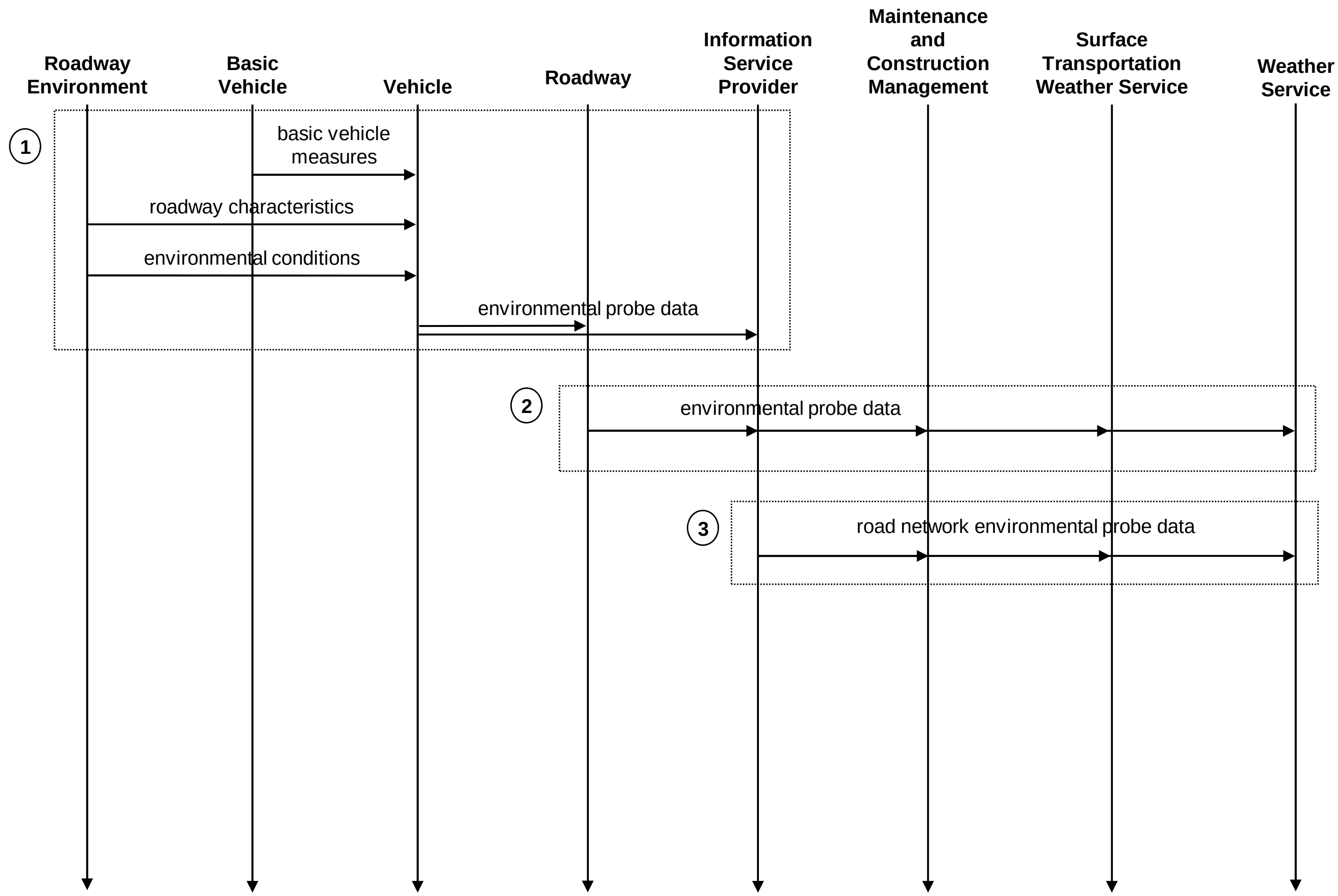
The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Vehicles monitor the operational status of the Basic Vehicle equipment (*basic vehicle measures*) to sense when the headlights are on, wipers are activated, traction control systems have been engaged, etc. The Vehicle Subsystems is also equipped with environmental sensors measuring temperature, precipitation, and other conditions from the Roadway Environment (*environmental conditions*) as well as the geometric features of the roadway, e.g. sharp turns, lane positioning, etc. (*roadway characteristics*). The Vehicle subsystem takes this collection of data from on-board and passes the (*environmental probe data*) to the Roadway Subsystems' roadside equipment using Field-Vehicle Communications or directly to an Information Service Provider (ISP) over a wide area wireless network.

2. The Roadway Subsystem (RS) takes the collected *environmental probe data* from the passing vehicles and forwards it on to the ISP. In some cases, the roadside equipment that has collected this probe data may be able to send its data directly to a Maintenance and Construction Management Subsystem (MCMS) to support its collection of environmental data or directly to a Surface Transportation Weather Service or Weather Service terminators.

3. The ISP collects all of the environmental probe data from the probe vehicles within its network and aggregates the data in order to send *road network environmental probe data* to the MCMS, a Surface Transportation Weather Service, or the Weather Service.

MC11: Environmental Probe Surveillance



7.12 MC12: Infrastructure Monitoring

This service package monitors the condition of pavement, bridges, tunnels, associated hardware, and other transportation-related infrastructure (e.g., culverts) using both fixed and vehicle-based infrastructure monitoring sensors. Fixed sensors monitor vibration, stress, temperature, continuity, and other parameters and mobile sensors and data logging devices collect information on current infrastructure condition. This service package also monitors vehicle probes for vertical acceleration data and other probe data that may be used to determine current pavement condition.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

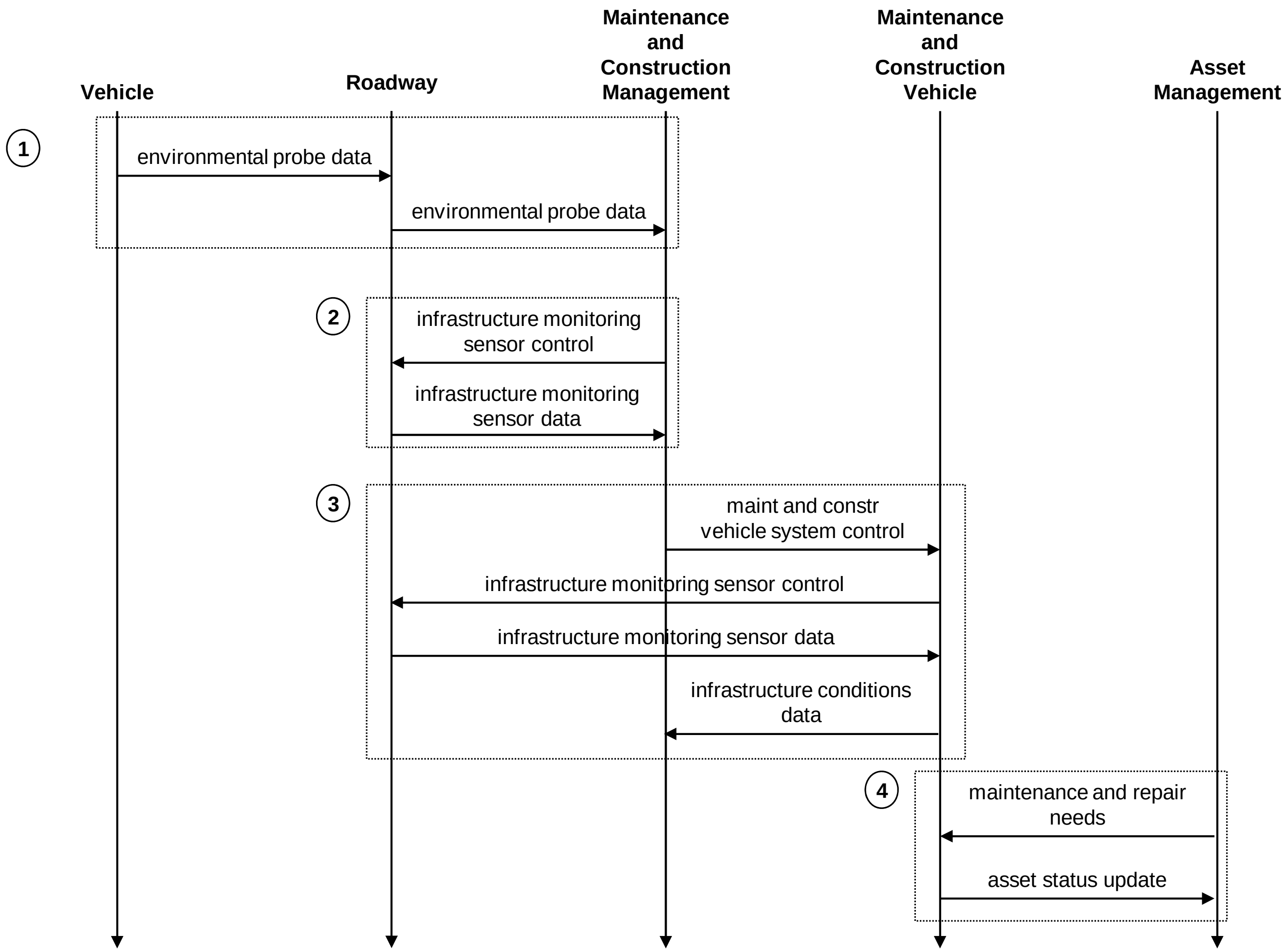
1. To support the collection of infrastructure conditions data, Vehicle Subsystem equipment using Field-Vehicle Communications can transmit *environmental probe data* to equipment located at the Roadway Subsystem (RS) including weather and environmental readings but also conditions of the pavement surface that may indicate areas needing repair. The RS then passes this collected *environmental probe data* on to the Maintenance and Construction Management Subsystem (MCMS) for analysis.

2. An additional maintenance activity that can be carried on by the MCMS is control (*infrastructure monitoring sensor control*) and monitoring (*infrastructure monitoring sensor data*) of roadway infrastructure sensors which are used to assist in identifying infrastructure repair needs.

3. The MCMS can send *maint and constr vehicle system control* commands to the Maintenance and Construction Vehicle Subsystem to manage the control and monitoring of the infrastructure via the vehicle fleet. MCVS, in this scenario, is controlling (*infrastructure monitoring sensor control*) and monitoring (*infrastructure monitoring sensor data*) of infrastructure sensors located at the Roadway Subsystem. The infrastructure data is passed along to the MCMS (*infrastructure conditions data*).

4. Finally, Asset Management sends recommended strategies and schedules for maintenance of the transportation infrastructure (*maintenance and repair needs*). The MCMS provides back to Asset Management changes to the status of pavement, bridges, signs and other assets resulting from infrastructure maintenance and repair activities (*asset status update*). This same flow can also contain results of infrastructure monitoring carried out by the maintenance organization.

MC12: Infrastructure Monitoring



8 Archived Data Management

This section provides the Theory of Operations for the Archive Data Management Service Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each service package section) to identify these service packages is AD—Archived Data.

