National ITS Architecture
Theory of Operations

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Prepared for:

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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 Market Package defined in the Market Packages document. The document is based on and complements the other National ITS Architecture documents: primarily the Physical Architecture and Market Packages documents.

The Theory of Operations document has been completely rewritten for Version 4 of the National ITS Architecture. The emphasis in this revision is on describing the operation of Market Packages, 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 Sets*, a representation of the sequence of architecture flows between architecture entities.

Market Packages

Market 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. Market Packages represent particular groupings of entities defined in the Physical Architecture that correspond to specific transportation services. Market Packages collect together one or more Equipment Packages that must work together to deliver a given transportation service 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. Market 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 market packages-- their definition, analysis, and a number of examples that illustrate ways Market Packages can be applied in regional and project architecture development activities—see the Market Packages Document. For a complete discussion of the

elements of the Physical architecture-- subsystems, terminators, equipment packages, and architecture flow— see the Physical Architecture Document.

Transaction Sets

The operation of the Market Packages is described in this document through the use of *Transaction Sets*. For each Market 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 market package activities have been partitioned into distinct phases of activity: for example an information collection phase, an execution phase, and a follow-up phase, where this is done these distinct phases are illustrated in separate transaction set diagrams.

The transaction set diagrams, when suitably customized for a 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, and these relationships are important to the *message set* group of standards.

Where market 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 market 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 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

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.

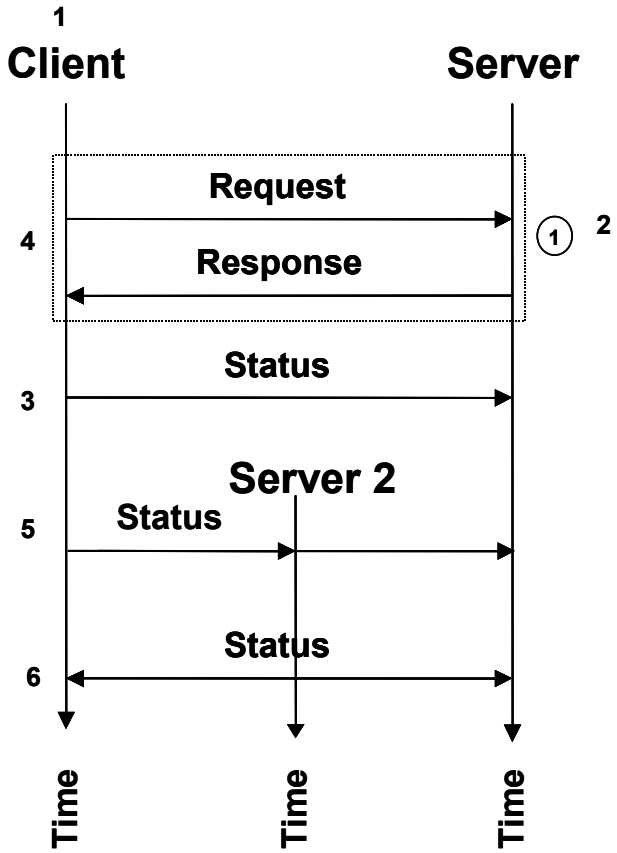


Figure 1 Transaction Set Diagram Notation

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 Market 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 market package. Some architecture flows may appear more than once on the diagram(s) for the market package. This is to indicate that the particular architecture flow is involved in the operation of several aspects of the market 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

market 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 architecture flows.

4. *Dotted boxes may be drawn around groups of architecture flows that are intended to be in a specific sequence in describing the operation of the market 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 market 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 the 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 market 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 conserve space in 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 market packages. Within a section each market package that belongs to the group (for example Traffic Management) is defined and then the operation of the market package is described in text that references the transaction set diagram (or diagrams for more complex market packages). The Sections, and market package groups they describe are as follows:

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

2. Traffic Management

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

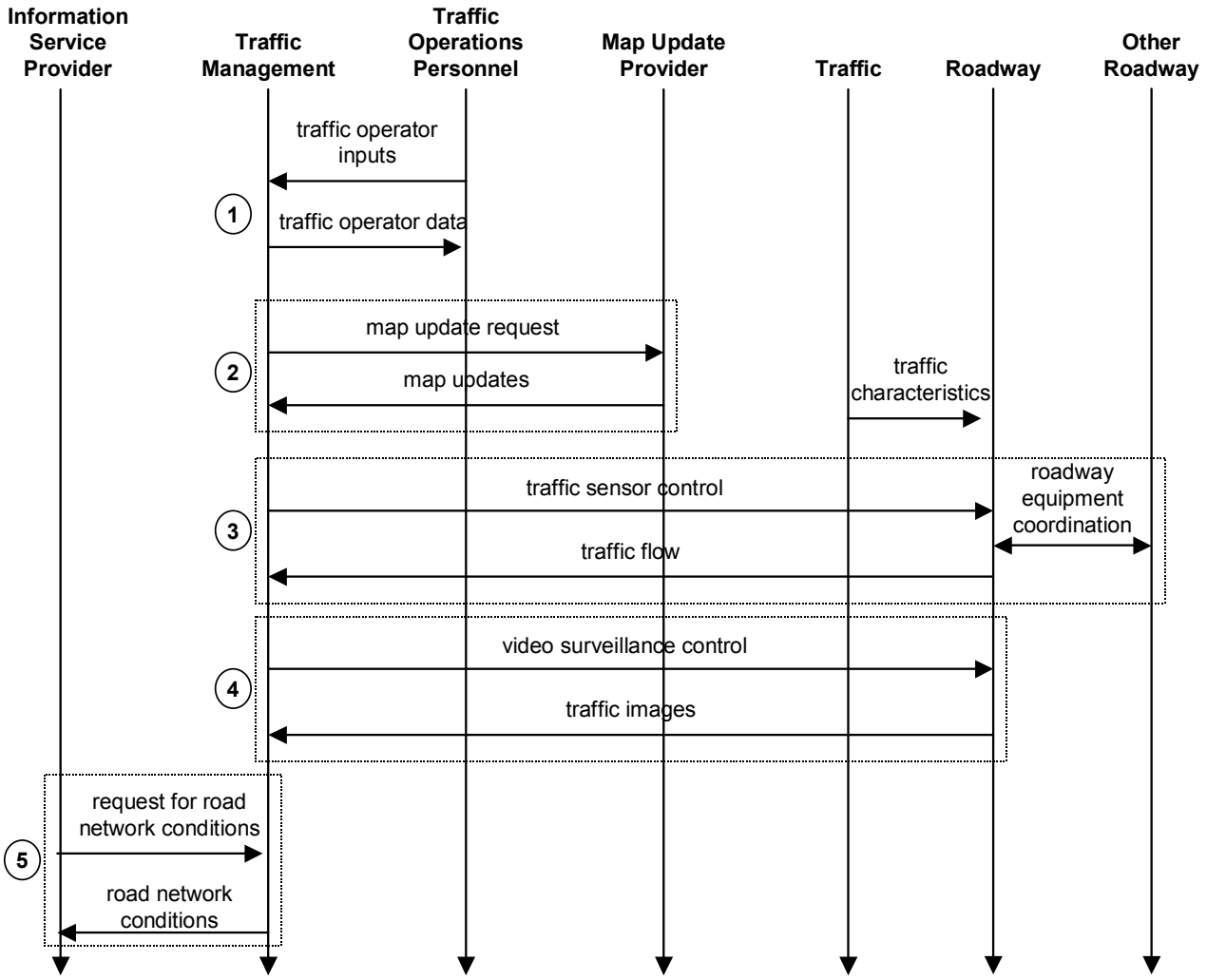
2.1. ATMS01: Network Surveillance

This market package includes traffic detectors, other surveillance equipment, and the supporting field equipment 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 market 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

3. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.
4. Data collected to 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.
5. 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 signal control* message). In addition, the *traffic sensor control* message can control the sharing of information directly between field equipment deployments (*roadway equipment coordination*).
6. Similarly, the Traffic Management Subsystem can control video equipment (*video surveillance control* e.g. pan/tilt/zoom) and receive *traffic images* in return.
7. All (or selected) collected *road network conditions* can be shared with Information Service Providers as either direct response to requests or subscription transactions. Information might also be pushed solely by configuration at the Traffic Management Subsystem without an explicit *request for road network conditions*.

ATMS01: Network Surveillance



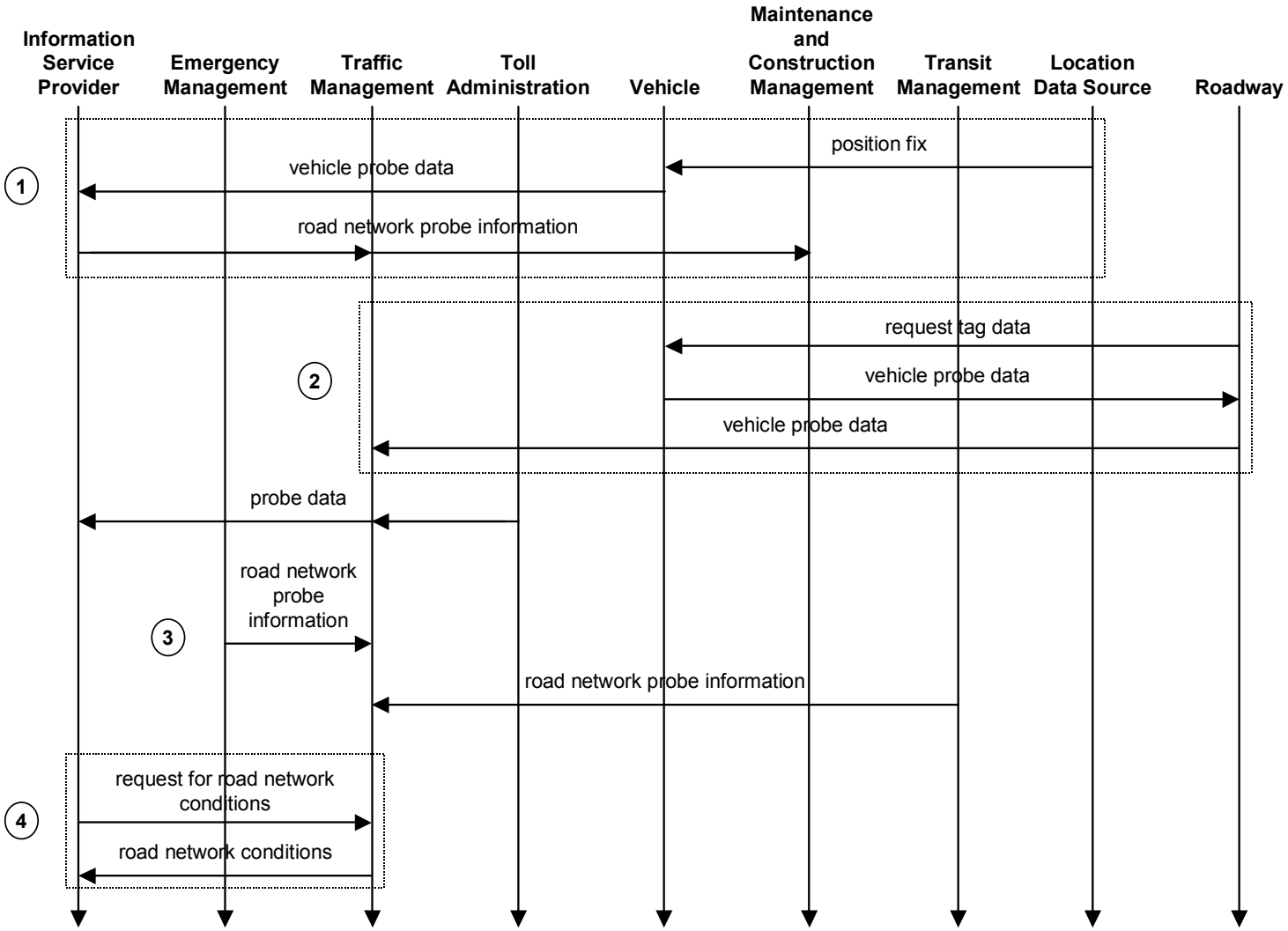
2.2. ATMS02: Probe Surveillance

This market package provides an alternative approach for surveillance of the roadway network. Two general implementation paths are supported by this market package: 1) wide-area wireless communications between the vehicle and Information Service Provider is used to communicate current vehicle location and status, and 2) dedicated short range communications between the vehicle and roadside is used to provide equivalent information directly to the Traffic Management Subsystem. 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 following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. The Information Service Provider (ISP) can receive the location and other parameters (*vehicle probe data*) of these vehicles. A device, Location Data Source, can be used to determine a vehicle's location (*position fix*) or data can be gathered with input from the driver. The ISP can aggregate the information from all of its subscriber vehicles to determine information about segments of roads. This information (*road network probe information*) can be shared with the Traffic Management Subsystem and/or the Maintenance and Construction Management Subsystem.
2. Another way to use vehicles as probes is to have readers on or along the roadway that gather (*request tag data*) information (*vehicle probe data*) about vehicles with transponders as they pass. This information (*vehicle probe data*) can be shared with the Traffic Management Subsystem which can use it to determine travel time, speed, etc. about the roadway.
3. It is also possible to use vehicles on toll roads and AVL-equipped transit and emergency vehicles as probes. The Toll Administration Subsystem can provide the Traffic Management Subsystem and/or an ISP with information on probe vehicles (*probe data*). The Traffic Management Subsystem can receive network conditions such as speed, travel time and environmental conditions (*road network probe information*) based on aggregated probe information from emergency vehicles from the Emergency Management Subsystem or from transit vehicles from the Transit Management Subsystem.
4. The Traffic Management Subsystem can analyze and reduce any collected probe information to determine current and expected traffic and environmental conditions. The Traffic Management Subsystem may share the raw data or the aggregated information (*road network conditions*) with an ISP. The information can be requested (*request for road network conditions*) when desired, it can be provided on a set schedule or when conditions warrant an update.

ATMS02: Probe Surveillance



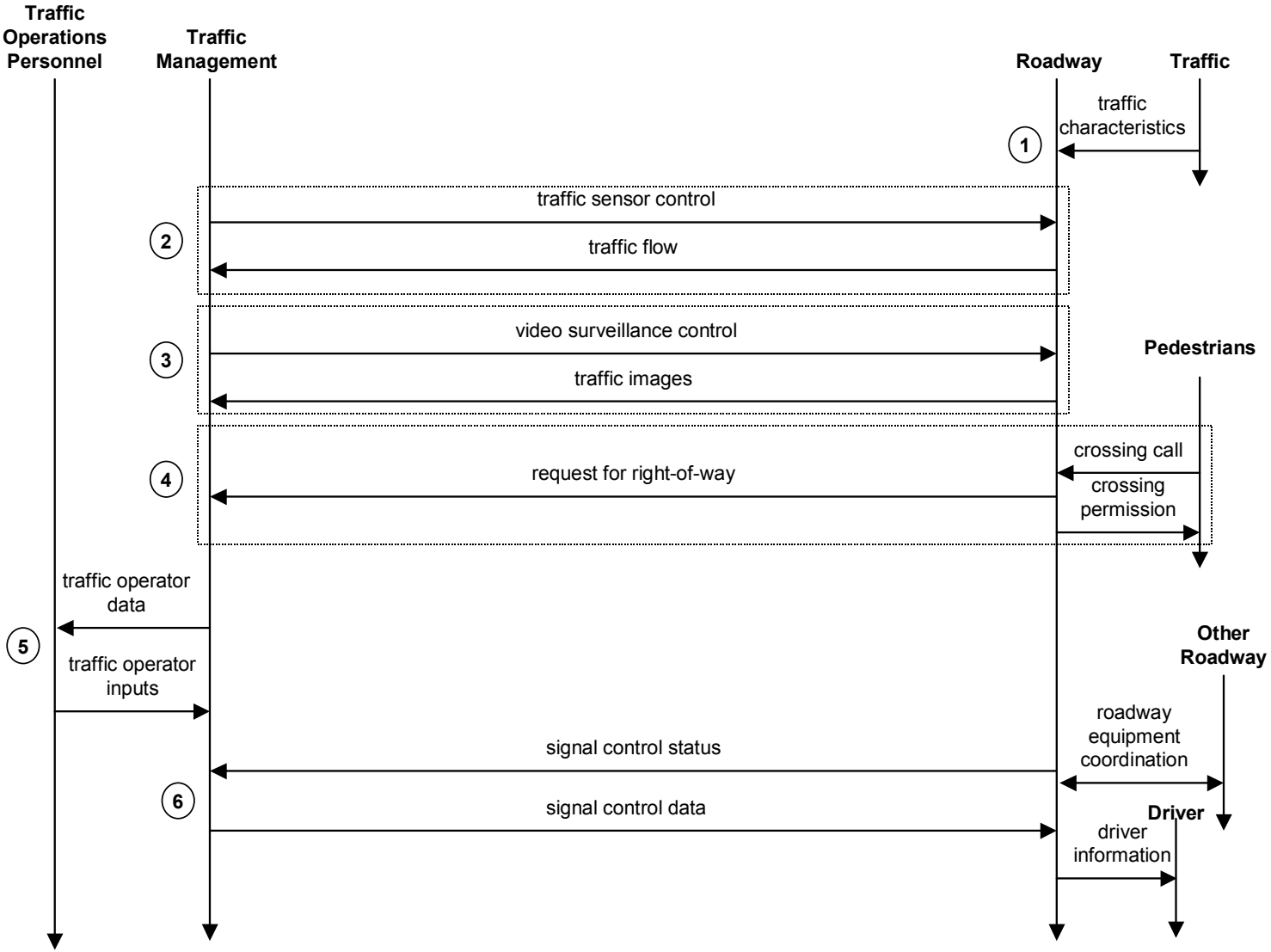
2.3. ATMS03: Surface Street Control

This market package provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. A range of traffic signal control systems are represented by this market package ranging from static pre-timed control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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 on surface streets, 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)* on surface streets from video equipment. The equipment can be controlled (e.g. pan/tilt/zoom) (*video surveillance control)* by the Traffic Management Subsystem.
4. 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 (*request for right-of-way*).
5. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs)* of Traffic Operations Personnel.
6. Traffic Management Subsystem can configure, download timings and otherwise control (*signal control data*) signal equipment along the roadway to control traffic. Traffic Management Subsystem can monitor the status of this equipment (*signal control status*). The various equipment on the Roadway can be coordinated (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations. Additionally, the roadway equipment provides traffic control indications (*driver information*) to the driver while en-route.