To understand the relationship of the three Archive Data Management Service Packages, it is sometimes useful to use the analogy of a library. The purpose of the Archive Data Management subsystem is to provide information to the archive users (Archive Data User Systems), much the same as a library serves the library users. The difference between the three service packages is the source of the information for the archive. In the analogy, the difference can be viewed as the difference between the source of information for the library. This analogy is continued in the introduction to the Theory of Operations for each of the following three Archive Data Management Service Packages.

8.1 AD1: ITS Data Mart

This service package provides a focused archive that houses data collected and owned by a single agency, district, private sector provider, research institution, or other organization. This focused archive typically includes data covering a single transportation mode and one jurisdiction that is collected from an operational data store and archived for future use. It provides the basic data quality, data privacy, and meta data management common to all ITS archives and provides general query and report access to archive data users.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Archive Data Management subsystem (ADMS) can maintain a current map database for geocoding archived data (if appropriate) by submitting a *map update request* either on a one-time basis for a subscription of updates from a Map Update Provider which will send *map updates* on the agreed upon schedule.

2. The ADMS can request or subscribe (*archive requests*) to operational data from one of the subsystems or terminators in the table in the AD1 diagram that follows (___ *archive data* or *transportation weather information*). On receipt of submitted operational data, the ADMS can confirm to the source that the data was received (*archive status*).

3. An Archive Data Administrator can set operational parameters on the archive (*archive management requests*) and the ADMS will display the appropriate (*archive management data*) to the administrator. These parameters can include how much and how long to store operational data, how to aggregate the data (e.g. averaging or sampling and at what age - for example older data may be sampled more sparsely than more current data). The Administrator can issue user IDs and passwords to limit access to certain types or classes of data, and may determine what data will be

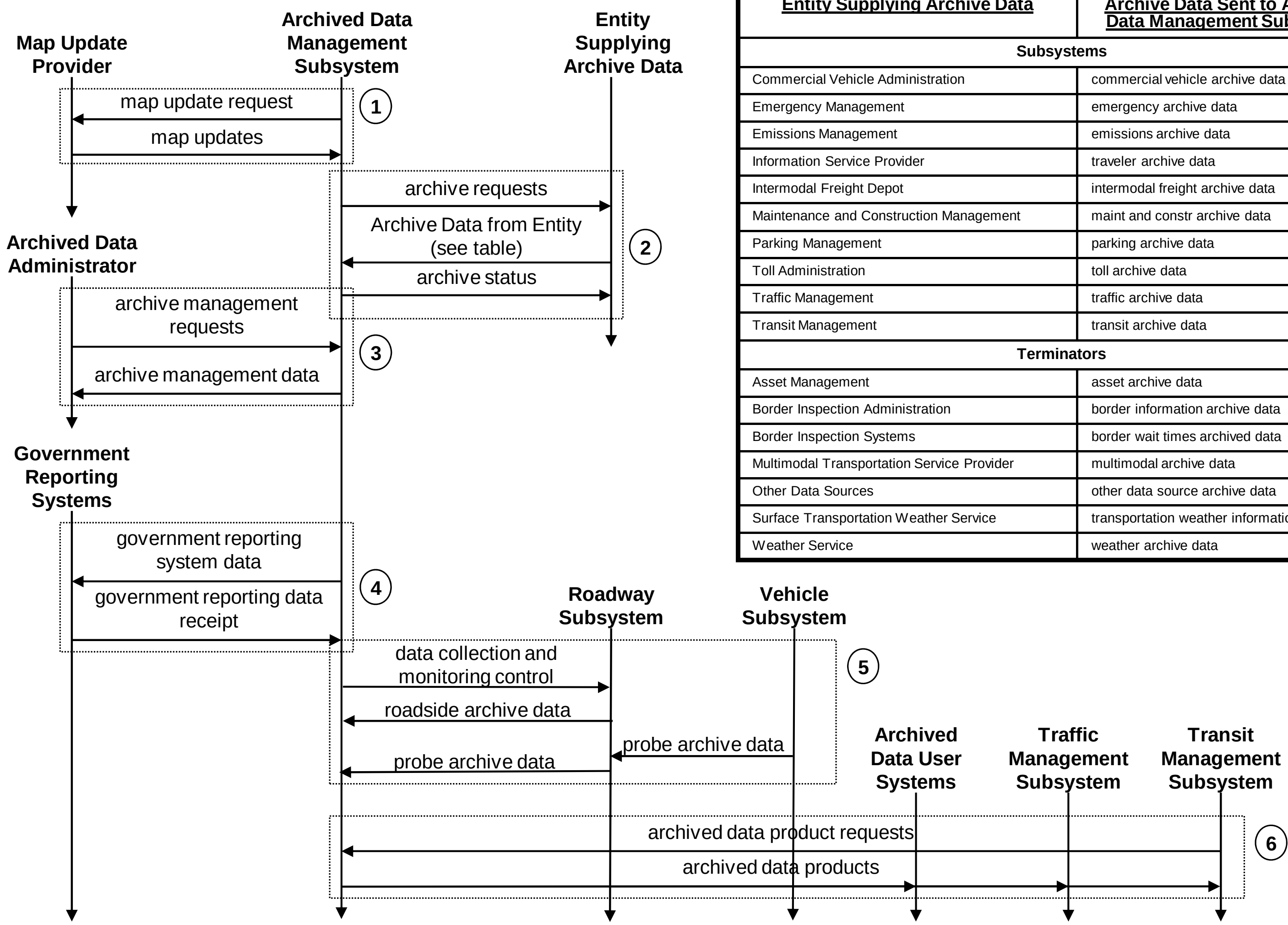
stored in an encrypted state in order to control access. The Archive Data Administrator corresponds to the librarian of the archive in our analogy, where the librarian is responsible for the storage organization of the library data contents, and is responsible for determining and administering access to the data.

4. A special interface is provided for standard government reports (such as, but not limited to, HPMS reports). To satisfy these requirements, ADMS will transmit the *government reporting system data* either asynchronously or upon some schedule established previously by the administrator. The Government Reporting Systems will acknowledge that the data was received and whether there were any issues with the data (*government reporting data receipt*).

5. A special interface is available to allow the archive to control and collect monitoring data directly from Roadway Subsystem (RS) monitoring equipment. This is in support of operations to collect data that will be used for federal HPMS (Highway Performance Monitoring System) reporting requirements or any ADMS that is setup with direct collection and monitoring of traffic sensors. ADMS sends *data collection and monitoring control* messages to the RS to manage how the data is collected. RS will send, either periodically or upon request from ADMS, the data collected from the field, e.g. traffic counts, classification data, speed data, etc. (*roadside archive data*). Alternatively, Vehicle Subsystems (VS) using on-board equipment to transmit probe information to the RS. This *probe archive data* will then be forwarded from the RS to the ADMS as part of its data collection.

6. An interface is provided for Archived Data User Systems, to request and then receive archived data products. These User Systems could include end-users requesting information from the archive for personal research or other data collection systems external to the Intelligent Transportation System (ITS). It could also include other operational ITS center subsystems, i.e. Traffic Management Subsystem (TMS) and Transit Management Subsystem (TRMS), that will use the data to enhance their planning and scheduling activities. In each case, the User Systems, TMS and TRMS will make a request (*archived data product requests*) for a type of data including how and when it should be delivered and ADMS will send the requested *archived data products*. This interface supports one-time requests or subscription for multiple/periodic updates.

AD1: ITS Data Mart



Entity Supplying Archive Data	Archive Data Sent to Archived Data Management Subsystem
Subsystems	
Commercial Vehicle Administration	commercial vehicle archive data
Emergency Management	emergency archive data
Emissions Management	emissions archive data
Information Service Provider	traveler archive data
Intermodal Freight Depot	intermodal freight archive data
Maintenance and Construction Management	maint and constr archive data
Parking Management	parking archive data
Toll Administration	toll archive data
Traffic Management	traffic archive data
Transit Management	transit archive data
Terminators	
Asset Management	asset archive data
Border Inspection Administration	border information archive data
Border Inspection Systems	border wait times archived data
Multimodal Transportation Service Provider	multimodal archive data
Other Data Sources	other data source archive data
Surface Transportation Weather Service	transportation weather information
Weather Service	weather archive data

8.2 AD2: ITS Data Warehouse

This service package includes all the data collection and management capabilities provided by the ITS Data Mart, and adds the functionality and interface definitions that allow collection of data from multiple agencies and data sources spanning across modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this service package in addition to the basic query and reporting user access features offered by the ITS Data Mart.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Archive Data Management subsystem (ADMS) can maintain a current map database for geocoding archived data (if appropriate) by submitting a *map update request* either on a one-time basis for a subscription of updates from a Map Update Provider which will send *map updates* on the agreed upon schedule.

2. The ADMS can request or subscribe (*archive requests*) to operational data from one or more of the subsystems or terminators in the table in the AD1 diagram (___ *archive data* or *transportation weather information*). On receipt of submitted operational data, the ADMS can confirm to the source that the data was received (*archive status*).

3. An Archive Data Administrator can set operational parameters on the archive (*archive management requests*) and the ADMS will display the appropriate *archive management data* to the administrator. These parameters can include how much and how long to store operational data, how to aggregate the data (e.g. averaging or sampling and at what age - for example older data may be sampled more sparsely than more current data). The Administrator can issue user IDs and passwords to limit access to certain types or classes of data, and may determine what data will be stored in an encrypted state in order to control access. The Archive Data Administrator corresponds to the librarian of the archive in our analogy, where the librarian is responsible for the storage organization of the library data contents, and is responsible for determining and administering access to the data.

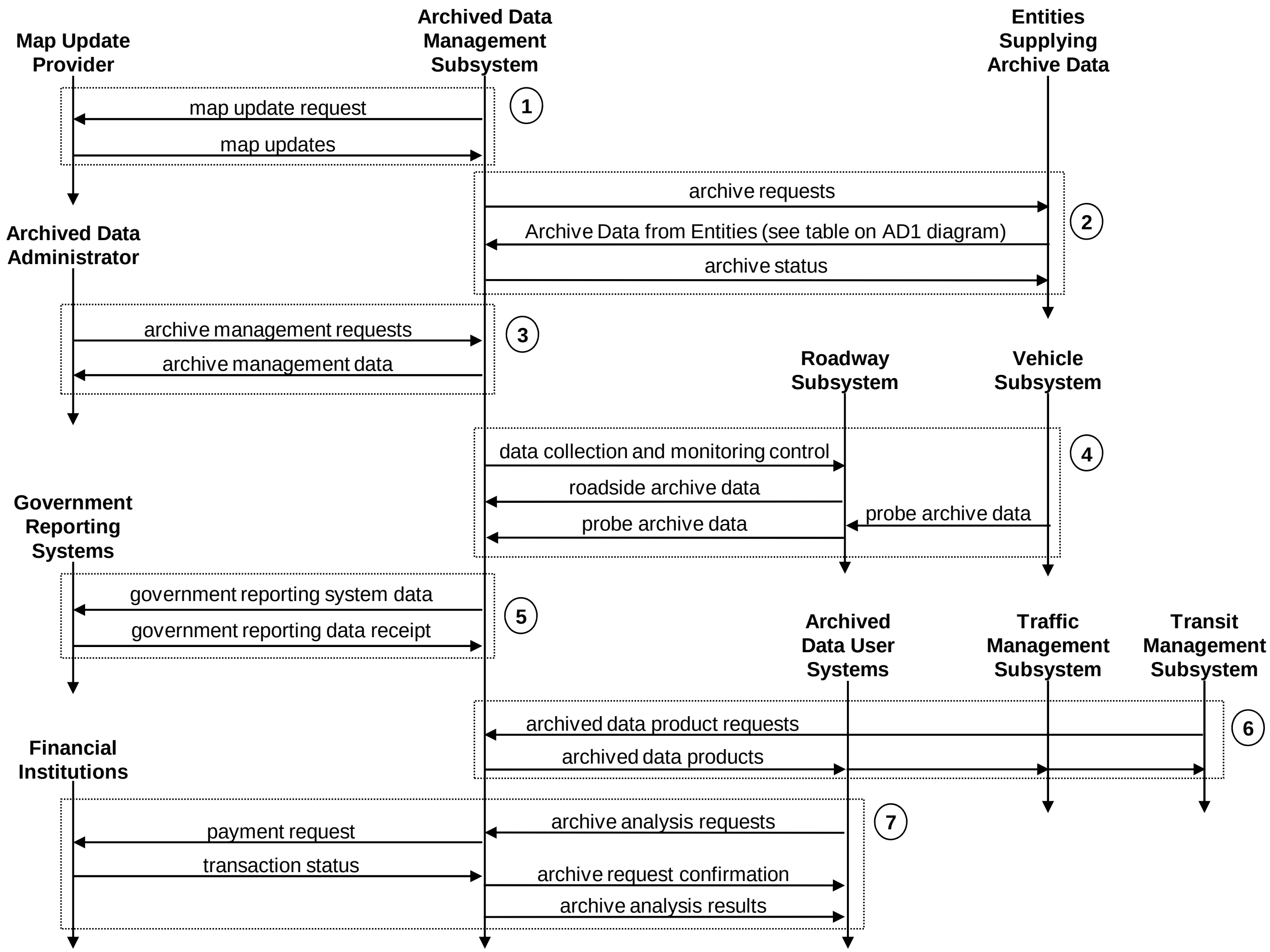
4. A special interface is available to allow the archive to control and collect monitoring data directly from Roadway Subsystem (RS) monitoring equipment. This is in support of operations to collect data that will be used for federal HPMS (Highway Performance Monitoring System) reporting requirements or any ADMS that is setup with direct collection and monitoring of traffic sensors. ADMS sends *data collection and monitoring control* messages to the RS to manage how the data is collected. RS will send, either periodically or upon request from ADMS, the data collected from the field, e.g. traffic counts, classification data, speed data, etc. (*roadside archive data*). Alternatively, Vehicle Subsystems (VS) using on-board equipment to transmit probe information to the RS. This *probe archive data* will then be forwarded from the RS to the ADMS as part of its data collection.

5. A special interface is provided for standard government reports (such as, but not limited to, HPMS reports). To satisfy these requirements, ADMS will transmit the *government reporting system data* either asynchronously or upon some schedule established previously by the administrator. The Government Reporting Systems will acknowledge that the data was received and whether there were any issues with the data (*government reporting data receipt*).

6. An interface is provided for Archived Data User Systems, to request and then receive archived data products. These User Systems could include end-users requesting information from the archive for personal research or other data collection systems external to the Intelligent Transportation System (ITS). It could also include other operational ITS center subsystems, i.e. Traffic Management Subsystem (TMS) and Transit Management Subsystem (TRMS), that will use the data to enhance their planning and scheduling activities. In each case, the User Systems, TMS and TRMS will make a request (*archived data product requests*) for a type of data including how and when it should be delivered and ADMS will send the requested *archived data products*. This interface supports one-time requests or subscription for multiple/periodic updates.

7. The Archive Data User Systems may request customized or predefined archive data analysis and reports to be generated (*archive analysis requests*), with the option of payment to the archive (using a separate Financial Institution interface for payment reconciliation) for these services (*payment request*). An *archive request confirmation* message can be sent to the User to indicate that a request has been accepted and is being processed (or payment is being processed). *Archive analysis results* are returned to the user systems.

AD2: ITS Data Warehouse



8.3 AD3: ITS Virtual Data Warehouse

This service package provides the same broad access to multimodal, multidimensional data from varied data sources as in the ITS Data Warehouse service package, but provides this access using enhanced interoperability between physically distributed ITS archives that are each locally managed. Requests for data that are satisfied by access to a single repository in the ITS Data Warehouse service package are parsed by the local archive and dynamically translated to requests to remote archives which relay the data necessary to satisfy the request.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

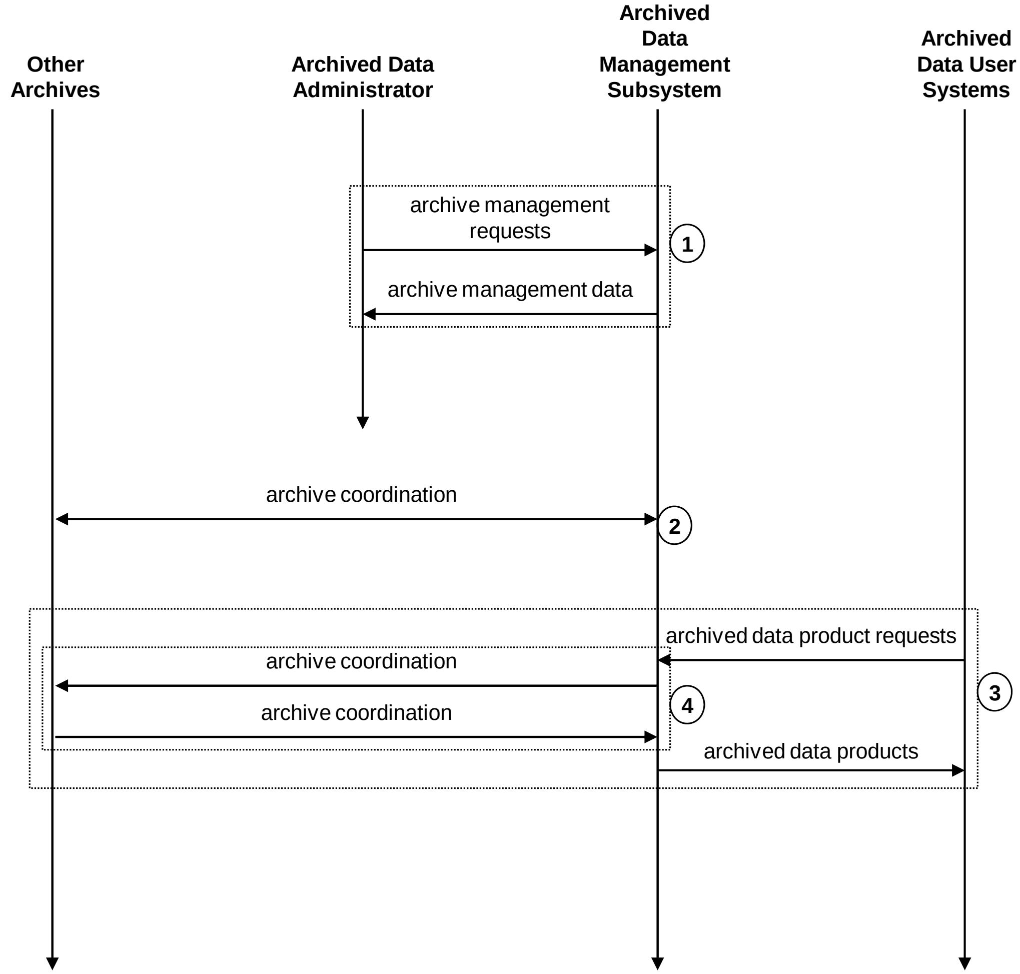
1. An Archive Data Administrator can set operational parameters on the archive (*archive management requests*). These can include how much and how long to store operational data, how to aggregate the data (e.g. averaging or sampling and at what age - for example older data may be sampled more sparsely than more current data). The Administrator can issue user IDs and passwords to limit access to certain types or classes of data, and may determine what data will be stored in an encrypted state in order to control access. The Archive Data Administrator corresponds to the librarian of the archive in our analogy, where the librarian is responsible for the storage organization of the library data contents, and is responsible for determining and administering access to the data on this or Other Archives. The archive returns *archive management data* to the Archive Data Administrator.

2. The ADMS can exchange *archive coordination* data with Other Archives. This exchange of information, when not in direct response to an Archive Data User System request for information, involves the exchange of indexes of data stored at each archive. In this way, a local index in each archive can be used to identify where data is stored that can be responsive to a user request.

3. An interface is provided for Archive Data User Systems, to request (*archived data product requests*) and then receive *archived data products*.

4. If necessary, to be responsive to an Archive Data User System, the archive may request and receive information from one or more Other Archives (*archive coordination*).

AD3: ITS Virtual Data Warehouse



9 Advanced Vehicle Safety

This section provides the Theory of Operations for the Advanced Vehicle Safety Service Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each service package section) to identify these service packages is AVSS—Advanced Vehicle Safety Systems. For all but one of these Service Packages, there are really no machine-to-machine interfaces outside of the vehicle. (That is not true for the last service package.) The interfaces are primarily human interfaces (with the driver), and interfaces that really don't exchange any data, but rather sense the environment.