ATMS03: Surface Street Control



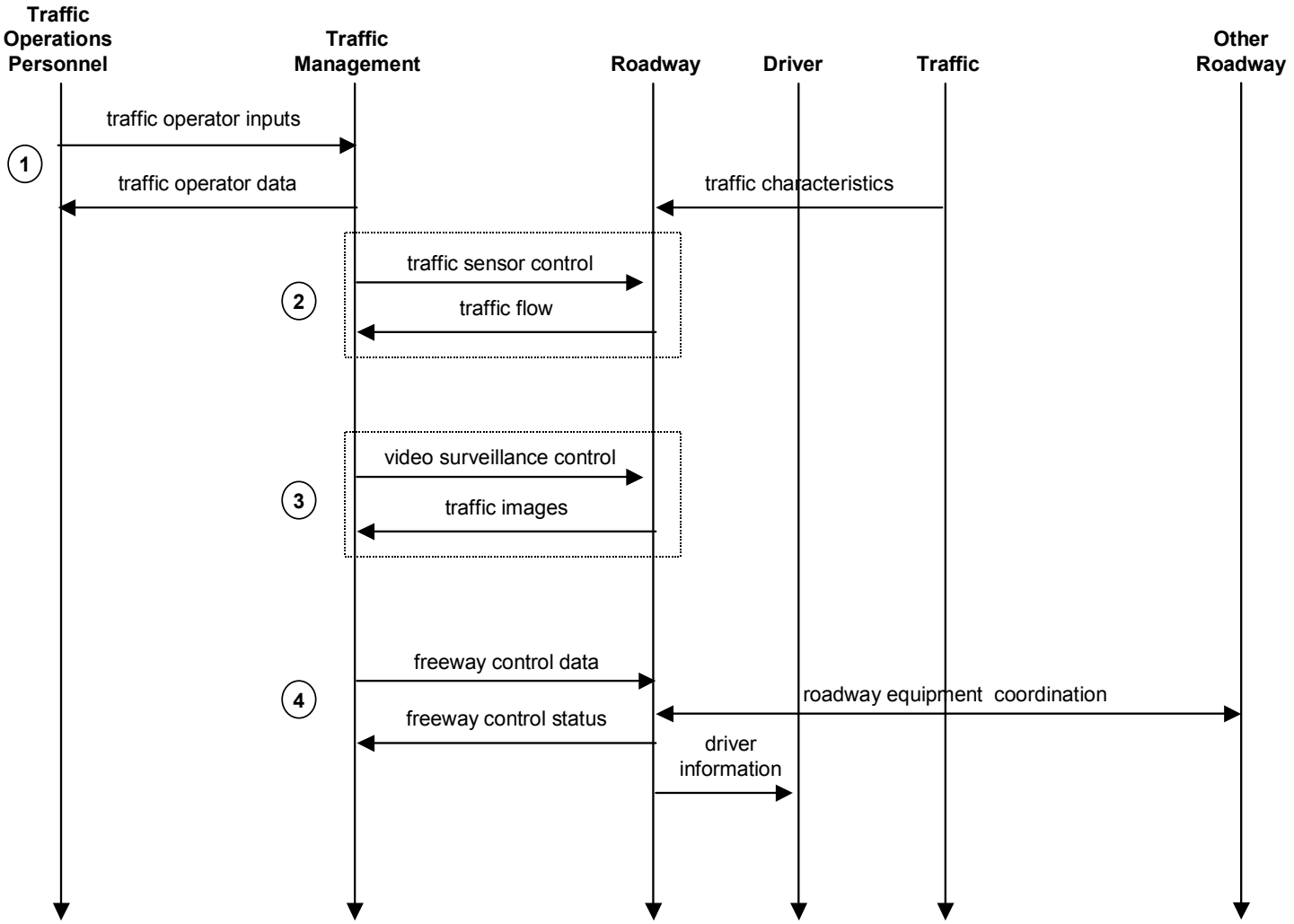
2.4. ATMS04: Freeway Control

This market package provides the communications and roadside equipment to support ramp control, lane controls, and interchange control for freeways. Coordination and integration of ramp meters are included as part of this market package.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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 on freeways, 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)* on freeways from video equipment. The equipment can be controlled e.g. pan/tilt/zoom (*video surveillance control*) by the Traffic Management Subsystem.
4. Traffic Management Subsystem can configure, download timings and otherwise control (*freeway control data*) equipment along a freeway to control traffic. Traffic Management Subsystem can monitor the status of the equipment (*freeway control status*). Roadway equipment can be coordinated (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations. Additionally, the roadway equipment provides traffic control indications (*driver information*) to the driver while en-route.

ATMS04: Freeway Control



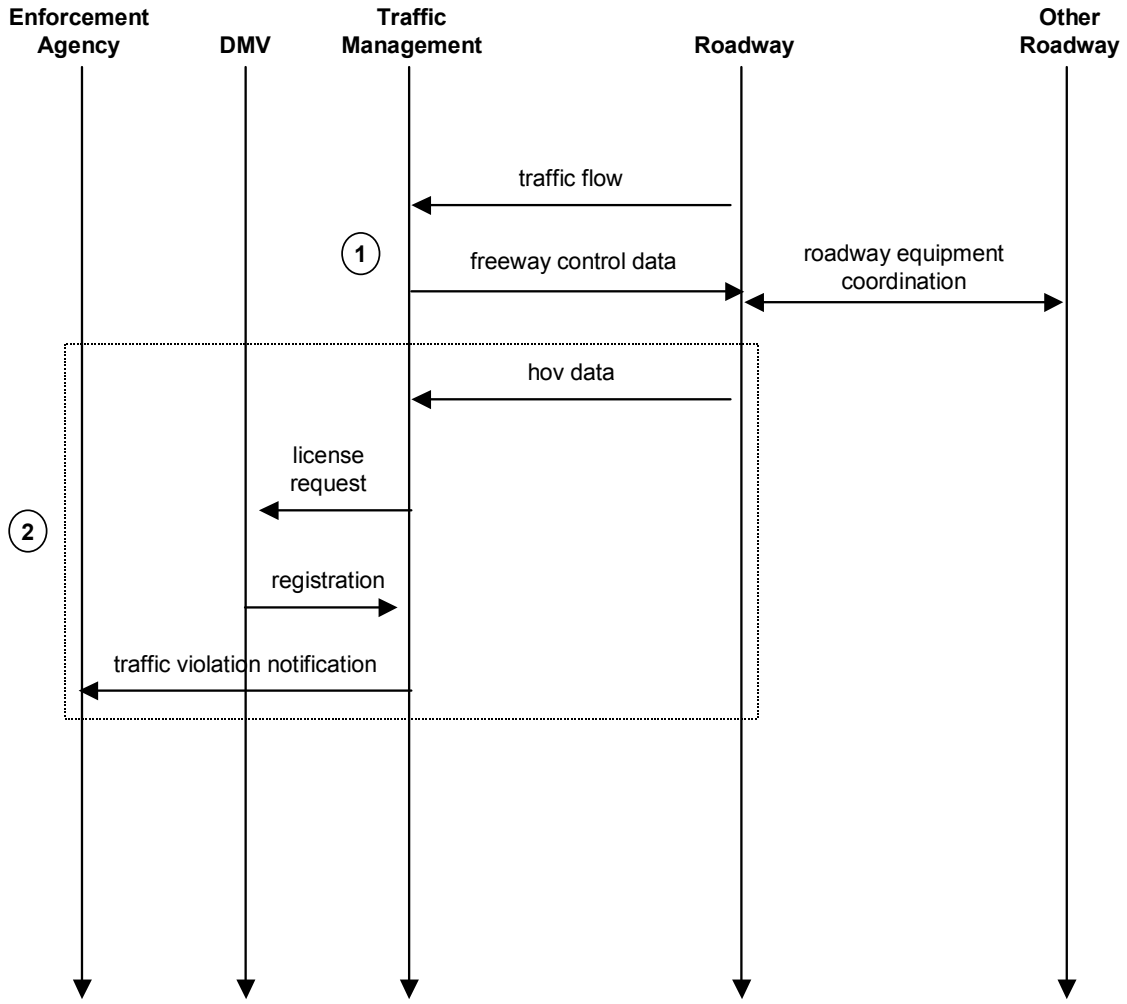
2.5. ATMS05: HOV Lane Management

This market package manages HOV lanes by coordinating freeway ramp meters and adjacent traffic 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. The Traffic Management Subsystem 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 (*freeway control data*) equipment along a freeway to control traffic. Roadway equipment can be coordinated (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations.
2. 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



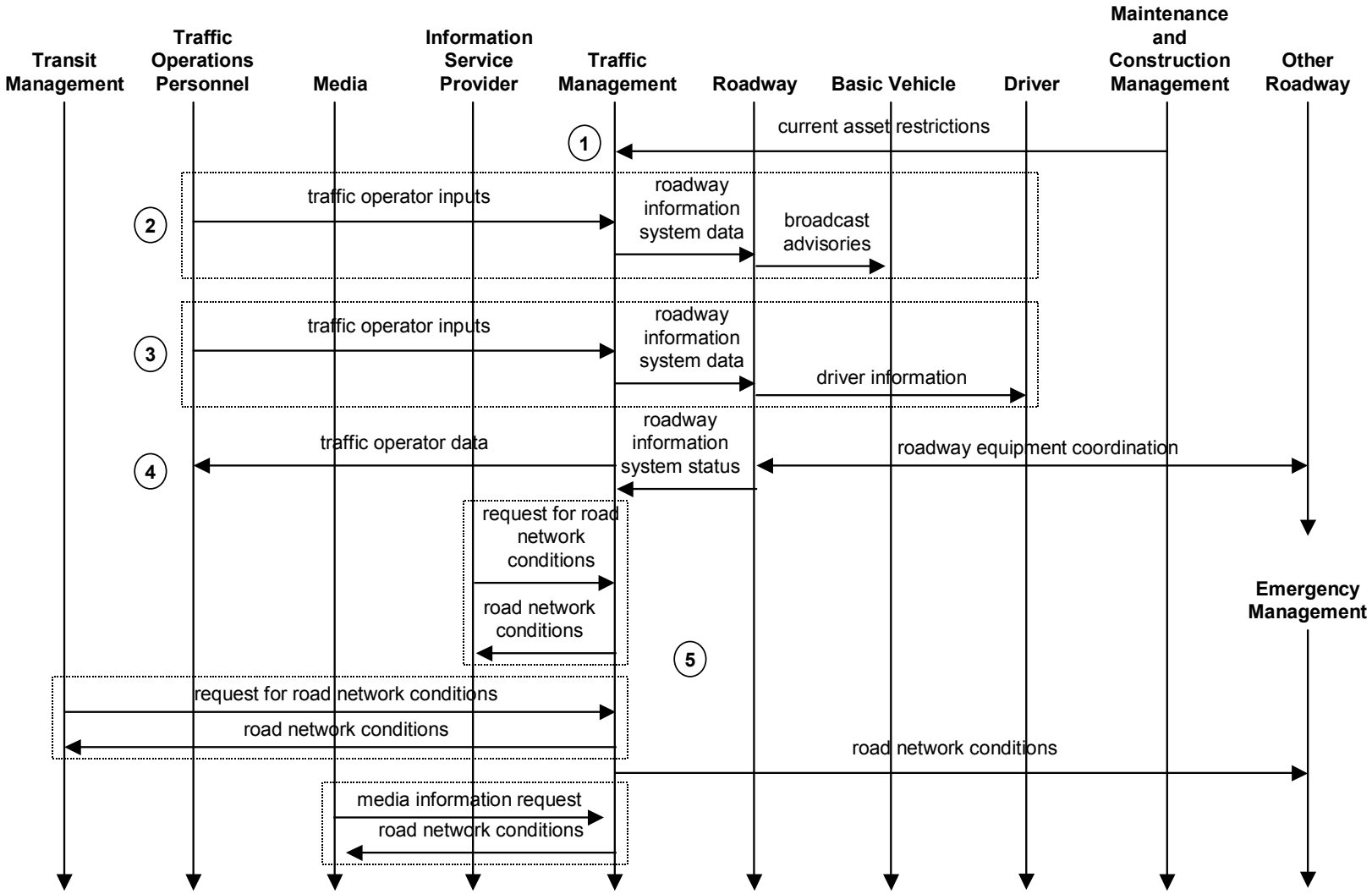
2.6. ATMS06: Traffic Information Dissemination

This market package allows traffic information to be disseminated to drivers and vehicles using roadway equipment such as dynamic message signs or highway advisory radio. This package provides a tool that can be used to notify drivers of incidents; 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, Transit Management Subsystem, Emergency Management Subsystem, and Information Service Providers. A link to the Maintenance and Construction Management Subsystem allows real time information on road/bridge closures due to maintenance and construction activities to be disseminated.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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.
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 (*road 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*) with an Information Service Provider Subsystem, Transit Management Subsystem, Emergency Management Subsystem and/or the Media. With the exception of the Emergency Management Subsystem, this information can be requested (*request for road network conditions*) when desired. Otherwise, it can be provided on a set update interval or when conditions change.

ATMS06: Traffic Information Dissemination



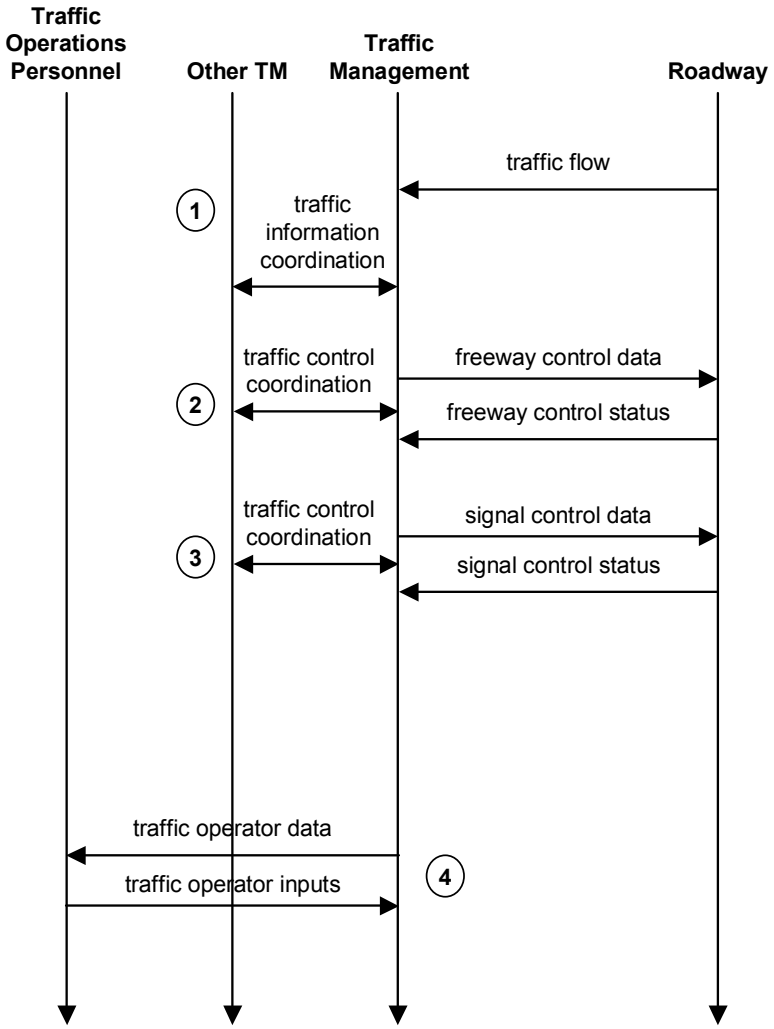
2.7. ATMS07: Regional Traffic Control

This market package provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy. This market package advances the Surface Street Control and Freeway Control Market Packages by adding the communications links and integrated control strategies that enable integrated interjurisdictional traffic control. This package relies principally on roadside instrumentation supported by the Surface Street Control and Freeway Control Market Packages and adds hardware and software 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. While monitoring traffic conditions (*traffic flow*) with equipment on Roadways, Traffic Management Subsystems can share information on traffic conditions (*traffic information coordination*) so traffic operations can be coordinated.
2. Traffic Management Subsystems can share (*traffic control coordination*) monitoring (*freeway control status*) and/or control (*freeway control data*) of equipment on freeways. Shared monitoring might be allowed video images from surveillance cameras to be viewed. Shared control might include allowing surveillance cameras to be paned, tilted or zoomed or ramp meters where the metering plan is selected based on the timing scheme of the surface street feeding the ramp.
3. Traffic Management Subsystems share (*traffic control coordination*) monitoring (*signal control status*) and/or control (*signal control data*) 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 Control



2.8. ATMS08: Incident Management

This market package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The market 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 weather service entities and event promoters. Information from these diverse sources are collected and correlated by this market package to detect and verify incidents and implement an appropriate response. This market 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 following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagrams.

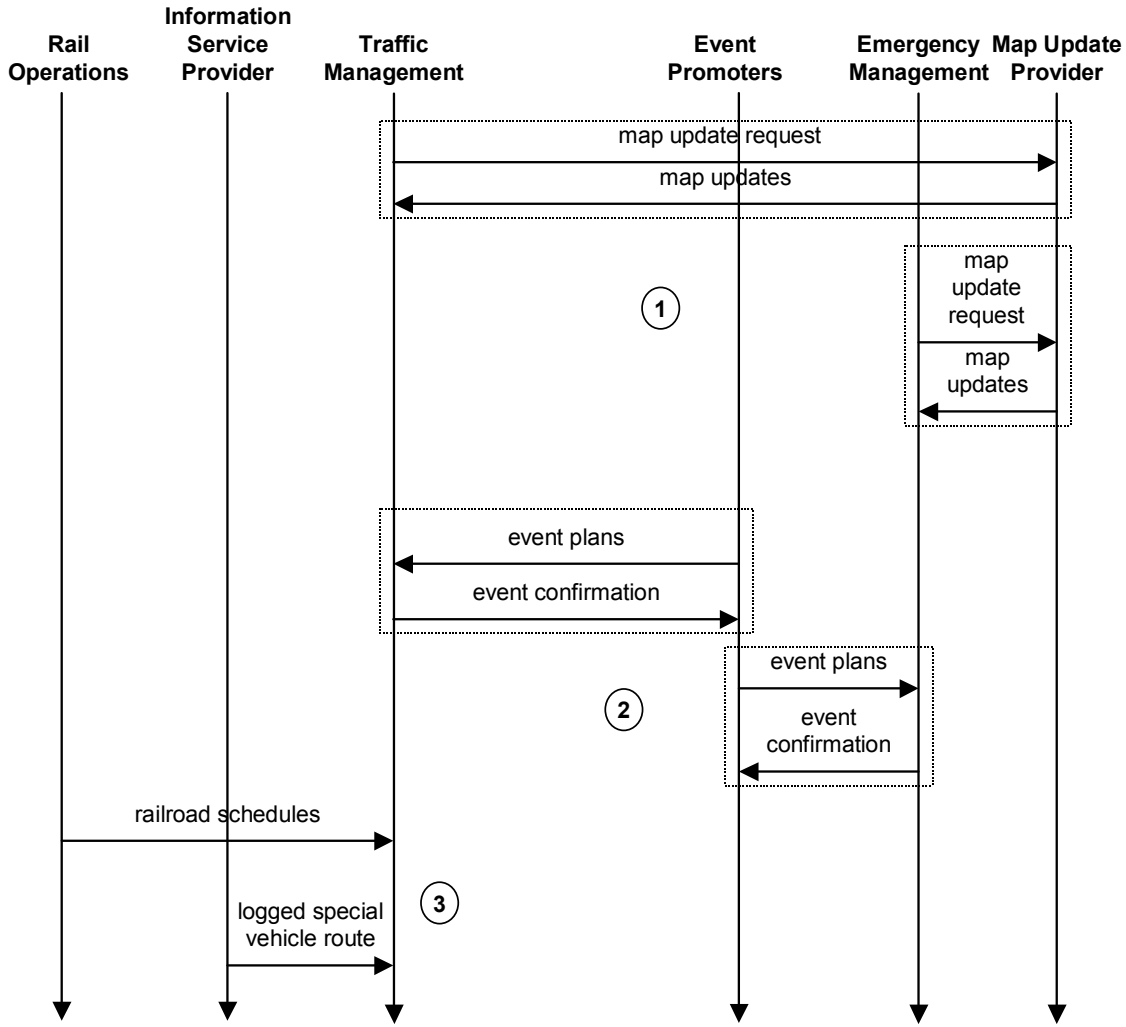
1. Incident information may be displayed on a map of the transportation network. The Traffic Management Subsystem and the Emergency Management Subsystem may use such maps to manage incidents. To keep the base map up to date, an update (*map updates*) can be acquired from a Map Update Provider. The update 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 special vehicles such as oversized vehicles or Presidential motorcades (*logged special vehicle route*).
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 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*).
5. To obtain information about traffic conditions, the Traffic Management Subsystem can control (*traffic sensor control)* and monitor (*traffic flow*) sensors in or along the roadway. Roadway equipment can be coordinated (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations.

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 may place limits on their control (*video surveillance control*). 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.
7. The Traffic Management Subsystems will share information (*traffic information coordination*) 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. In the event of detecting or being notified of an incident, 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 may share confidential details about incidents (*incident reports*) when notifying other Emergency Management Subsystems of incidents. The Emergency Management Subsystems may coordinate the response to incidents (*incident response coordination*.)
9. Emergency Systems Operator dispatches (*emergency operations request* and *incident command information*) the appropriate Emergency Vehicles to respond to an incident. The Emergency Management Subsystem monitors and manages the incident with feedback (*incident status*) from Emergency Vehicles on the screen. With the Emergency Management Subsystem, the Emergency Systems Operator monitors (*emergency operations status*) the incident response.
10. During an incident, the Traffic Management Subsystem may request (*incident information request*) updates on the incident (*incident information*) from the Emergency Management Subsystem. The Emergency Management Subsystem may inform the Traffic Management Subsystem and the Maintenance and Construction Management Subsystem of their response (*incident response status*.)
11. The Traffic Management Subsystem can share information on incidents (*road network conditions*) with an Information Service Provider (ISP). This information can be requested (*request for road network conditions*) when desired. Otherwise, it can be provided on a set update interval or when conditions change.
12. The ISP may request (*incident information request*) information on current incidents (*incident information*) from the Emergency Management Subsystem so that travelers can be notified and routed around incidents. This information can be provided on a set update interval or when conditions change.
13. 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). 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 MCMSs (*maint and*

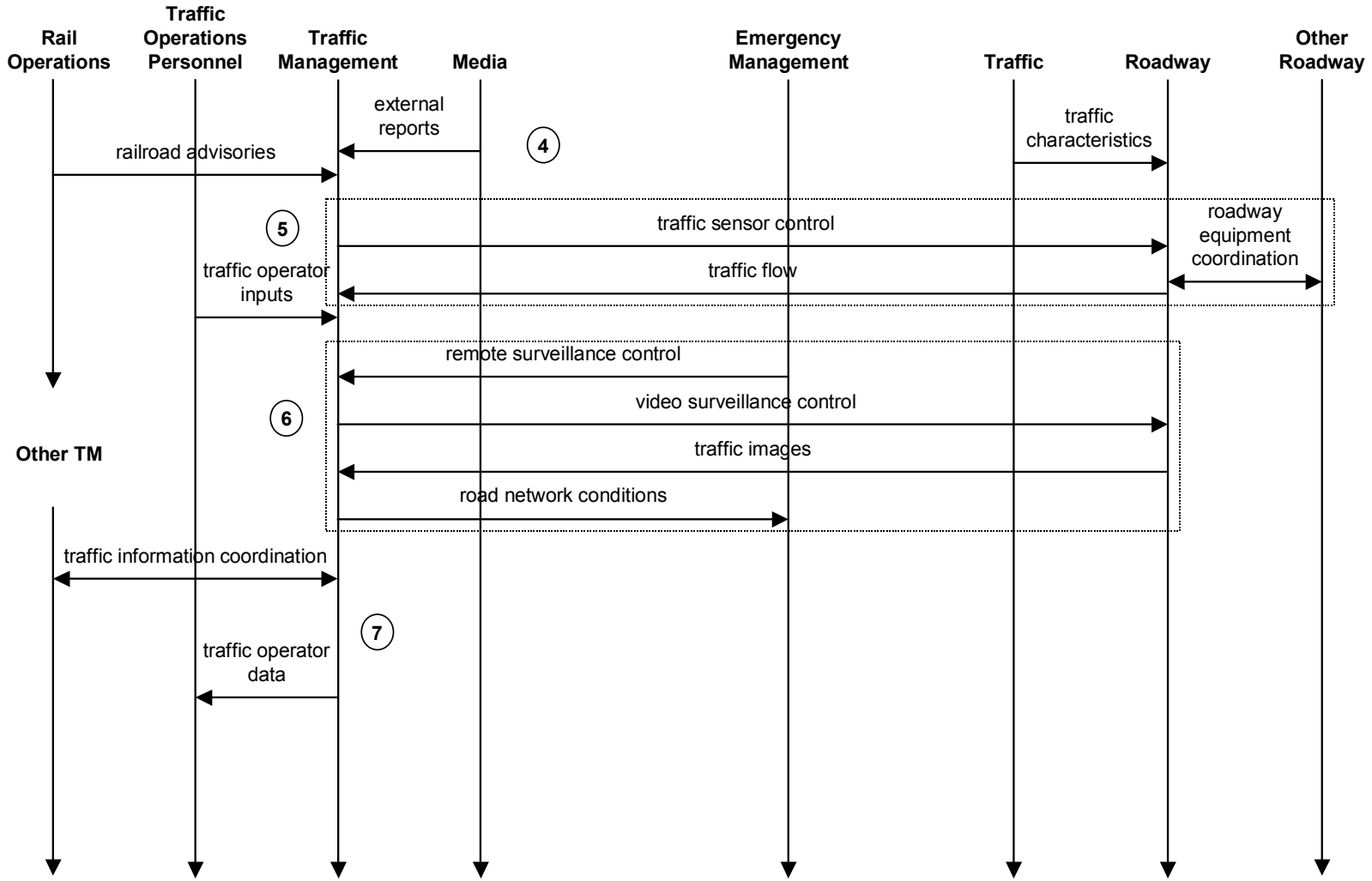
constr resource coordination), a response to the resource request (*maint and constr center resource response*) can be sent to the Emergency Management Subsystem.

14. In responding to an incident, the Emergency Management Subsystem may need assistance (*resource request*) from the Traffic Management Subsystem such as verifying incident location, implementing special traffic control, etc. If required, the Traffic Management Subsystem may request resources from the Maintenance and Construction Management Subsystem (*maint and const resource request*). 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 MCMSs (*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. The Traffic Management Subsystem may then respond (*resource deployment status*) to the Emergency Management Subsystem on when the resource will be implemented or arrive on the screen.

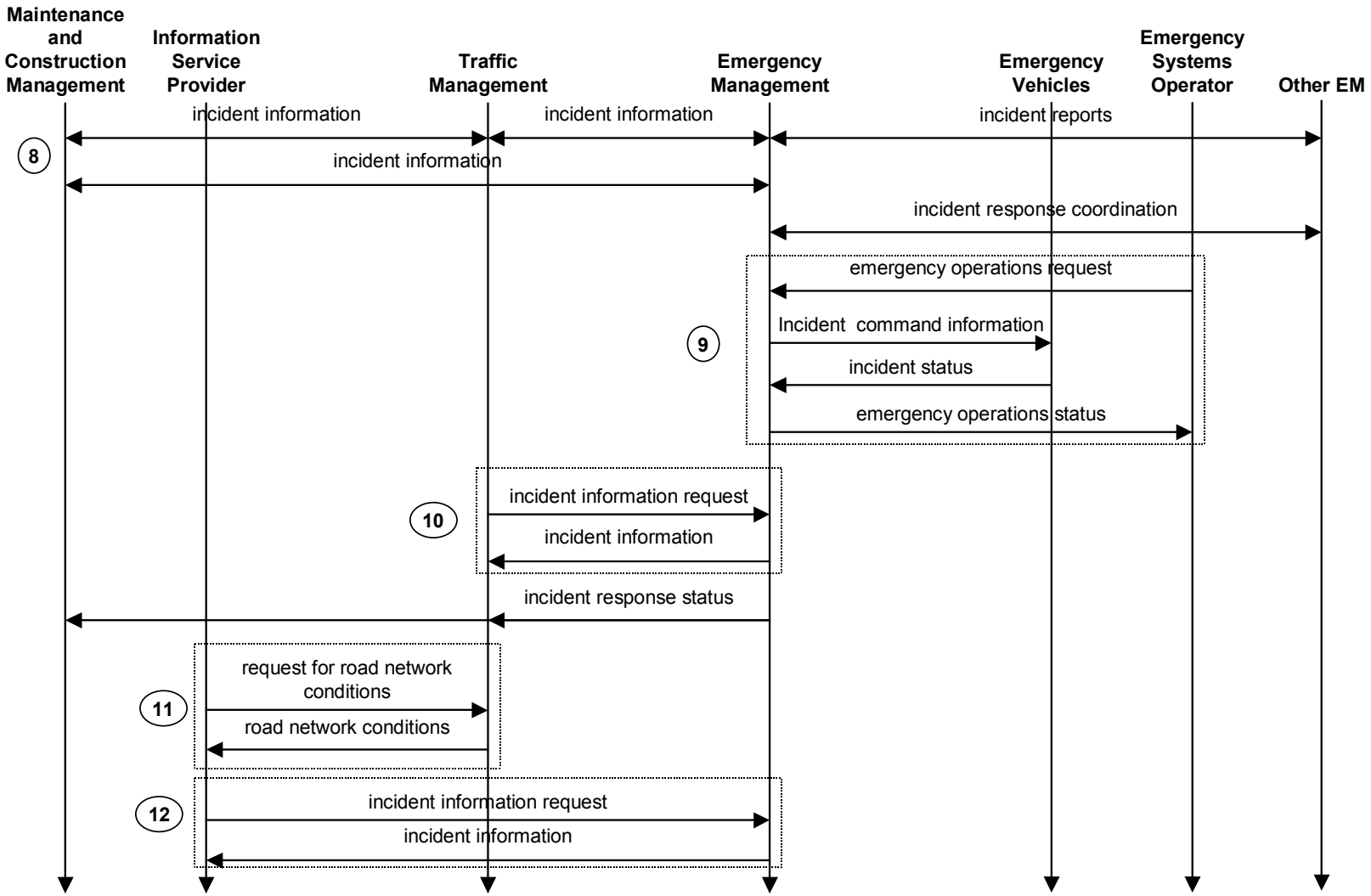
ATMS08: Incident Management (1 of 4)
Setup and Pre-Incident Data Collection



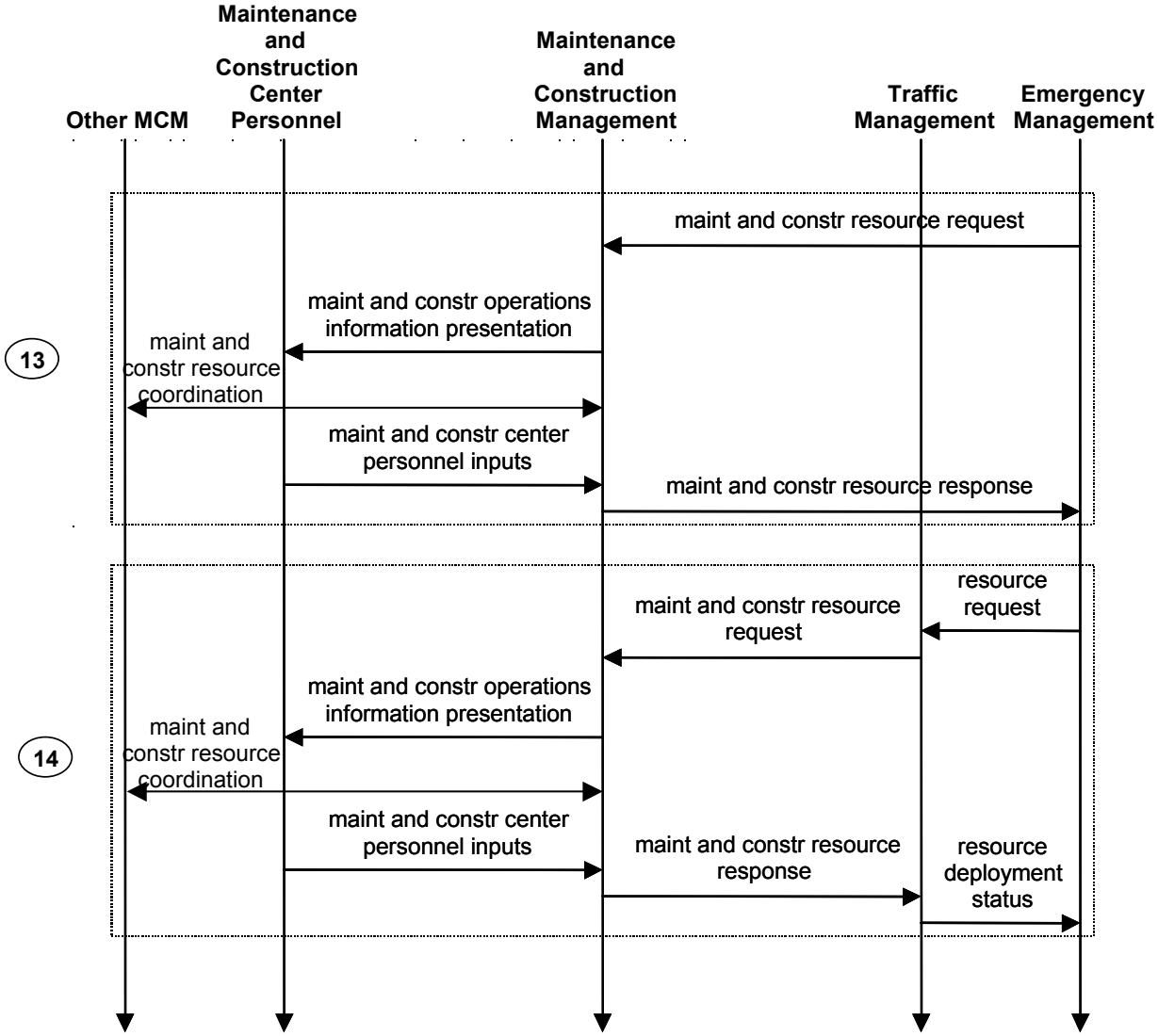
ATMS08: Incident Management (2 of 4)
Real-Time Monitoring



ATMS08: Incident Management (3 of 4)
Incident Coordination



ATMS08: Incident Management (4 of 4)
Resource Coordination to Incidents



2.9. ATMS09: Traffic Forecast and Demand Management

This market package includes advanced algorithms, processing, and mass storage capabilities that support historical evaluation, real-time assessment, and forecast of the roadway network performance. This includes the prediction of travel demand patterns to support better travel time forecasts. This market package provides data that supports the implementation of TDM programs, and policies managing both traffic and the environment.