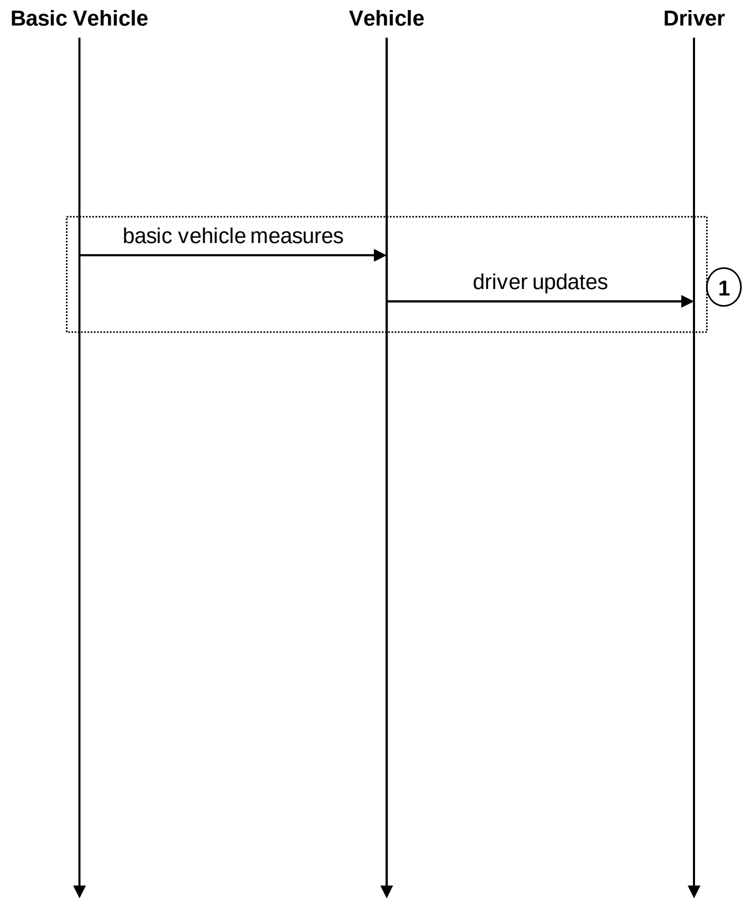
9.1 AVSS01: Vehicle Safety Monitoring

This service package will diagnose critical components of the vehicle and warn the driver of potential dangers. On-board sensors will determine the vehicle's condition, performance, on-board safety data, and display information.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The vehicle receives input from sensors on the vehicle associated with basic vehicle systems e.g. traction control, anti-lock brakes, speedometer, accelerometer, basic engine measurements (*basic vehicle measures*). The Vehicle subsystem analyzes this data and presents updates and alarms to the Driver (*driver updates*).

AVSS01: Vehicle Safety Monitoring



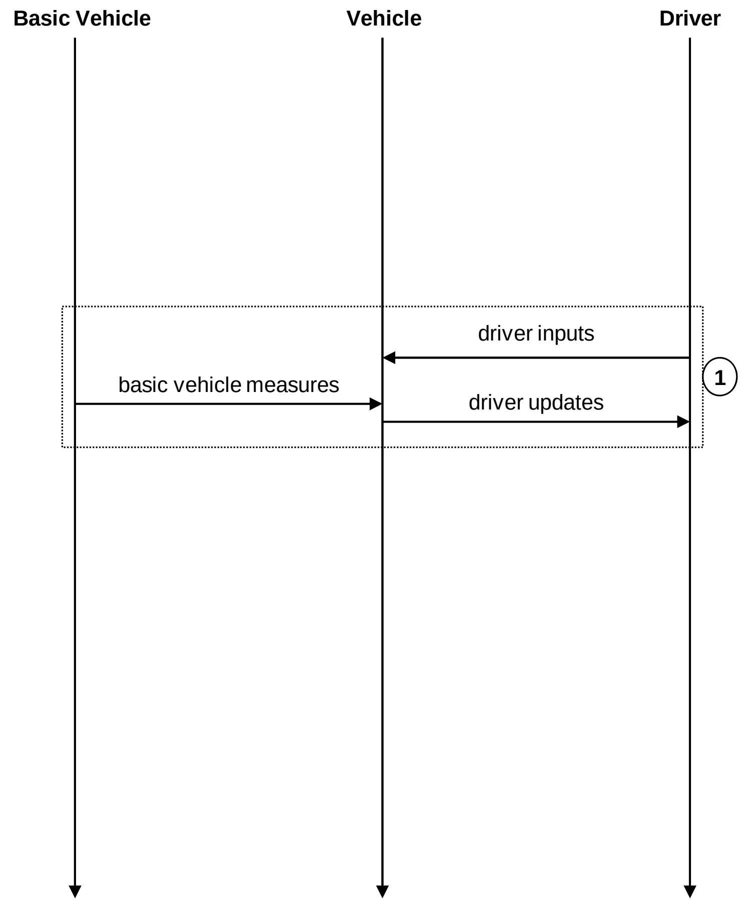
9.2 AVSS02: Driver Safety Monitoring

This service package will determine the driver's condition, and warn the driver of potential dangers. On-board sensors will determine the driver's condition, performance, on-board safety data, and display information.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The vehicle receives input from the Driver (e.g. throttle, brake and steering) and from devices such as; motion detectors, eye movement detectors, and breath analyzers (*driver inputs*). Data is also collected from sensors on the vehicle associated with basic vehicle systems e.g. traction control, anti-lock brakes, speedometer, accelerometer, and basic engine measurements (*basic vehicle measures*). The Vehicle subsystem analyzes this data and presents updates and alarms to the Driver (*driver updates*).

AVSS02: Driver Safety Monitoring



9.3 AVSS03: Longitudinal Safety Warning

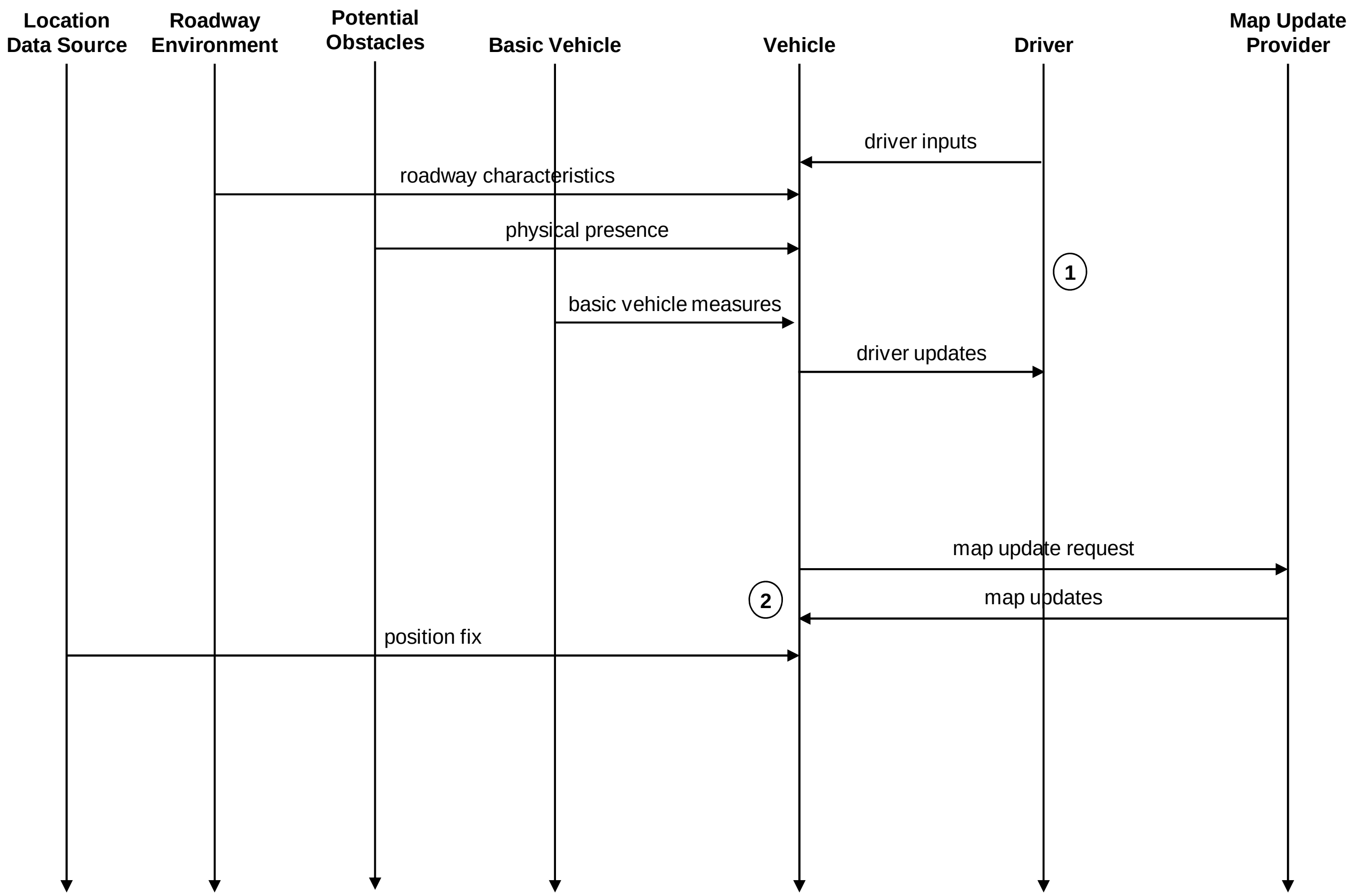
This service package allows for longitudinal warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas in front of and behind the vehicle and present warnings to the driver about potential hazards.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The vehicle receives input from the Driver (e.g. throttle and brake) (*driver inputs*). Data is also collected from sensors on the vehicle (*basic vehicle measures*) associated with basic vehicle systems (e.g. traction control, anti-lock brakes, speedometer, accelerometer, and basic engine measurements) and sensors detect objects that may be in front of or behind the vehicle (*physical presence*) as well as sensing the roadway environment (*roadway characteristics*). The Vehicle subsystem analyzes this data and presents updates and alarms to the Driver regarding potential collision with objects, people or vehicles ahead of or behind the vehicle (*driver updates*).

2. Accurate positioning of the vehicle on the road network can also be used to improve performance of the vehicle safety system. Accurate position combined with detailed map data provides information about the road geometry ahead of the vehicle which can be used to adjust alarm thresholds and reduce false alarms. A *position fix* provides vehicle location and current accurate map data is provided to the vehicle (*map update request* and *map updates*).

AVSS03: Longitudinal Safety Warning



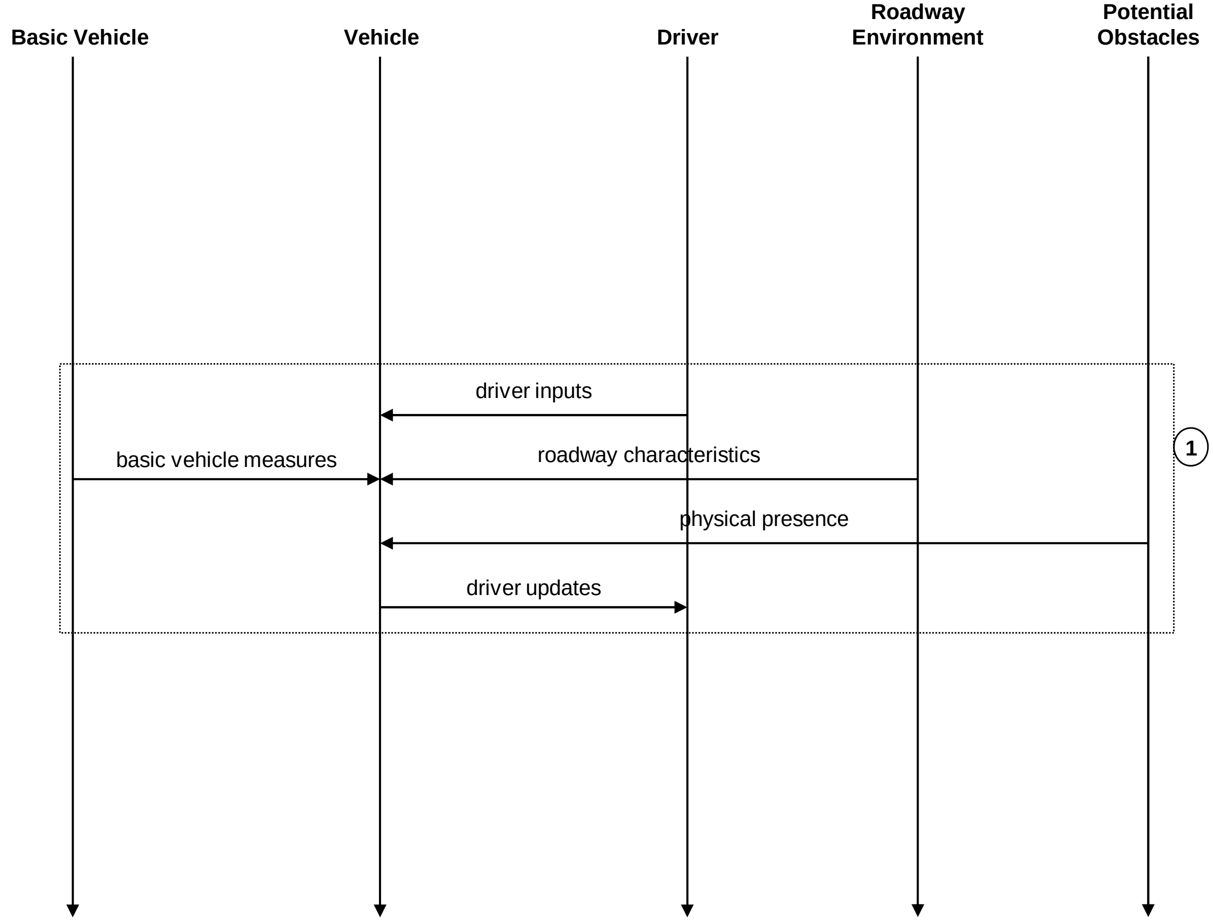
9.4 AVSS04: Lateral Safety Warning

This service package allows for lateral warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas to the sides of the vehicle and present warnings to the driver about potential hazards.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The vehicle receives input from the Driver (e.g. steering) (*driver inputs*). Data is also collected from sensors on the vehicle (*basic vehicle measures*) associated with basic vehicle systems (e.g. traction control, anti-lock brakes, speedometer, accelerometer, and basic engine measurements) and sensor data about lane position (*roadway characteristics*) and Potential Obstacles (*physical presence*). The Vehicle subsystem analyzes this data and presents updates and alarms to the Driver regarding potential lane departure conditions (*driver updates*).

AVSS04: Lateral Safety Warning



9.5 AVSS05: Intersection Safety Warning

This service package monitors vehicles approaching an intersection and warns drivers when hazardous conditions are detected. The service package detects impending violations (e.g., red-light violations) and potential conflicts between vehicles occupying or approaching the intersection (e.g., situations where a left turn would be unsafe because of approaching traffic). When a potentially hazardous condition is detected, a warning is communicated to the involved vehicles using short range communications and/or signs/signals in the intersection.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Intersection safety warnings can be provided by a combination of infrastructure-based and vehicle-based systems. Some implementations rely on the vehicle's ability to determine its precise location on the road network. *Map updates* ensure that the vehicle has current map data as an intersection is approached. Map data may be requested by the vehicle (*map update request*) for an entire region or dynamically as it moves through the network, depending on implementation.

2. The driver controls the on-board systems that provide safety warnings (*driver inputs*). The vehicle monitors its current position relative to the intersection (*position fix*), detects vehicles, pedestrians, and other objects in the vehicle's path (*physical presence*) and monitors the driver's current control of the vehicle including *basic vehicle measures* such as vehicle speed, acceleration, anti-lock brake status, traction control status, acceleration, and turning movement.

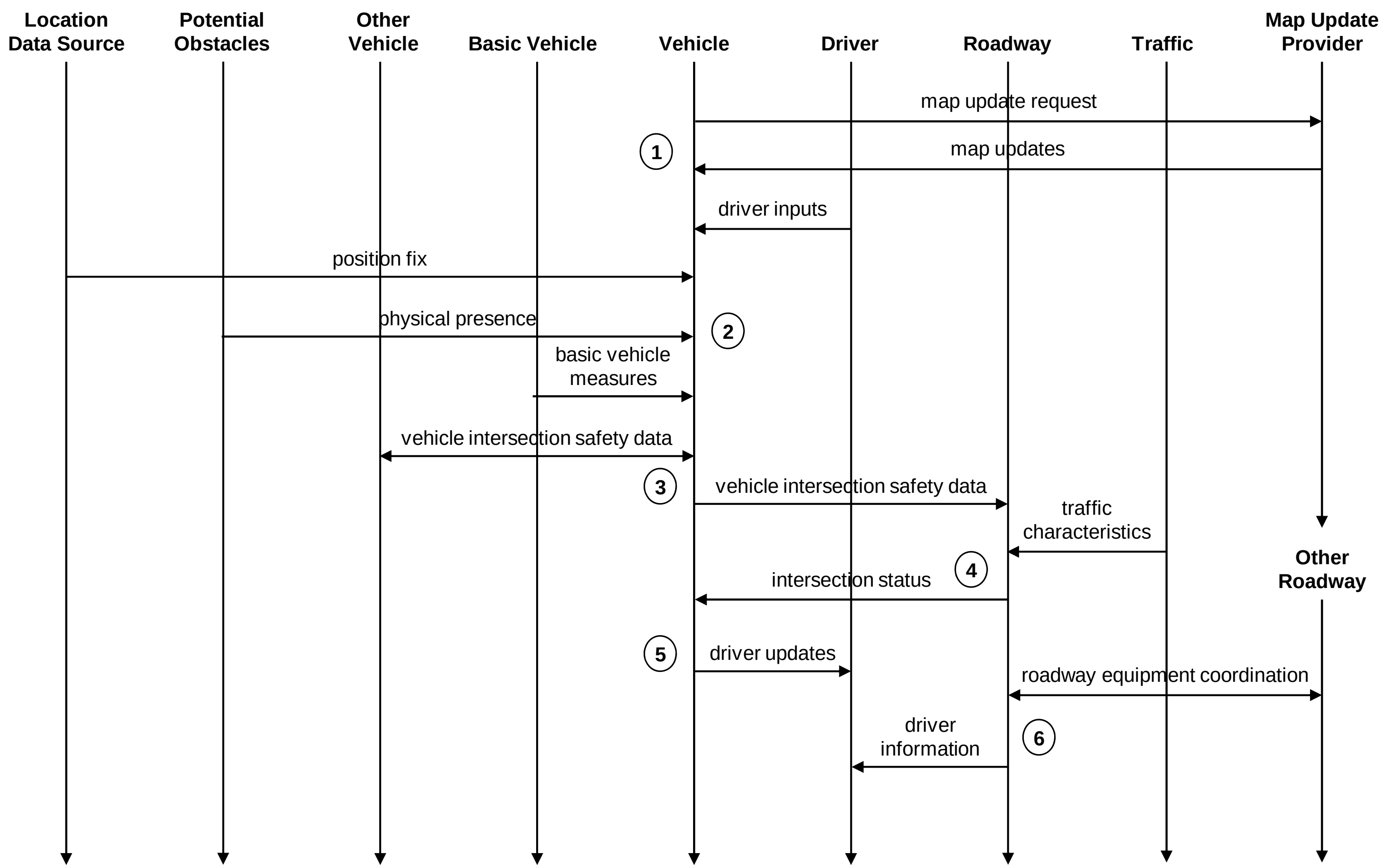
3. The Vehicle monitors its approach to the intersection and detects potential hazards. It uses short range communications to send its current position, motion, and anticipated path through the intersection to other vehicles approaching the intersection and to field equipment at the intersection (*vehicle intersection safety data*).

4. For implementations that allocate intelligence to the intersection, *vehicle intersection safety data* is collected from approaching vehicles and sensors are used to monitor approaching traffic that may include unequipped vehicles (*traffic characteristics*). The intersection uses short range communications to send *intersection status* to the approaching vehicles that includes signal phase and timing information, intersection geometry, warnings of potential violations and hazardous conditions, and approaching vehicle information.

5. The vehicle processes data collected from on-board systems and/or information received from the intersection and provides safety warnings to the driver, notifying the driver of potential hazards or violations (*driver updates*).

6. The intersection may also use signs and signals to warn approaching vehicles of hazardous situations. In this case, the intelligent intersection activates the signal or sign (*roadway equipment coordination*, which provides the warning to approaching traffic (*driver information*).

AVSS05: Intersection Safety Warning



9.6 AVSS06: Pre-Crash Restraint Deployment

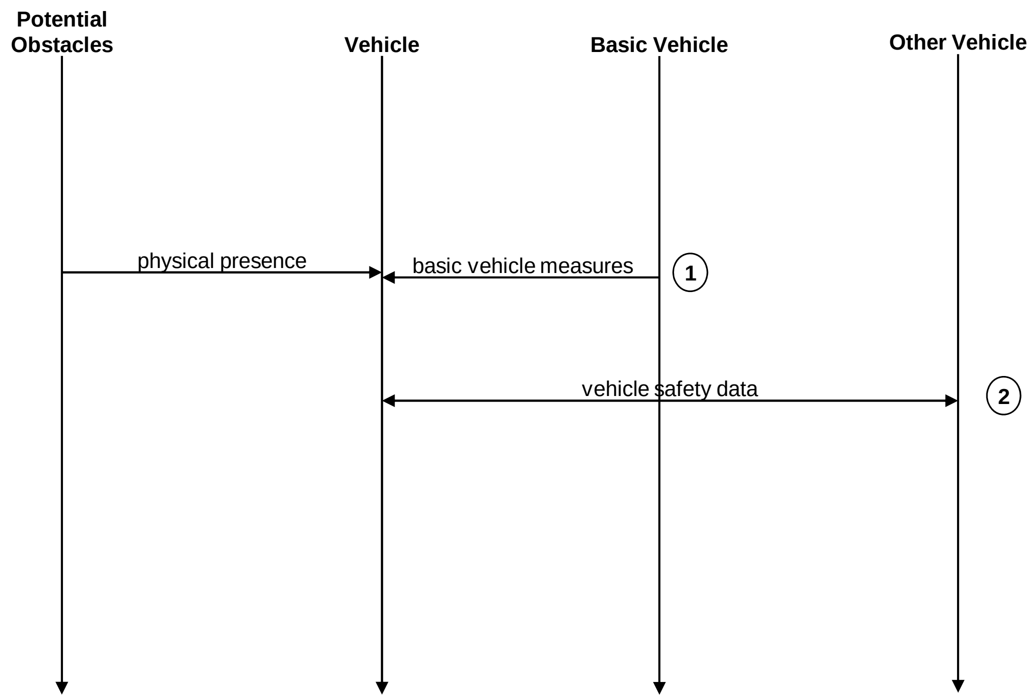
This service package provides in-vehicle sensors and on-board communications to monitor the vehicle's local environment, determine collision probability and deploy a pre-crash safety system. It will include on-board sensors to measure lateral and longitudinal gaps and together with weather and roadway conditions will determine lateral and longitudinal collision probability. It will exchange messages with other equipped vehicles to determine the precise location of surrounding vehicles. It will deploy a pre-crash safety system when a crash is imminent.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The *physical presence* of potential obstacles and *basic vehicle measures* (e.g. speed, acceleration in all 6 degrees of freedom) are combined to identify conditions where a collision is likely, and to then deploy vehicle restraints (e.g. pre-tension safety belts) in advance of the collision.