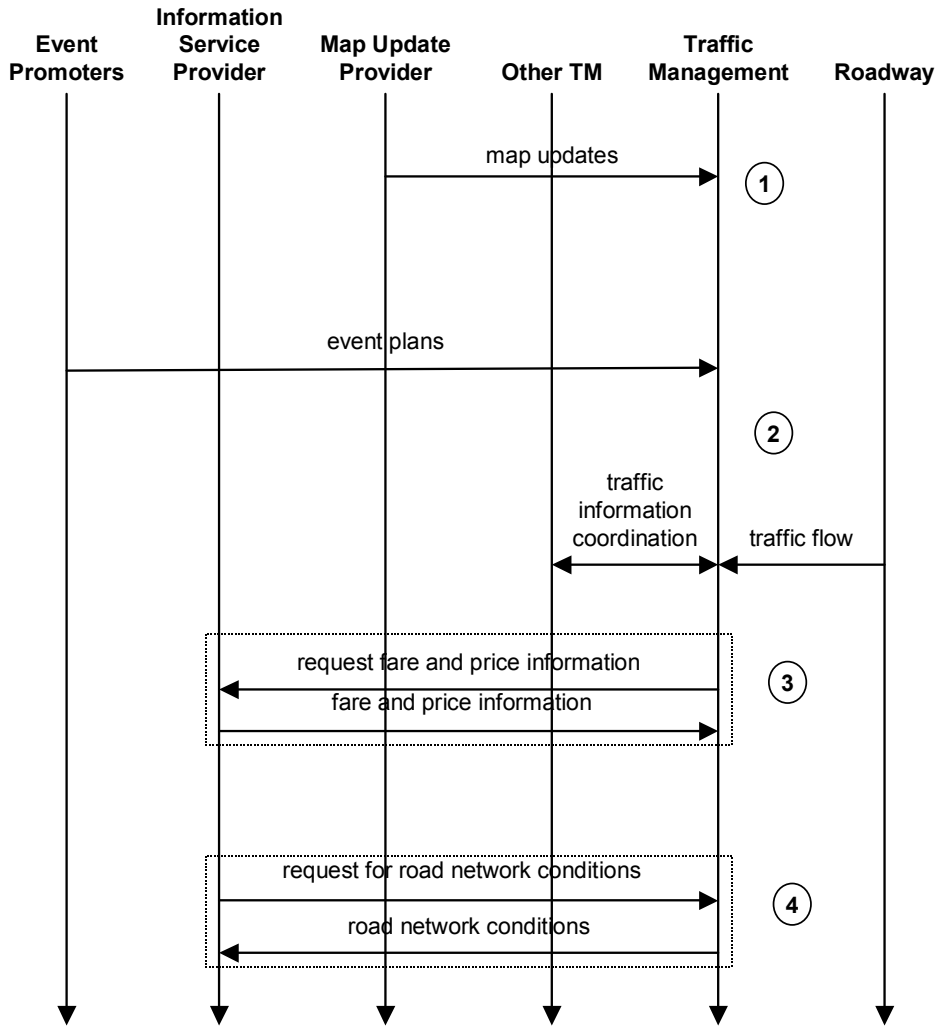
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagrams.

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*).
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*.) Information on the flow of traffic such as volume and speed (*traffic flow*) can be obtained from equipment on or along the roadway. Traffic information (*traffic information coordination*) can also be obtained from Other TMs in the region.
3. Information on current values of transit fares, tolls and parking fees (*fare and price information*) can be obtained from an Information Service Provider (ISP). This information can be requested (*request fare and price information*) when desired. Otherwise, it can be provided on a set schedule or as revisions warrant it.
4. The Traffic Management Subsystem can share the current and/or expected use of the road network (*road network conditions*) with an ISP. The information can be requested (*request for road network conditions*) when desired or it can be provided on a set schedule or when conditions warrant an update.
5. The entire process is under the asynchronous monitoring (*traffic operator data*) and control (*traffic operator inputs*) of Traffic Operations Personnel.
6. Traffic Management Subsystem receives the current or expected parking availability (*parking availability*) from Parking Management Subsystem. Based on the availability, traffic conditions and other factors, a regional traffic management plan can be developed. To implement the plan, parking instructions (*parking instructions*) are sent to the Parking Management Subsystem.
7. 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*) informing when the request was or will be honored.
8. To assist in travel demand management, the Traffic Management Subsystem may request (*toll demand management request*) a change in toll prices or procedures. The Toll

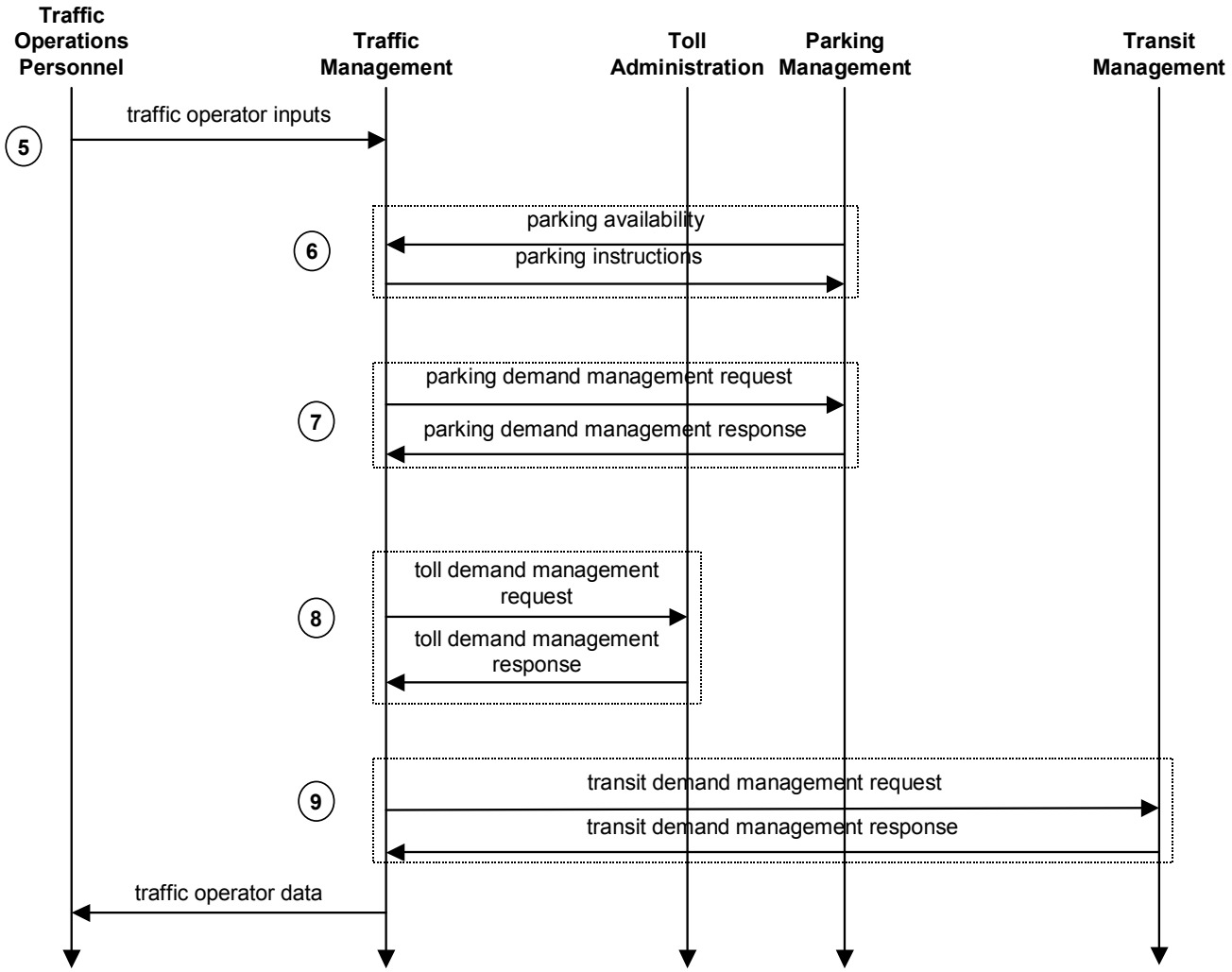
Administration Subsystem may send a response (*toll demand management response*) informing when the request was or will be honored.

9. 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: Traffic Forecast and Demand Management (1 of 2) (Data Collection)



ATMS09: Traffic Forecast and Demand Management (2 of 2) (Demand Adjustment Options)



2.10. ATMS10: Electronic Toll Collection

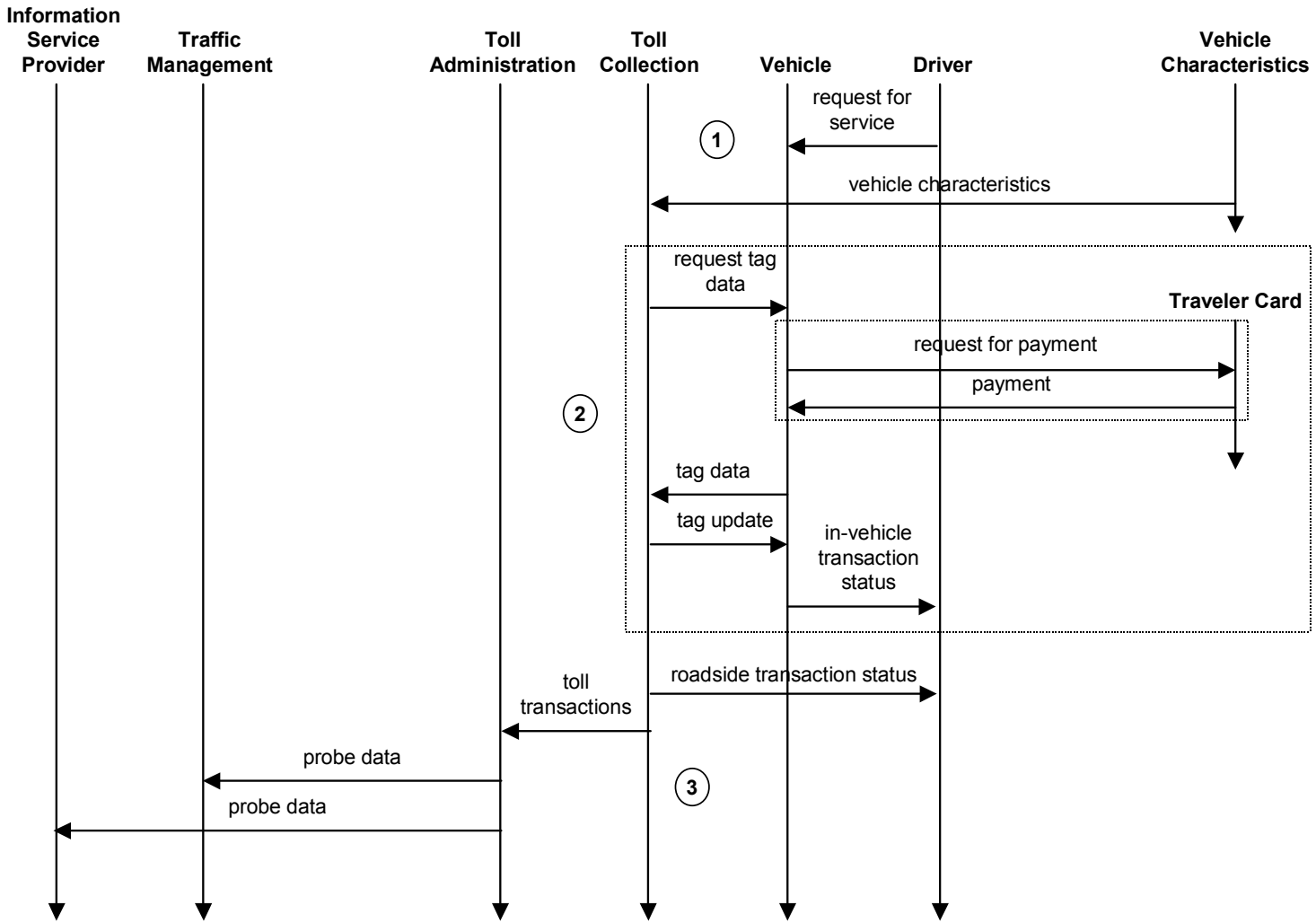
This market package provides toll operators with the ability to collect tolls electronically and detect and process violations. Dedicated short-range communication between the roadway equipment and the vehicle is required as well as wireline interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Vehicle tags of toll violators are read and electronically posted to vehicle owners.

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

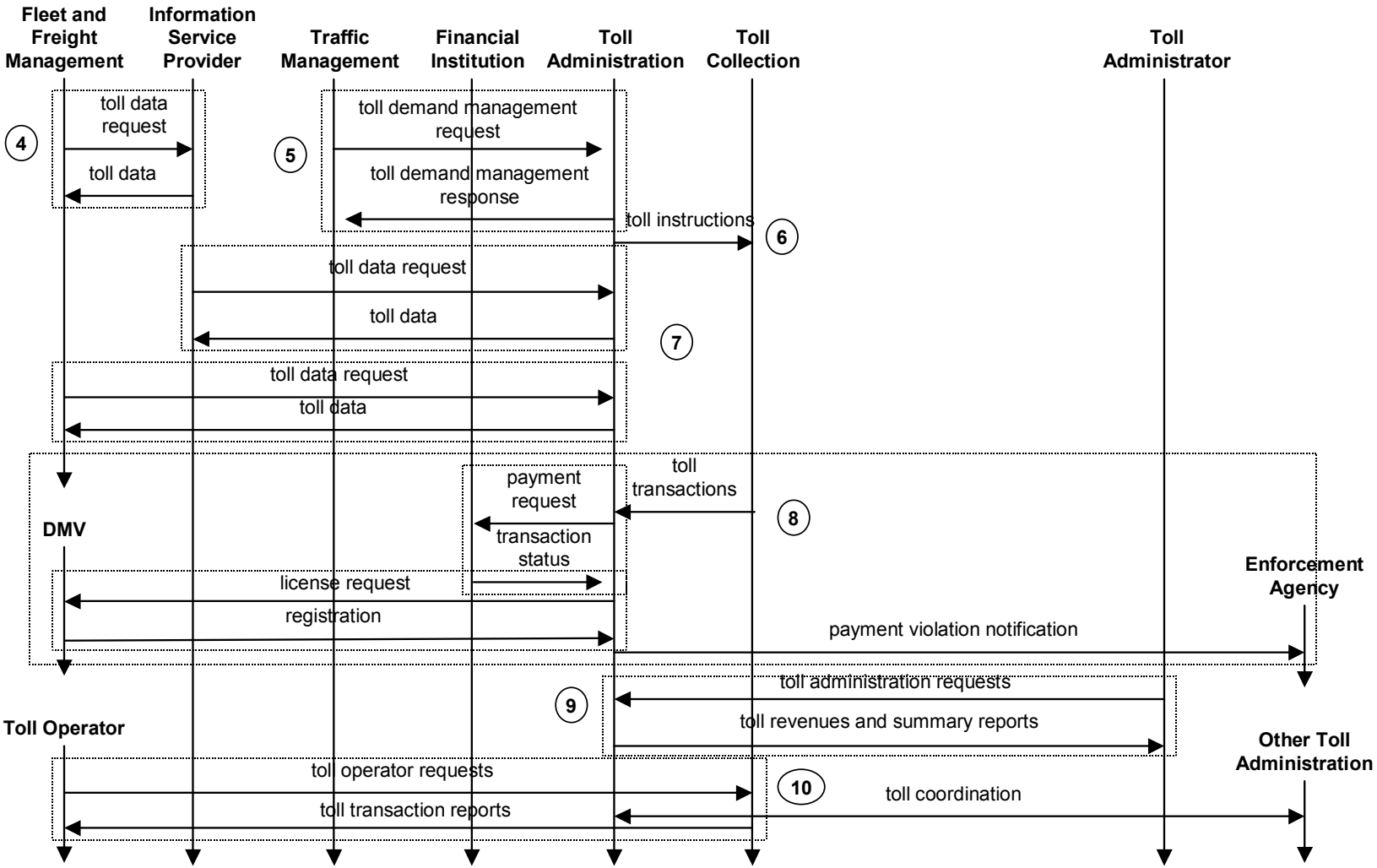
1. In preparation for paying tolls, the Driver requests payment of the toll (*request for service*) from the Vehicle. The Toll Collection Subsystem monitors (*vehicle characteristics*) the physical characteristics of a passing vehicle so it can be classified and images it to uniquely identify it.
2. When the Toll Collection Subsystem detects a vehicle, a request (*request tag data*) for information on the toll tag is made to the Vehicle. The Vehicle requests payment (*request for payment*) from the Traveler Card. When payment (*payment*) is received from the Traveler Card, a response (*tag data*) is sent to the Toll Collection Subsystem that responds with an update on the tag (*tag update.*) A message (*in-vehicle transaction status*) may be sent by the Vehicle to the Driver to confirm payment and/or update the value of the tag.
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 Toll Administration Subsystem. The tolls can be sent as collected or can be aggregated and sent on a set schedule or as warranted. The Toll Administration Subsystem can provide information such as speed and travel time on vehicles paying tolls (*probe data*) to the Traffic Management Subsystem and an Information Service Provider.
4. An Information Service Provider (ISP) 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.
5. To assist in travel demand management, the Traffic Management Subsystem may request (*toll demand management request*) a change in toll prices or procedures. The Toll Administration Subsystem may send a response (*toll demand management response*) informing when the request was or will be honored.
6. The toll collection process is under the asynchronous setting of tolls (*toll instructions*) by the Toll Administration Subsystem.
7. 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.