2. The VS will also exchange *vehicle safety data* with other equipped vehicles within the range of the Vehicle-Vehicle Communications. VS will use this information to help calculate probability of a collision and determine the need to deploy any pre-crash restraints.

AVSS06: Pre-Crash Restraint Deployment



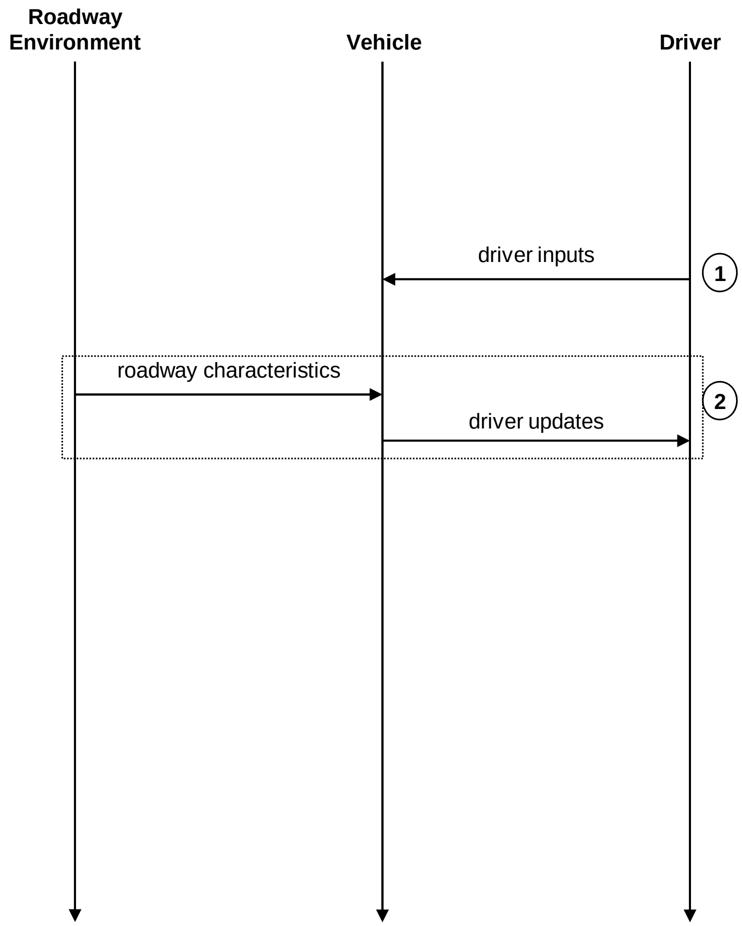
9.7 AVSS07: Driver Visibility Improvement

This service package will enhance driver visibility using an enhanced vision system. On-board display hardware is needed

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The driver activates or deactivates or adjusts performance parameters (e.g. sensitivity or contrast) of the system (*driver inputs*).
2. The vehicle senses characteristics of the roadway (*roadway characteristics*) and environment and presents this as an enhanced image to the driver (*driver updates*).

AVSS07: Driver Visibility Improvement



9.8 AVSS08: Advanced Vehicle Longitudinal Control

This service package automates the speed and headway control functions on board the vehicle. It utilizes safety sensors and collision sensors combined with vehicle dynamics processing to control the throttle and brakes. It requires on-board sensors to measure longitudinal gaps and a processor for controlling the vehicle speed.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

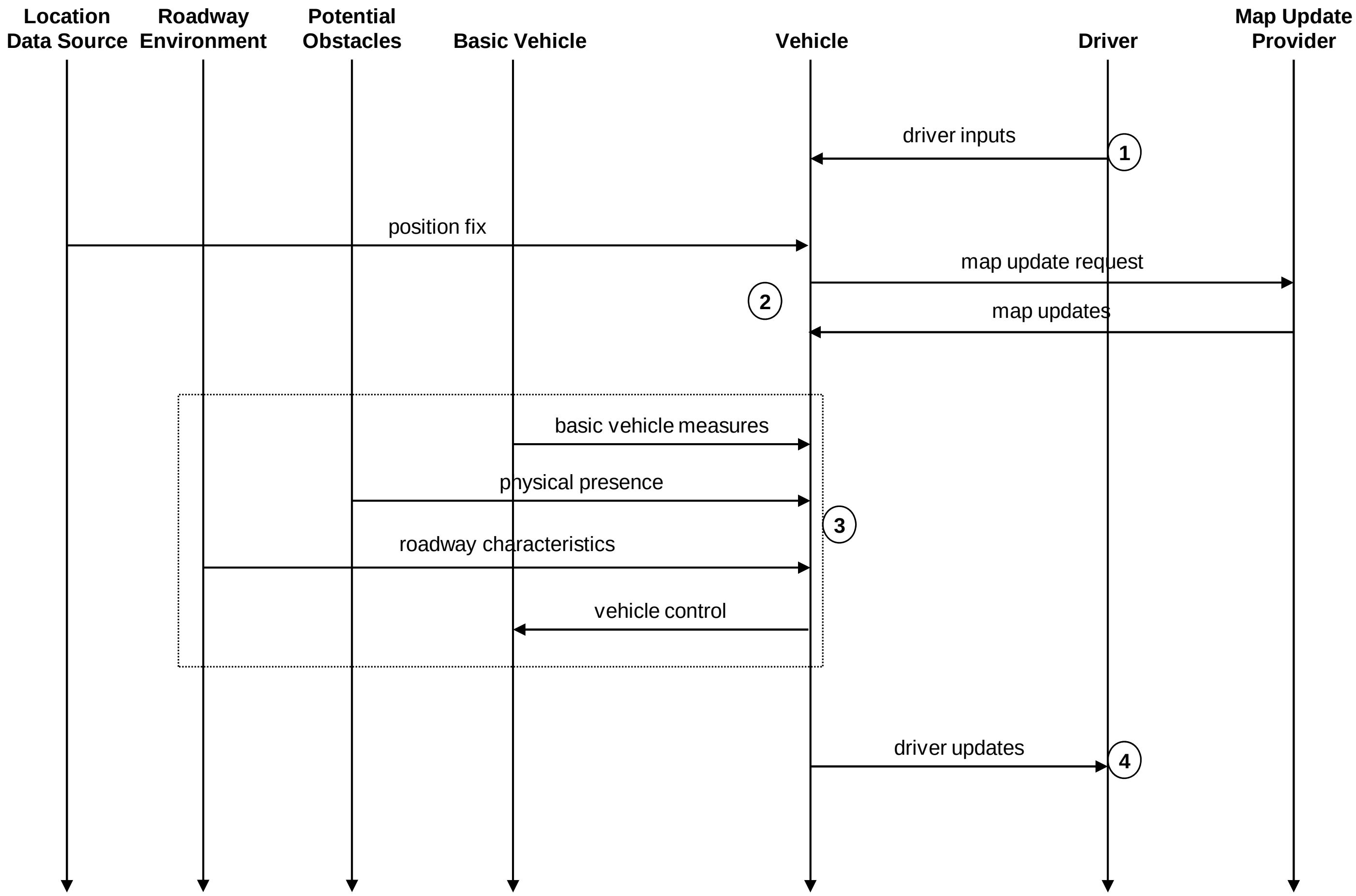
1. The driver can activate the system and provide steering and other vehicle control inputs to the vehicle (*driver inputs*).

2. Accurate positioning of the vehicle on the road network can also be used to improve performance of the vehicle safety system. Accurate position combined with detailed map data provides information about the road geometry ahead of the vehicle which can be used to adjust alarm thresholds and reduce false alarms. A *position fix* provides vehicle location and current accurate map data is provided to the vehicle (*map update request* and *map updates*).

3. Vehicle performance and the driver's current control of the vehicle are monitored including *basic vehicle measures* such as vehicle speed, acceleration, anti-lock brake status, traction control status, acceleration, and turning movement. Sensors detect objects that may be in front of or behind the vehicle (*physical presence*) as well as the Roadway Environment (*roadway characteristics*). The Vehicle subsystem analyzes this data and presents updates and alarms to the Driver regarding potential collision with objects, people or vehicles ahead of or behind the vehicle. If a collision or a safety violation is imminent, the vehicle may take evasive action (e.g. change in throttle position, change in transmission gearing, braking - *vehicle control*).

4. *Driver updates* provide information about the operational status of the safety system and a positive indication of any hazardous conditions and automated system activations.