8. Tolls that are collected (*toll transactions*) by the Toll Collection Subsystem are sent to the Toll Administration Subsystem. The tolls can be sent as collected or can be aggregated and sent on a set schedule or as warranted. The Toll Administration Subsystem sends the payments (*payment request*) to a Financial Institution. The Financial Institution may respond with the status of the transaction (*transaction status.*) When an invalid payment is detected, the Toll 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.
9. The Toll Administrator can request (*toll administration requests*) information on toll operation. When requested or on a set schedule, the Toll Administration Subsystem provides information on toll operation (*toll revenues and summary reports*) to the Toll Administrator.
10. The Toll Operator can request (*toll operator requests*) information on toll operation. When requested or on a set schedule, the Toll Administration Subsystem provides information on toll operation (*toll transaction reports*) to the Toll Operator. The Toll Administration Subsystem can support reciprocity between toll agencies/service centers. The Toll Administration Subsystem exchanges information (*toll coordination*) to support reconciliation of toll charges by customers that are enrolled with Other Toll 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



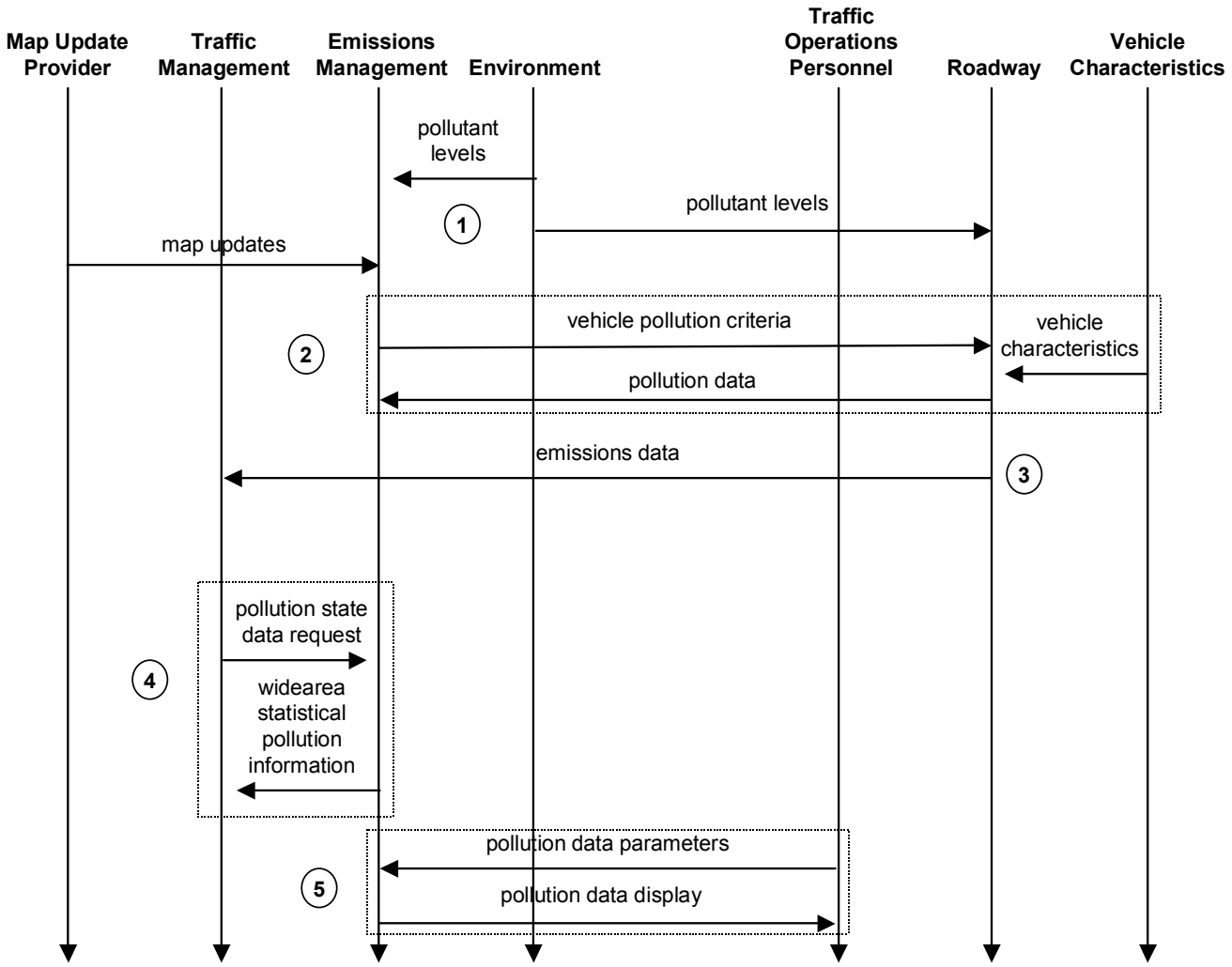
2.11. ATMS11: Emissions Monitoring and Management

This market 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 market package. For area wide monitoring, this market 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 market package measures tail pipe emissions and identifies vehicles that exceed emissions standards. 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. Atmospheric pollutant levels (*pollutant levels*) are constantly monitored by the Emissions Management Subsystem and the Roadway Subsystem. Emissions information may be displayed on a map of the transportation network by the Emissions Management Subsystem. To keep the base map up to date, an update (*map updates*) can acquired from a Map Update Provider.
2. The Emissions Management Subsystem provides the current criteria of acceptable emission levels (*vehicle pollution criteria*) to monitoring equipment on the Roadway. The equipment measures atmospheric pollutants and/or emissions of passing vehicles and identifies vehicles (*vehicle characteristics*) that exceed the acceptable standards. Measured emissions data (*pollution data)* are sent from the Roadway to the Emissions Management Subsystem.
3. The measured emissions data (*emissions data*) is sent from the Roadway to the Traffic Management Subsystem. The data can be sent as collected or it can be aggregated and sent as warranted or on a set schedule.
4. The Traffic Management Subsystem can request (*pollution state data request*) information on the pollution level for a region. The Emissions Management Subsystem responds with the requested information (*widearea statistical pollution information*.)
5. The Traffic Operations Personnel can request pollution data compliance levels for a specific region (*pollution data parameters*) to the Emissions Management Subsystem. The Emissions Management Subsystem responds with reference and/or current pollution status details (*pollution data display*) for the specified area.

ATMS11: Emissions Monitoring and Management



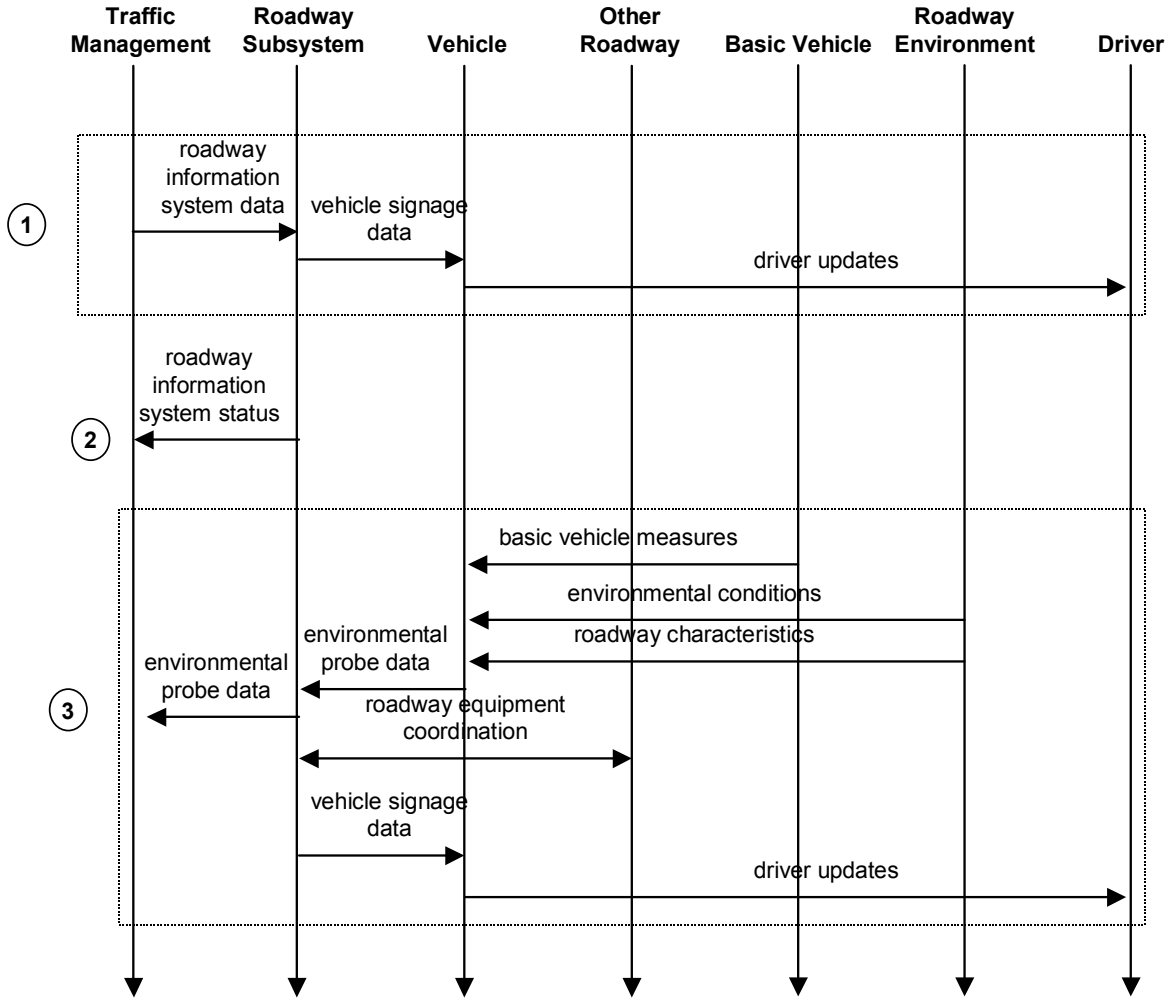
2.12. ATMS12: Virtual TMC and Smart Probe Data

This market package provides for special requirements of rural road systems. Instead of a central TMC, the traffic management is distributed over a very wide area (e.g., a whole state or collection of states). Each locality has the capability of accessing available information for assessment of road conditions. The package uses vehicles as smart probes that are capable of measuring road conditions and providing this information to the roadway for relay to the Traffic Management Subsystem and potentially direct relay to following vehicles (i.e., the automated road signing equipment is capable of autonomous operation). In-vehicle signing is used to inform drivers of detected road conditions.

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

1. The Traffic Management Subsystem provides information (*roadway information system data*) to travelers via equipment on the Roadway. The information can be forwarded (*vehicle signage data*) for display within Vehicles that is viewed (*driver updates*) by the Driver.
2. The Traffic Management Subsystem continues asynchronous monitoring (*roadway information system status*) of the equipment on the roadway.
3. Properly equipped vehicles can be used as sensors (*basic vehicle measures*) to determine the current environmental (*environmental conditions*) and roadway conditions (*roadway characteristics*). The vehicles send the collected information (*environmental probe data*) to equipment on the Roadway. The roadway equipment can forward the information (*environmental probe data*) to the Traffic Management Subsystem. Various roadway equipment can be coordinated (*roadway equipment coordination*) through peer-to-peer, master-slave or other configurations. Information on environmental or roadway conditions (*vehicle signage data*) can be sent for display within Vehicles that is viewed (*driver updates*) by the Driver.

ATMS12: Virtual TMC and Smart Probe Data



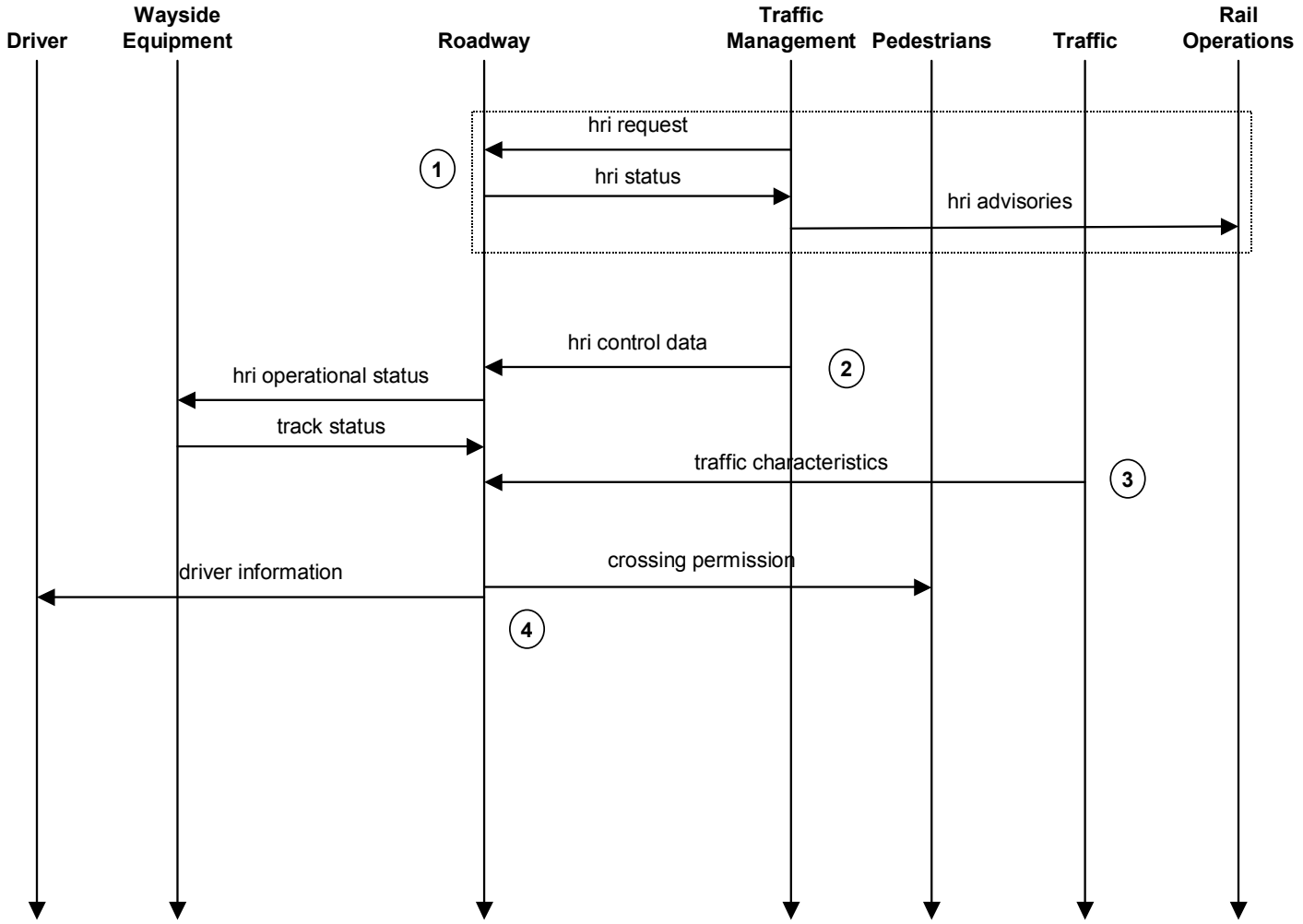
2.13. ATMS13: Standard Railroad Grade Crossing

This market 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. 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 market package. Each numbered item describes the operation of that portion of the market 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 (*hri control data*) at highway-rail intersections to control traffic. The Traffic Management Subsystem may use signals or gates 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. Equipment on the Roadway can be used to signal pedestrians when to safety cross the highway-rail intersection (*crossing permission*). 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



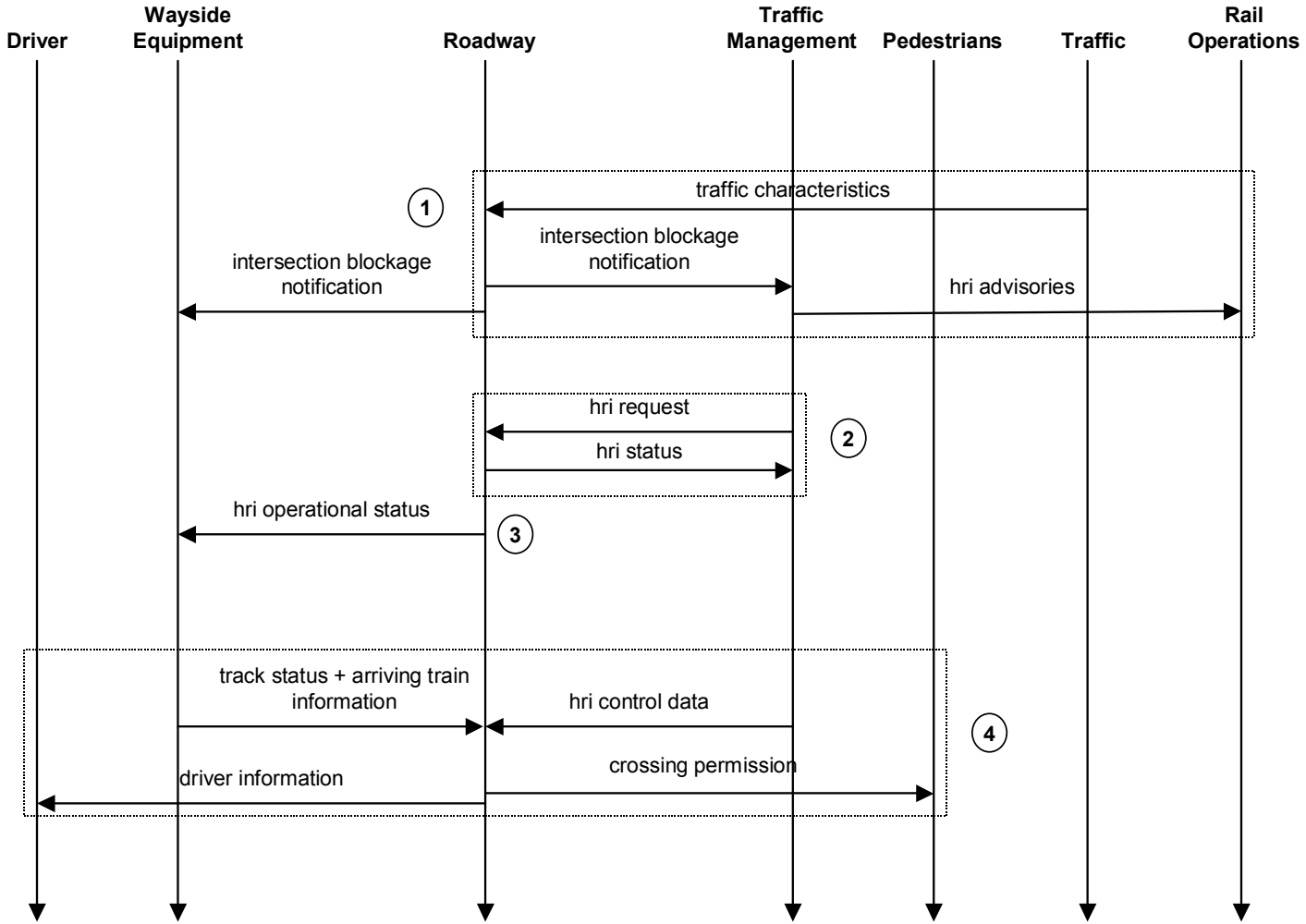
2.14. ATMS14: Advanced Railroad Grade Crossing

This market 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 market package includes all capabilities from the Standard Railroad Grade Crossing Market Package and augments these with additional safety features to mitigate the risks associated with higher rail speeds. The active warning systems supported by this market 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 market 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 market 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 market package. Each numbered item describes the operation of that portion of the market 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 + 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. Additionally, equipment on the Roadway can be used to signal pedestrians when to safety cross the highway-rail intersection (*crossing permission*).

ATMS14: Advanced Railroad Grade Crossing



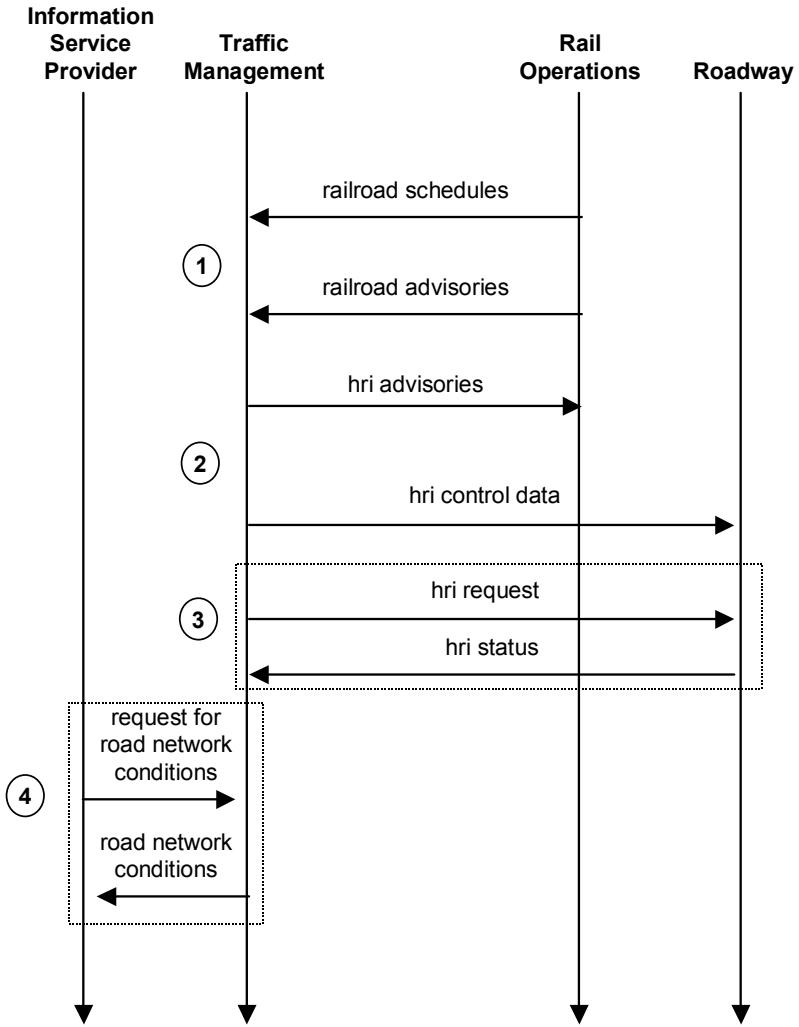
2.15. ATMS15: Railroad Operations Coordination

This market package provides an additional level of strategic coordination between 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. The Rail Operations sends train schedules, maintenance schedules, and other information that supports forecast of HRI 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.
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, 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. The information can be requested (*request for road network conditions*) when desired or it can be provided on a set schedule or when conditions warrant an update.

ATMS15: Railroad Operations Coordination



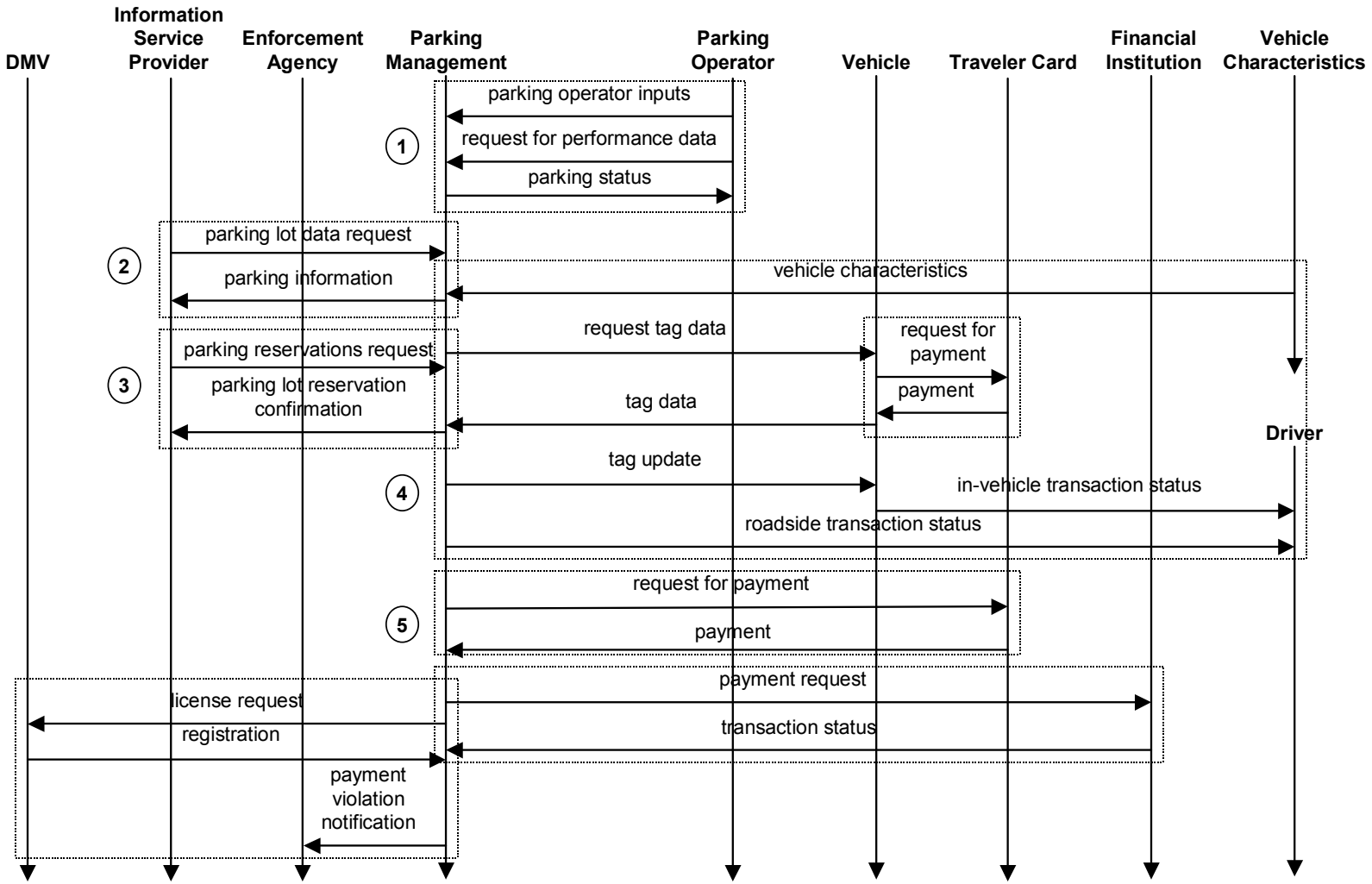
2.16. ATMS16: Parking Facility Management

This market 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 market 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.

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

1. The Parking Operator monitors (*parking status*) and controls (*parking operator inputs* and *request for performance data*) the Parking Management Subsystem.
2. An Information Service Provider (ISP) 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 ISP 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. The Parking Management Subsystem detects passing vehicles and may identify the vehicles (*vehicle characteristics*). When a vehicle is detected, a request (*request tag data*) for information on the parking tag is made to the Vehicle. The Vehicle requests payment (*request for payment*) from the Traveler Card. When payment (*payment*) is received from the Traveler Card, a response (*tag data*) is sent to the Parking Management Subsystem that responds with an update to the tag (*tag update.*) A message (*in-vehicle transaction status*) may be sent by the Vehicle to the Driver to confirm payment and/or update the value of the tag. 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.
5. When a vehicle is detected at Parking Management Subsystem, a request for payment of parking fees (*request for payment*) is made to the Traveler Card. The Traveler Card responds with the payment (*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 status of the transaction (*transaction status.*) 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



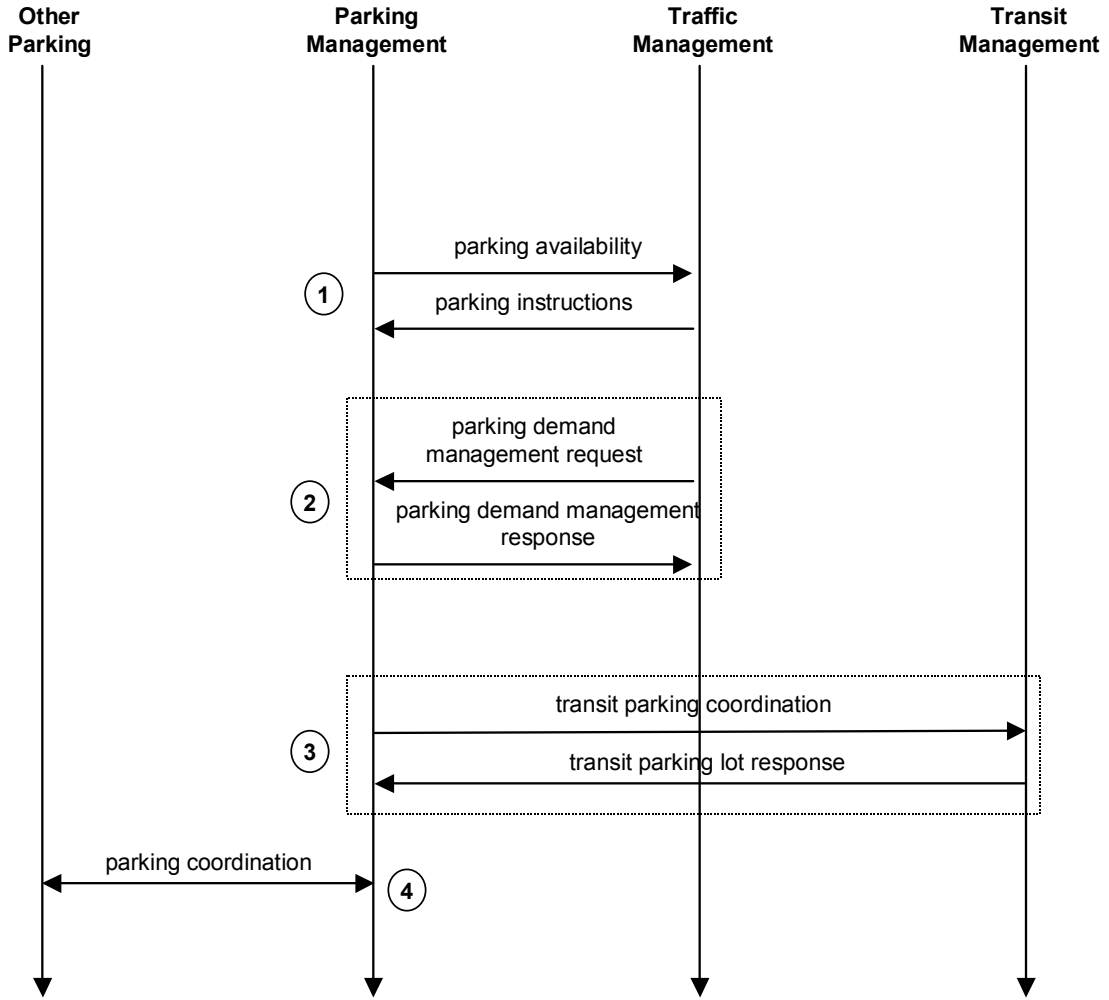
2.17. ATMS17: Regional Parking Management

This market package supports coordination between parking facilities to enable regional parking management strategies.

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

1. Traffic Management Subsystem asynchronously receives the current or expected parking availability (*parking availability*) from the Parking Management Subsystem. Based on the availability, traffic conditions and other factors, a regional traffic management plan can be developed. To implement the plan, parking instructions (*parking instructions*) are sent to the Parking Management Subsystem.
2. 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*) informing when the request was or will be honored.
3. The Parking Management Subsystem can coordinate with Transit Management Subsystem also. The Parking Management Subsystem can request coordinated fare payment and parking lot price data (*transit parking coordination*). In response to the request, on a set schedule or as conditions warrant, the Transit Management Subsystem may send transit occupancies and parking coordination information (*transit parking lots response*).
4. 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 provided to coordinate parking operations.