AVSS08: Advanced Vehicle Longitudinal Control



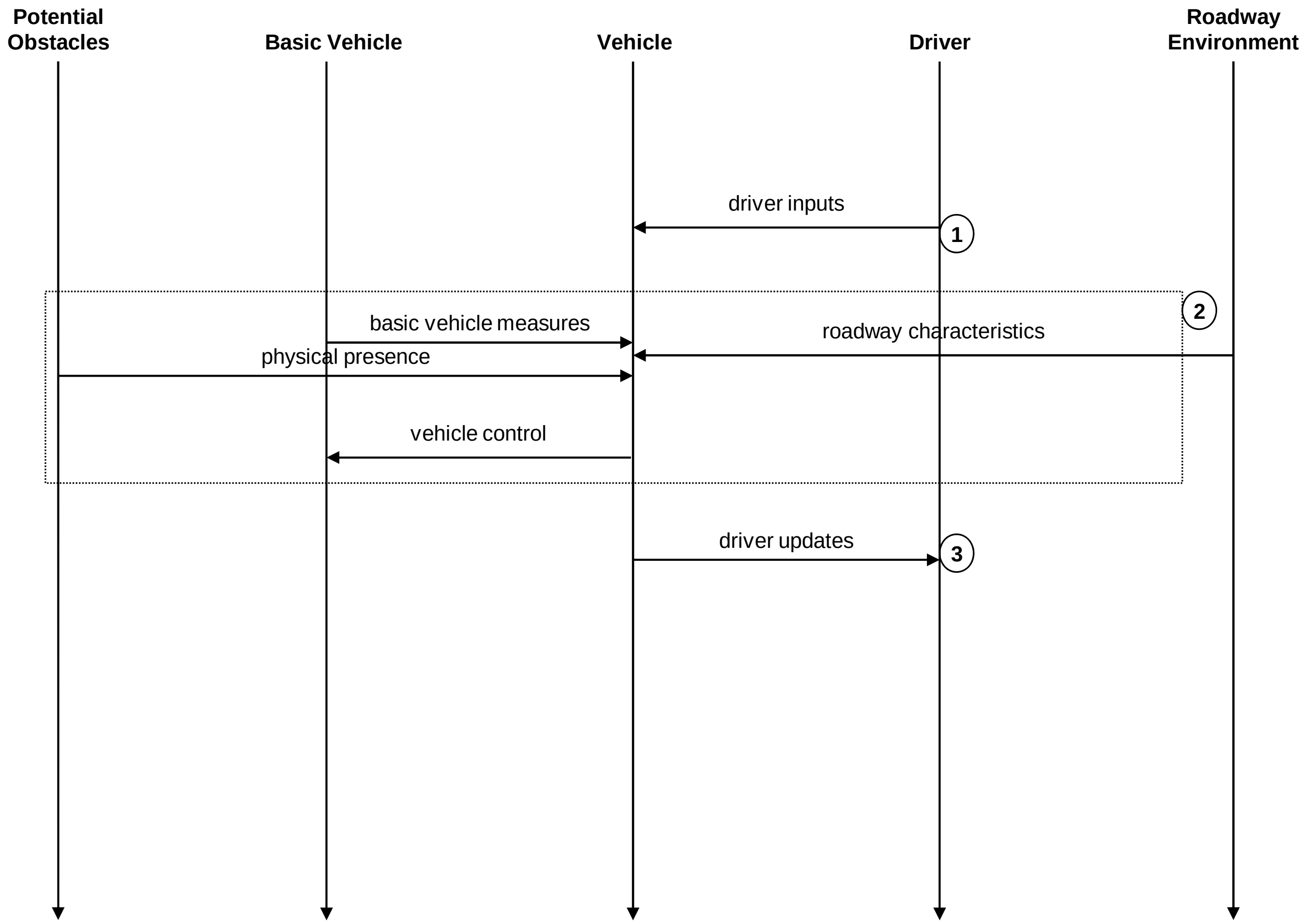
9.9 AVSS09: Advanced Vehicle Lateral Control

This service package automates the steering control on board the vehicle. It utilizes safety sensors and collision sensors combined with vehicle dynamics processing to control the steering. It requires on-board sensors to measure lane position and lateral deviations and a processor for controlling the vehicle steering.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The driver can activate the system and provide steering and other vehicle control inputs to the vehicle (*driver inputs*).
2. The vehicle receives *basic vehicle measures* (speed, surface traction), *physical presence* of potential obstacles and *roadway characteristics* input (e.g. lane marker position). If a collision seems possible or if the vehicle seems to be departing from the lane, the vehicle may take evasive action (e.g. adjust steering position, change in throttle position, change in transmission gearing, braking) (*vehicle control*).
3. Driver is updated on lateral collision and control conditions (*driver updates*).

AVSS09: Advanced Vehicle Lateral Control



9.10 AVSS10: Intersection Collision Avoidance

This service package will determine the probability of an intersection collision and provide timely warnings to approaching vehicles so that avoidance actions can be taken. This service package builds on the Intersection Safety Warning field and in-vehicle equipment and adds equipment in the vehicle that can take control of the vehicle to avoid intersection violations and potential collisions. The same sensors and communications equipment in the roadway infrastructure are used to assess vehicle locations and speeds near an intersection. This information is determined and communicated to the approaching vehicle using a short range communications system. The vehicle uses this information to develop control actions which alter the vehicle's speed and steering control and potentially activate its pre-crash safety system.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. Intersection collision avoidance can be supported by a combination of infrastructure-based and vehicle-based systems. Some implementations rely on the vehicle's ability to determine its precise location on the road network. *Map updates* ensure that the vehicle has current map data as an intersection is approached. Map data may be requested by the vehicle (*map update request*) for an entire region or dynamically as it moves through the network, depending on implementation.

2. The driver controls the on-board collision avoidance systems and also maintains manual control of the vehicle with throttle, brake, and steering adjustments (*driver inputs*). The vehicle monitors its current position relative to the intersection (*position fix*), detects vehicles, pedestrians, and other objects in the vehicle's path (*physical presence*) and monitors the driver's current control of the vehicle including *basic vehicle measures* such as vehicle speed, acceleration, anti-lock brake status, traction control status, acceleration, and turning movement.

3. The Vehicle monitors its approach to the intersection and detects potential hazards. It uses short range communications to send its current position, motion, and anticipated path through the intersection to other vehicles approaching the intersection and to field equipment at the intersection (*vehicle intersection safety data*).

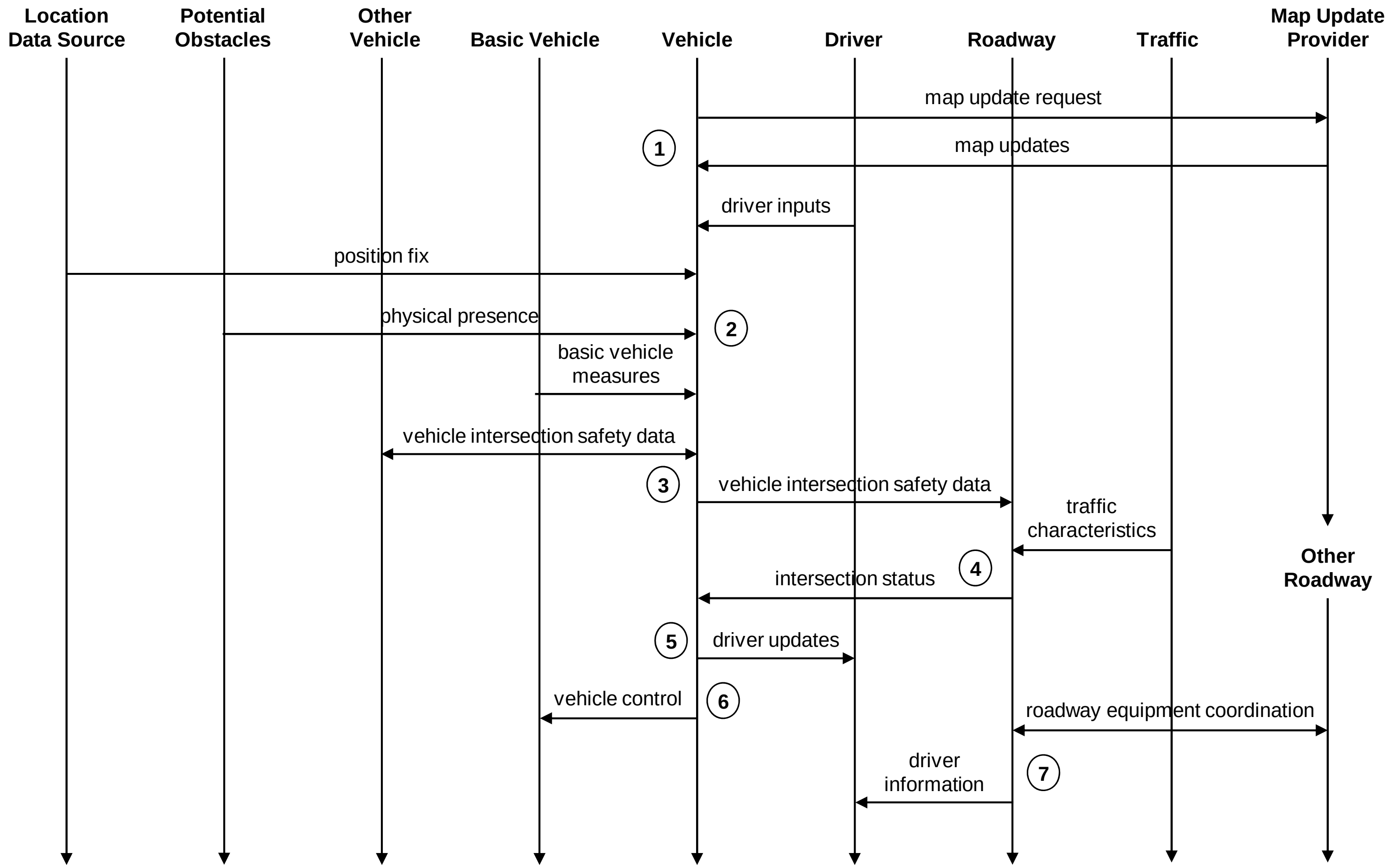
4. For implementations that allocate intelligence to the intersection, *vehicle intersection safety data* is collected from approaching vehicles and sensors are used to monitor approaching traffic that may include unequipped vehicles (*traffic characteristics*). The intersection uses short range communications to send *intersection status* to the approaching vehicles that includes signal phase and timing information, intersection geometry, warnings of potential violations and hazardous conditions, and approaching vehicle information.

5. The vehicle processes data collected from on-board systems and/or information received from the intersection and provides safety warnings to the driver, notifying the driver of potential hazards or violations (*driver updates*).

6. If a collision or safety violation is imminent, the vehicle takes evasive action (e.g. adjust steering position, change in throttle position, apply braking) (*vehicle control*).

7. The intersection may also use signs and signals to warn approaching vehicles of hazardous situations. In this case, the intelligent intersection activates the signal or sign (*roadway equipment coordination*, which provides the warning to approaching traffic (*driver information*).

AVSS10: Intersection Collision Avoidance



9.11 AVSS11: Automated Vehicle Operations

This service package enables "hands-off" operation of the vehicle on automated portions of the highway system. Implementation requires lateral lane holding, vehicle speed and steering control. Communications between vehicles and between the vehicles and supporting infrastructure equipment supports cooperative check-in to the automated portion of the system and transition to automated mode, coordination of maneuvers between vehicles in automated mode, and checkout from the automated system as the driver resumes control of the vehicle.

The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Roadway subsystem provides *automated roadway status* information to the Traffic Management subsystem, and the Traffic Management subsystem provides *automated roadway control data* to the Roadway subsystem, allowing the center to monitor and provide strategic control of the automated system.

2. The Vehicle subsystem collects control inputs from the Driver (*driver inputs*), and non-ITS system status measures from the Basic Vehicle (*basic vehicle measures*)

3. The Vehicle subsystem collects information from sensed *physical presence* of obstacles and *roadway characteristics* (e.g. lane markers, exit markers, AHS entry/exit location markers).

4. The Vehicle subsystem exchanges control and status information directly with Other Vehicles in the vicinity (*vehicle control coordination*). For example, the lead vehicle in a platoon of vehicles may send its predicted acceleration profile to the vehicle just behind, and that vehicle will send the acceleration profile to the vehicle behind it. In this way, very small and precise headway control is possible while minimizing the power requirements on the individual vehicles that might otherwise be necessary if the headway holding was based entirely on distance sensors.

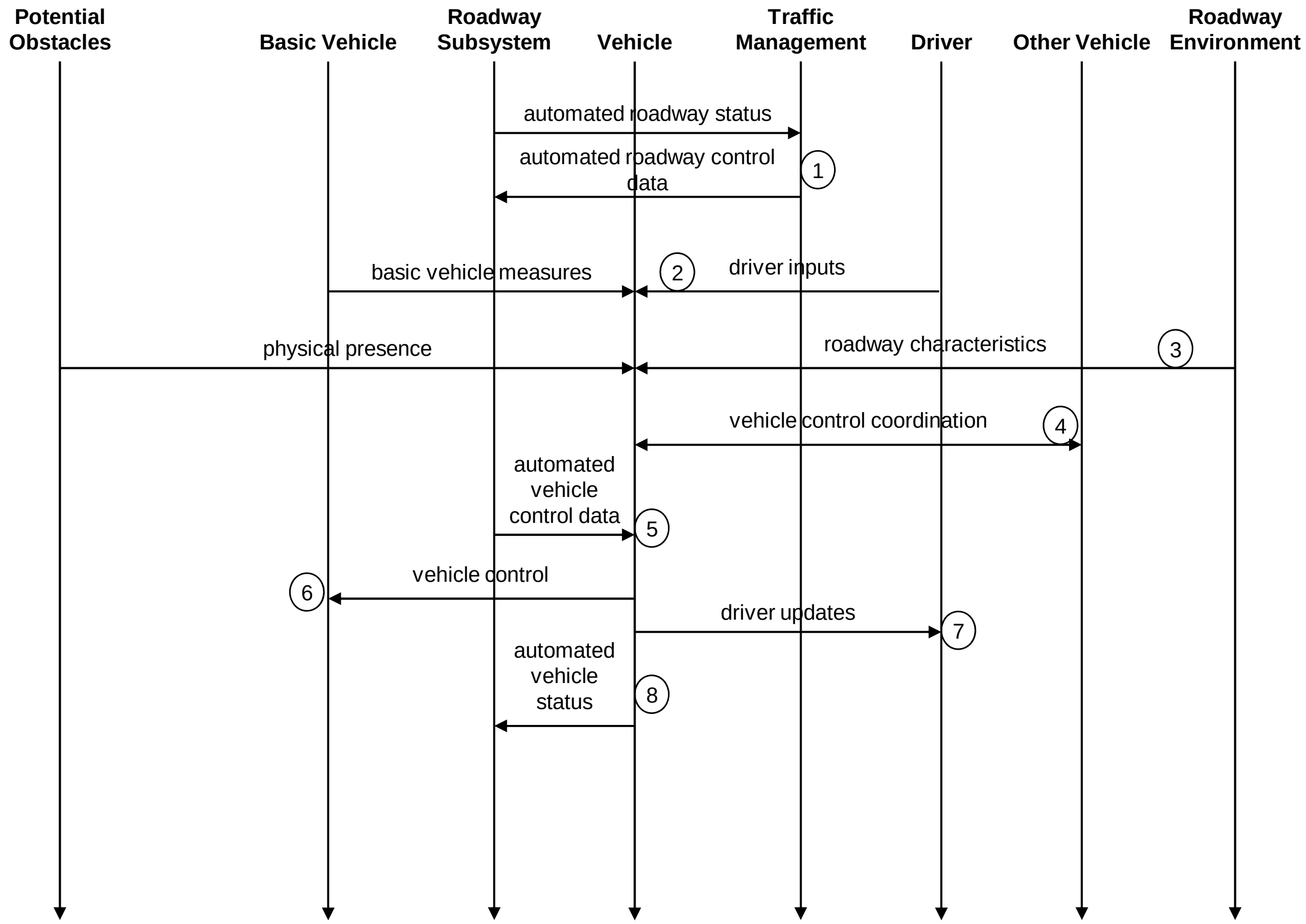
5. The Roadway sends *automated vehicle control data* to the individual vehicles. This would include operating parameters such as maximum speed and information about when and where to merge into or depart the automated portion of the system.

6. The Vehicle subsystem can send (*vehicle control*) information to the basic vehicle (e.g. steering, braking, and throttle position).

7. The Driver receives (*driver updates*) about the automated system, vehicle operational status, and vehicle condition.

8. The vehicle can notify the roadway about its operational status and condition (*automated vehicle status*).

AVSS11: Automated Vehicle Operations



9.12 AVSS12: Cooperative Vehicle Safety Systems

This service package enhances the on-board longitudinal and lateral warning stand-alone systems by exchanging messages with other surrounding vehicles and roadside equipment. Vehicles send out information concerning their location, speed, and direction to surrounding vehicles. The roadside equipment provides information about potential safety hazards in the vehicle path such as stalled (unequipped) vehicles, wrong-way drivers, debris, or water hazards. The on-board systems can then process this information and present warnings to the driver including headway warnings, merge warnings, unsafe passing warnings, and warnings about hazards detected in the vehicle path. Special messages from approaching emergency vehicles may also be received and processed.

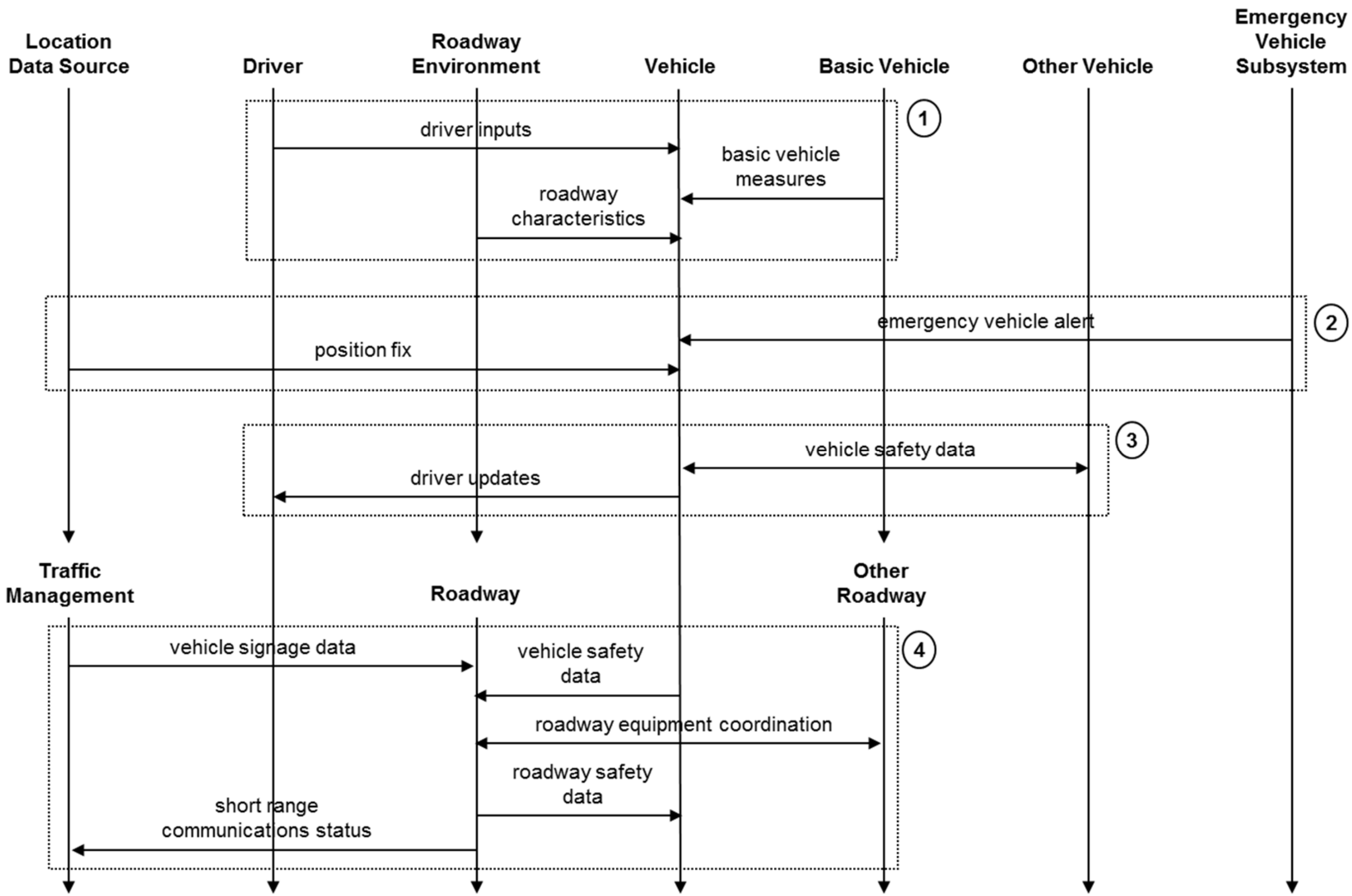
The following discusses how the National ITS Architecture provides the transportation service described by this service package. Each numbered item describes the operation of that portion of the service package identified with the corresponding number on the transaction set diagram.

1. The Vehicle subsystem (VS) monitors the *driver inputs* from the Driver, e.g. throttle and brake systems. Data is also collected from sensors on the vehicle associated with basic vehicle systems, e.g. traction control, anti-lock brakes, speedometer, accelerometer, and basic engine measurements (*basic vehicle measures*). Sensors that are part of the on-board equipment may also be collecting data regarding objects that may be close to the vehicle. The VS includes sensors to collect data about the roadway itself including the lane positioning of the vehicle within the roadway (*roadway characteristics*).

2. An Emergency Vehicle Subsystem (EVS) may transmit an *emergency vehicle alert* to surrounding vehicles which will be received by VS and used as part of its analysis to determine if a collision is imminent. Current vehicle location is also determined (*position fix*) and used in the analysis.

3. The VS will exchange *vehicle safety data* with other equipped vehicles within the range of the Vehicle-Vehicle Communications. With all of the data received VS will determine probability of a collision and determine the need to deploy any safety systems. The VS presents updates and alarms to the Driver (*driver updates*) regarding potential collisions with objects, people or vehicles ahead of or behind the vehicle, including emergency vehicles in the area.

4. The VS may also send the same *vehicle safety data* to Roadway equipment that looks at all data provided by vehicles in the proximity and identifies potential hazardous situations. In addition, data is gathered from other Roadway sensors (*roadway equipment coordination*) that detect road conditions, unequipped vehicles, and other objects on the road. From all of the data received, the Roadway identifies hazardous situations and sends warning(s) to vehicle(s) (*roadway safety data*). The Traffic Management Subsystem monitors (*short range communications status*) and controls (*vehicle signage data*) the Roadway equipment.


Location Data Source
Driver
Roadway Environment
Vehicle
Basic Vehicle
Other Vehicle
Emergency Vehicle Subsystem
1
driver inputs
basic vehicle measures
roadway characteristics
2
emergency vehicle alert
position fix
3
vehicle safety data
driver updates
Traffic Management
Roadway
Other Roadway
4
vehicle signage data
vehicle safety data
roadway equipment coordination
roadway safety data
short range communications status