ATMS17: Regional Parking Management



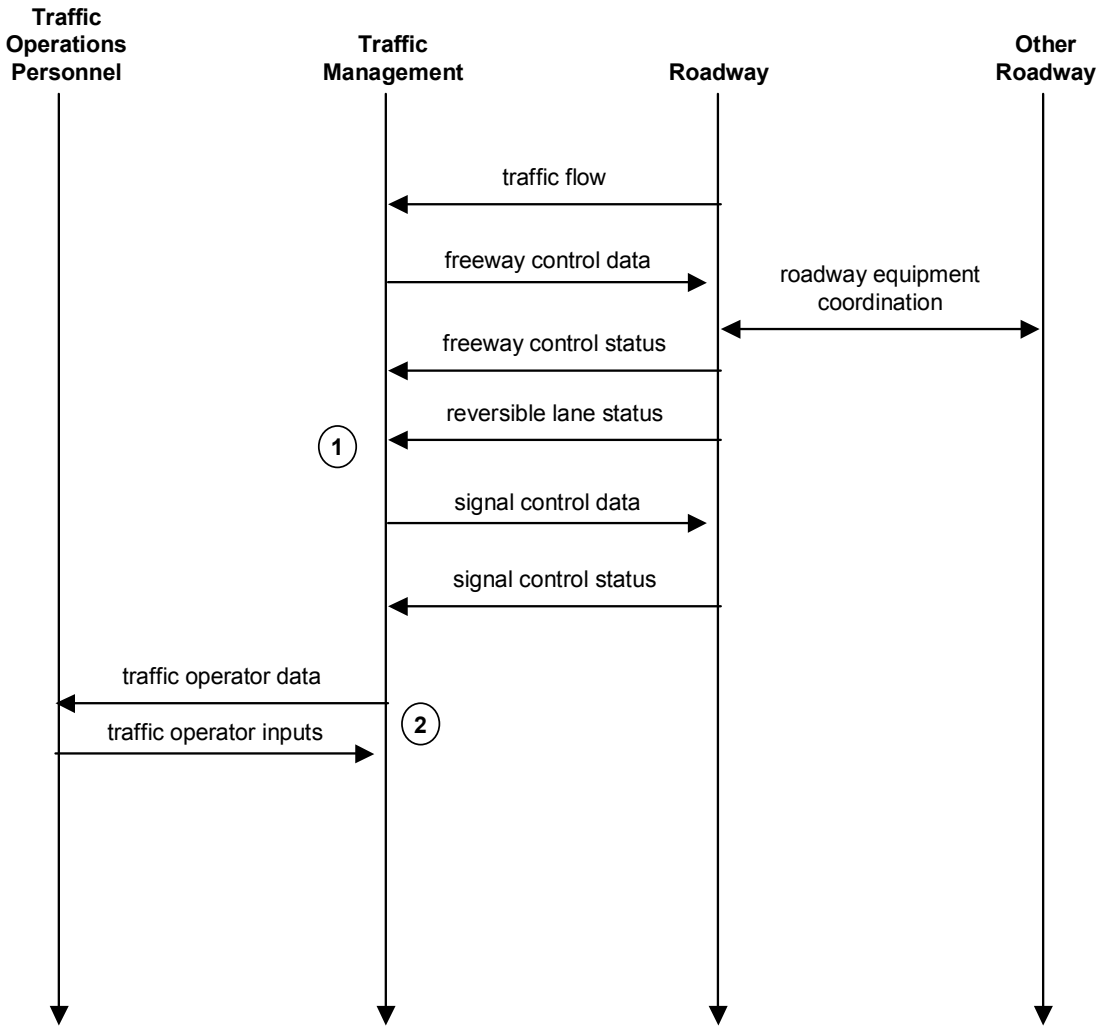
2.18. ATMS18: Reversible Lane Management

This market package provides for the management of reversible lane facilities. In addition to standard surveillance capabilities, this market 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 market 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. The Traffic Management Subsystem monitors traffic (*traffic flow*) in reversible lanes. It also monitors (*signal control status* and *freeway control status*) and controls (*signal control data* and *freeway control data*) 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*). Reversible lane equipment might include sensory functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. The equipment on the Roadway can be coordinated (*roadway equipment coordination*) 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 Monitoring

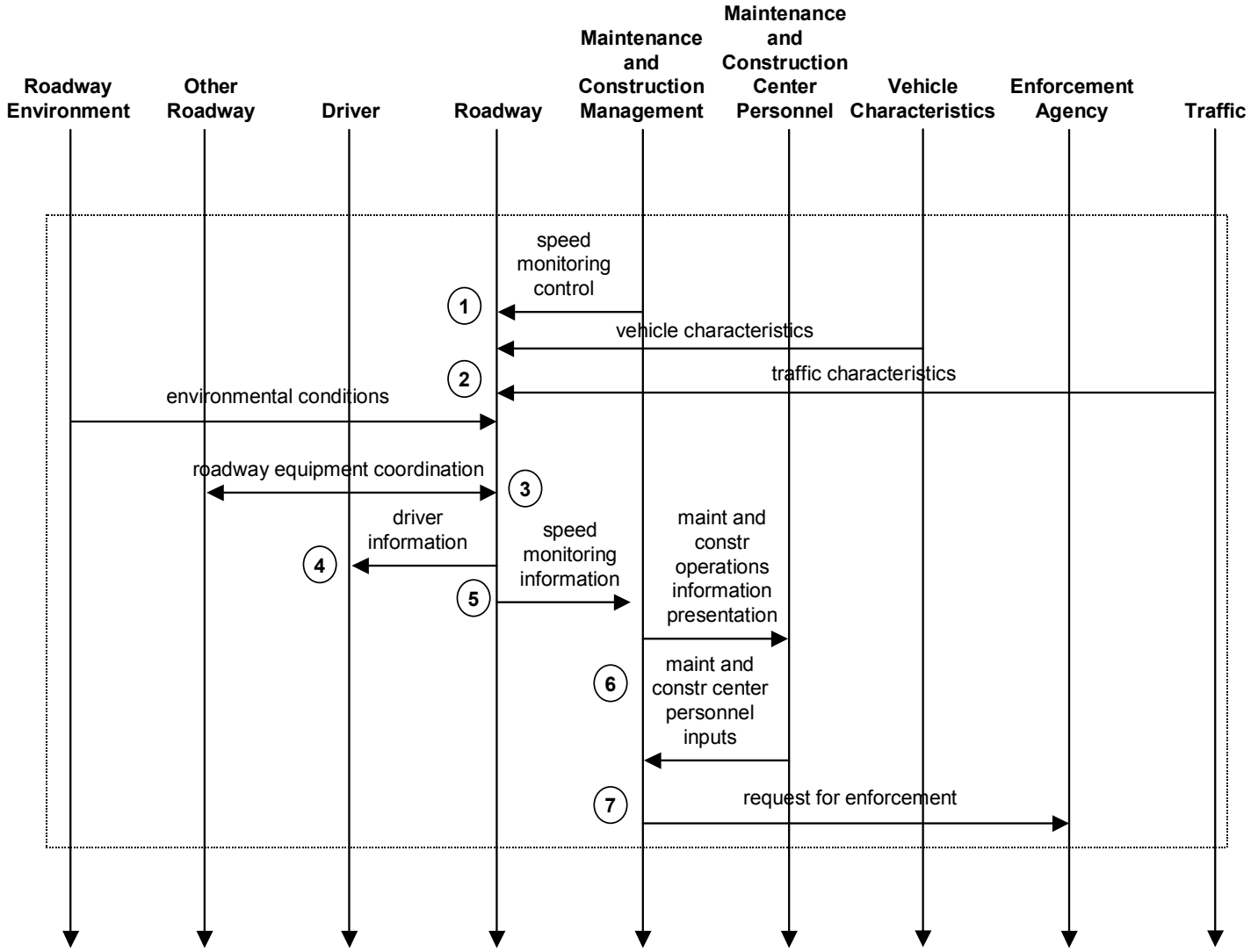
This market package monitors the speeds of vehicles traveling through a roadway system. If the speed is determine to be excessive, roadside equipment can suggest a safe driving speed. Environmental conditions may be monitored and factored into the safe speed advisories that are provided to the motorist. This service can also support notifications to an enforcement agency to enforce the speed limit on a roadway system.

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

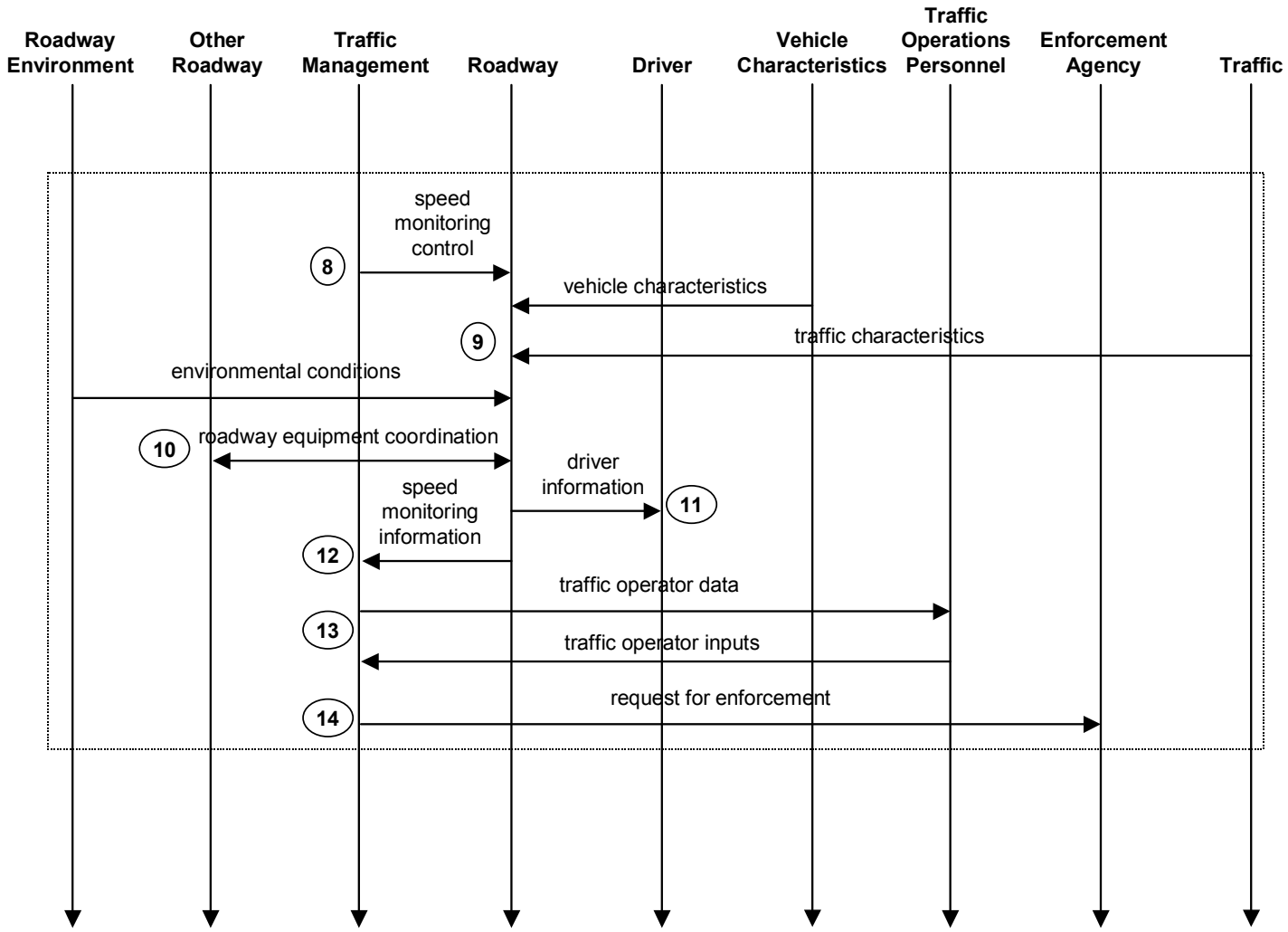
1. The Maintenance and Construction Management Subsystem (MCMS) can monitor vehicle speeds on a roadway. Speed monitoring is critically important in construction zones where maintenance personnel are working. The MCMS configures and controls automated speed monitoring, speed warning, and speed enforcement 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 (*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.
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 7speeds (*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 (*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.
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.

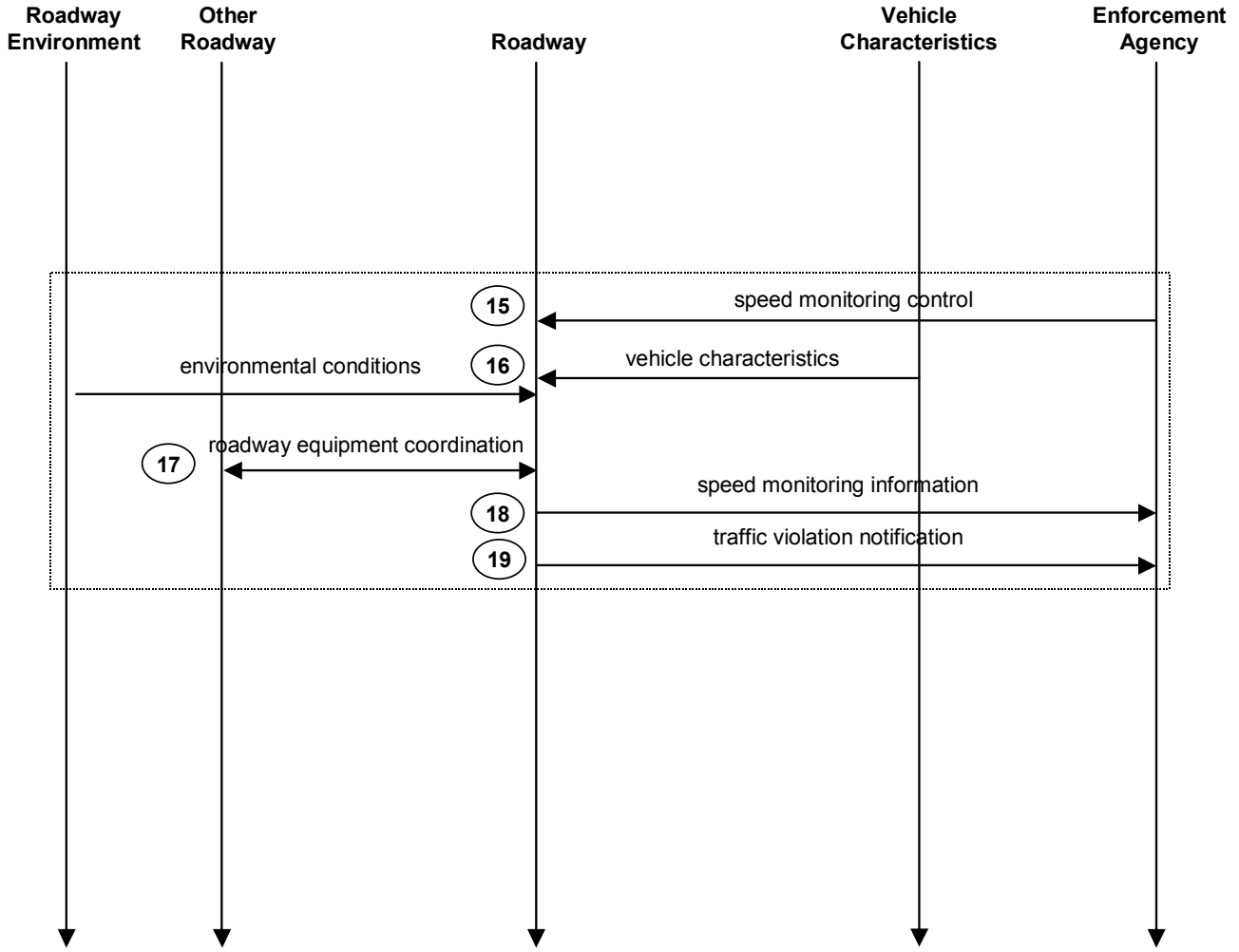
ATMS19: Speed Monitoring (1 of 3)
(Maintenance and Construction Controlled)



ATMS19: Speed Monitoring (2 of 3)
(Traffic Management Controlled)



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



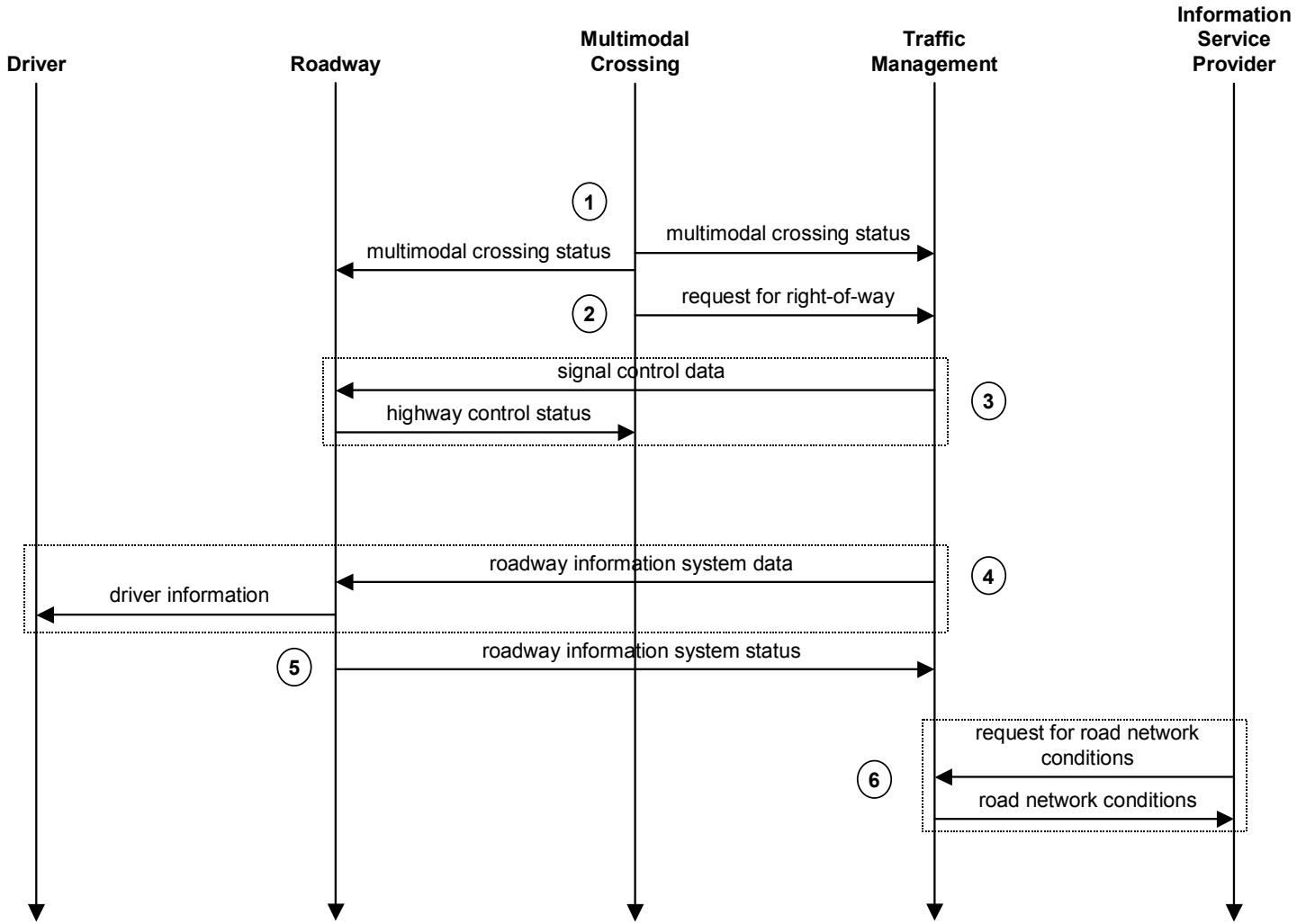
2.20. ATMS20: Drawbridge Management

This market 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 market packages). The equipment managed by this market package includes control devices (e.g., gates, warning lights, dynamic message signs) at the draw bridge as well as the information systems that keep travelers appraised of current and forecasted draw bridge status.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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. Multimodal Crossing can request an opening of the draw bridge (*request for right-of-way*) for a marine vessel.
3. The Traffic Management Subsystem can configure, download timings and otherwise control (*signal control data*) signal equipment along the roadway to control traffic approaching a drawbridge. 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. The information can be requested (*request for road network conditions*) when desired or it can be provided on a set schedule or when conditions warrant an update.

ATMS20: Drawbridge Management



3. Traveler Information

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

3.1. ATIS1: Broadcast Traveler Information

This Market Package enables the Information Service Provider subsystem (ISP) to provide basic traveler information to drivers as well as to users of the Internet, wireless PDA devices, cell phones, and kiosks. The ISP collects traffic conditions, advisories, general public transportation, toll and parking information, incident information, air quality and weather information, and broadly disseminates this information through existing infrastructures and low cost user equipment. 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 market package ATMS6 - Traffic Information Dissemination, which provides localized HAR and DMS information capabilities, ATIS1 provides a wide area digital broadcast service. Successful deployment of this market 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagrams.

1. The entire process is under the asynchronous monitoring (*ISP operating parameters*) and control (*ISP operating parameter updates*) 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*)
    - Transit Management Subsystem (*transit and fare schedules*, which includes static as well as real time transit information and *transit incident information*, which includes real time incident information)
    - Emergency Management Subsystem (*incident information*)
    - Emissions Management Subsystem (*air quality information*)
    - Maintenance and Construction Management Subsystem (*current asset restrictions, maint and const work plans, roadway maintenance status*, and *work zone information*)
    - Parking Management Subsystem (*parking information*)
    - Toll Administration (*toll data*)
    - Event Promoters (*event information*)

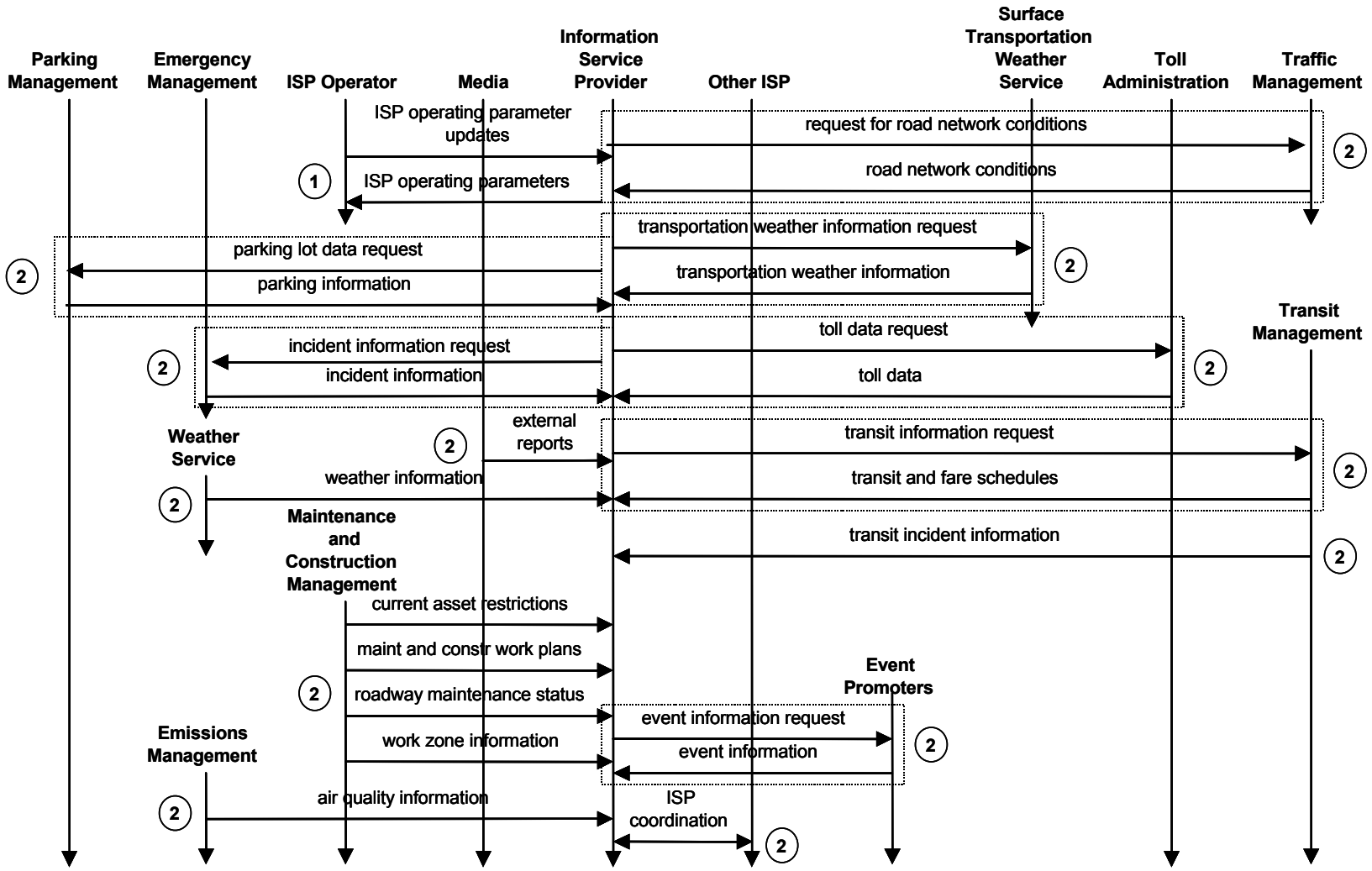
- Media (*external reports,* which includes traffic or incident information collected by the media)
- Surface Transportation Weather Service (*transportation weather information*)
- Weather Service (*weather information*)
- Other ISP (*ISP coordination,* Multiple ISPs may exchange information from separate 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.

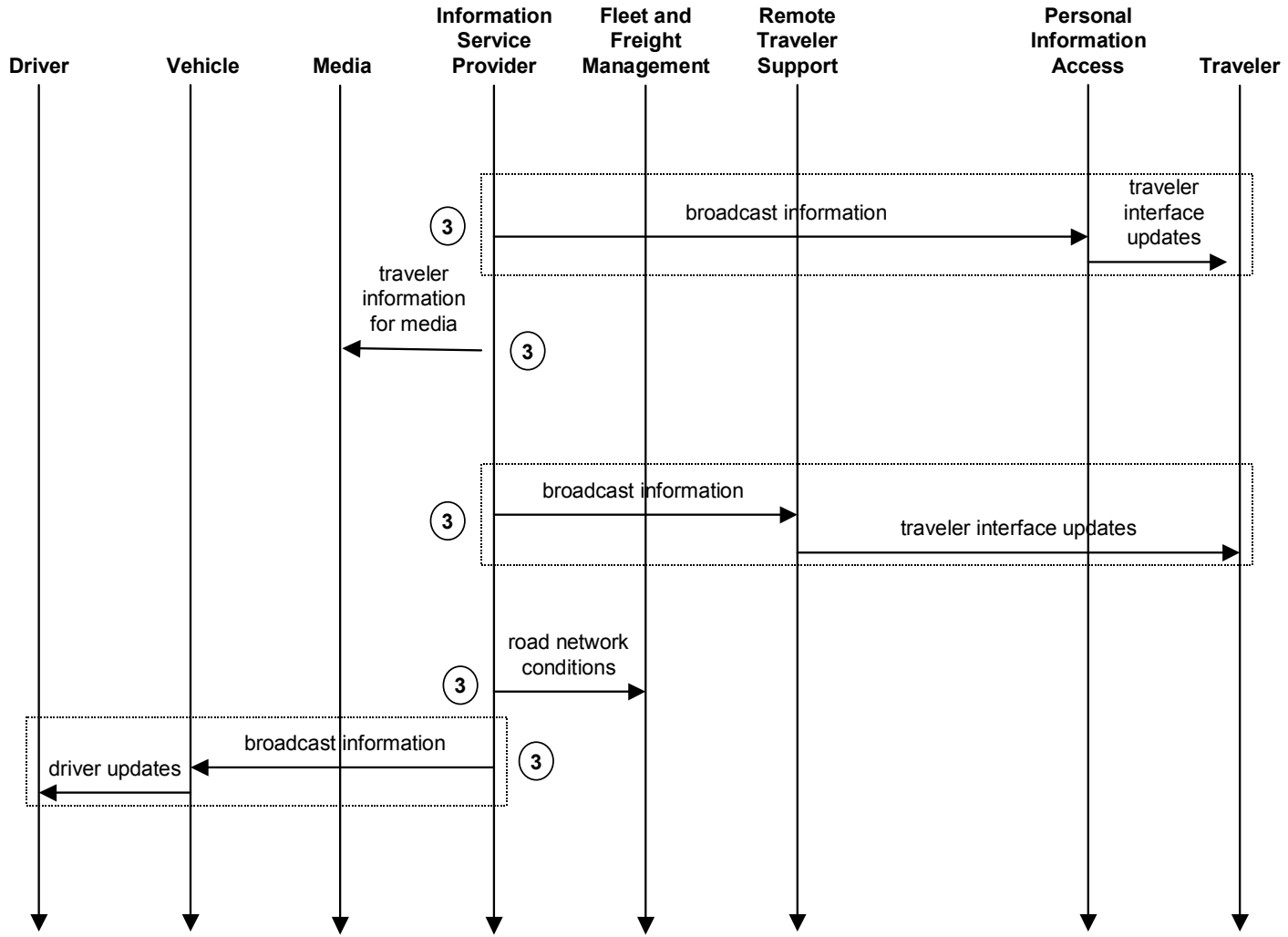
Information collected by the ISP from some sources may come as the result of a specific request or be obtained through subscriptions. With subscriptions, providers usually send periodic updates on a scheduled basis.

3. ISPs broadcast information that contains link travel times, incidents, advisories, transit services and a myriad of other traveler information. The broadcasts are received by travelers (*broadcast information*) via the Personal Information Access Subsystem (e.g. a personal computing device) and the Remote Traveler Support Subsystem (e.g. a kiosk). Similar information is sent to the Media (*traveler information for media*). For commercial fleet and freight customers, current and forecasted traffic information, road and weather conditions, incident information, and other road network status are sent to the Fleet and Freight Management Subsystem (*road network conditions*). Either raw data, processed data, or some combination of both may be provided by this architecture flow.

ATIS1: Broadcast Traveler Information (1 of 2) (Information Collection)



ATIS1: Broadcast Traveler Information (2 of 2) (Information Dissemination)



3.2. ATIS2: Interactive Traveler Information

This market 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, transit services, ride share/ride match, parking management, and pricing information. A range of two-way wide-area wireless and wireline communications systems may be used to support the required data communications between the traveler and Information Service Provider (ISP). A variety of interactive devices may be used by the traveler to access information prior to a trip or en route including phone, kiosk, Personal Digital Assistant, personal computer, and a variety of in-vehicle devices. This market package also allows merchants to receive traffic information to their personal devices or remote traveler systems to better inform customers of road travel conditions. Successful deployment of this market package relies on availability of real-time transportation data from roadway instrumentation, 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagrams.

1. The entire process is under the asynchronous monitoring (*ISP operating parameters*) and control (*ISP operating parameter updates*) 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*)
    - Transit Management Subsystem (*transit and fare schedules*, which includes static as well as real time transit information and *transit incident information*, which includes real time incident information)
    - Emergency Management Subsystem (*incident information*)
    - Emissions Management Subsystem (*air quality information*)
    - Maintenance and Construction Management Subsystem (*current asset restrictions, maint and const work plans, roadway maintenance status*, and *work zone information*)
    - Parking Management Subsystem (*parking information*)
    - Toll Administration (*toll data*)
    - Event Promoters (*event information*)
    - Media (*external reports,* which includes 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 (*weather information*)
- Other ISP (*ISP coordination,* Multiple ISPs may exchange 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. With subscriptions, providers usually send periodic updates on a scheduled basis.

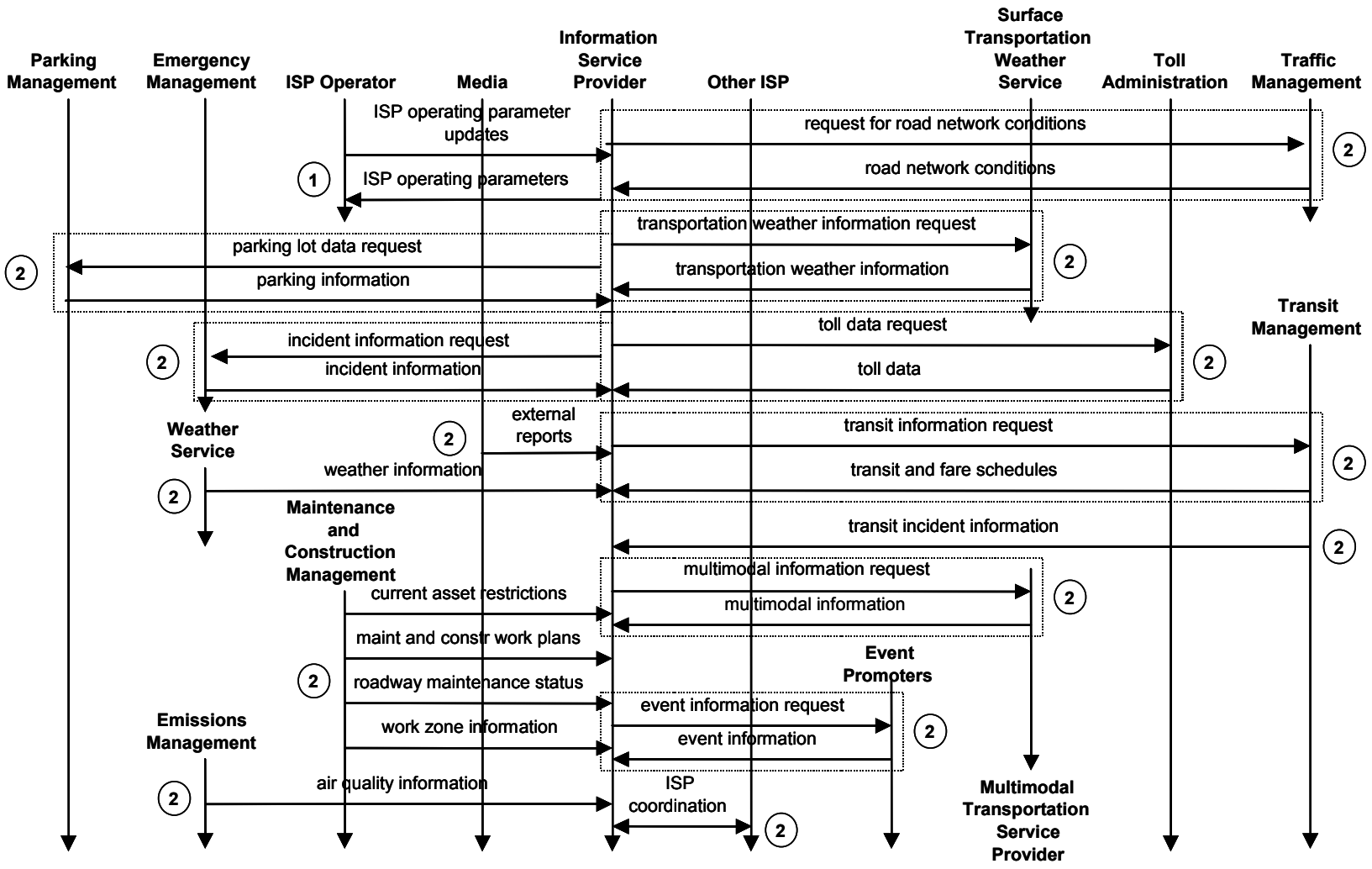
3. The ISP provides information to several centers or systems tailored to their requests or needs. It provides *road network conditions* to the Fleet and Freight Management Subsystem, *traveler information for media* to the Media, and *fare and price information* to the Traffic Management Subsystem (TMS). This last flow to the TMS supports demand management functions at the TMS, with the ISP providing a single source for all fare and price information rather than requiring the TMS to go to multiple entities individually. 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.
4. Periodically, possibly by subscription or maybe on a regular schedule, the Remote Traveler Support Subsystem, RTS (e.g. a kiosk), may request and download map updates.
5. 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) or the RTS.
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 market 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 "request" registers 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). Alternately the traveler profile may provide parameters 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 (*traveler information*). This information is provided to the Traveler by the PIAS or ISP 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

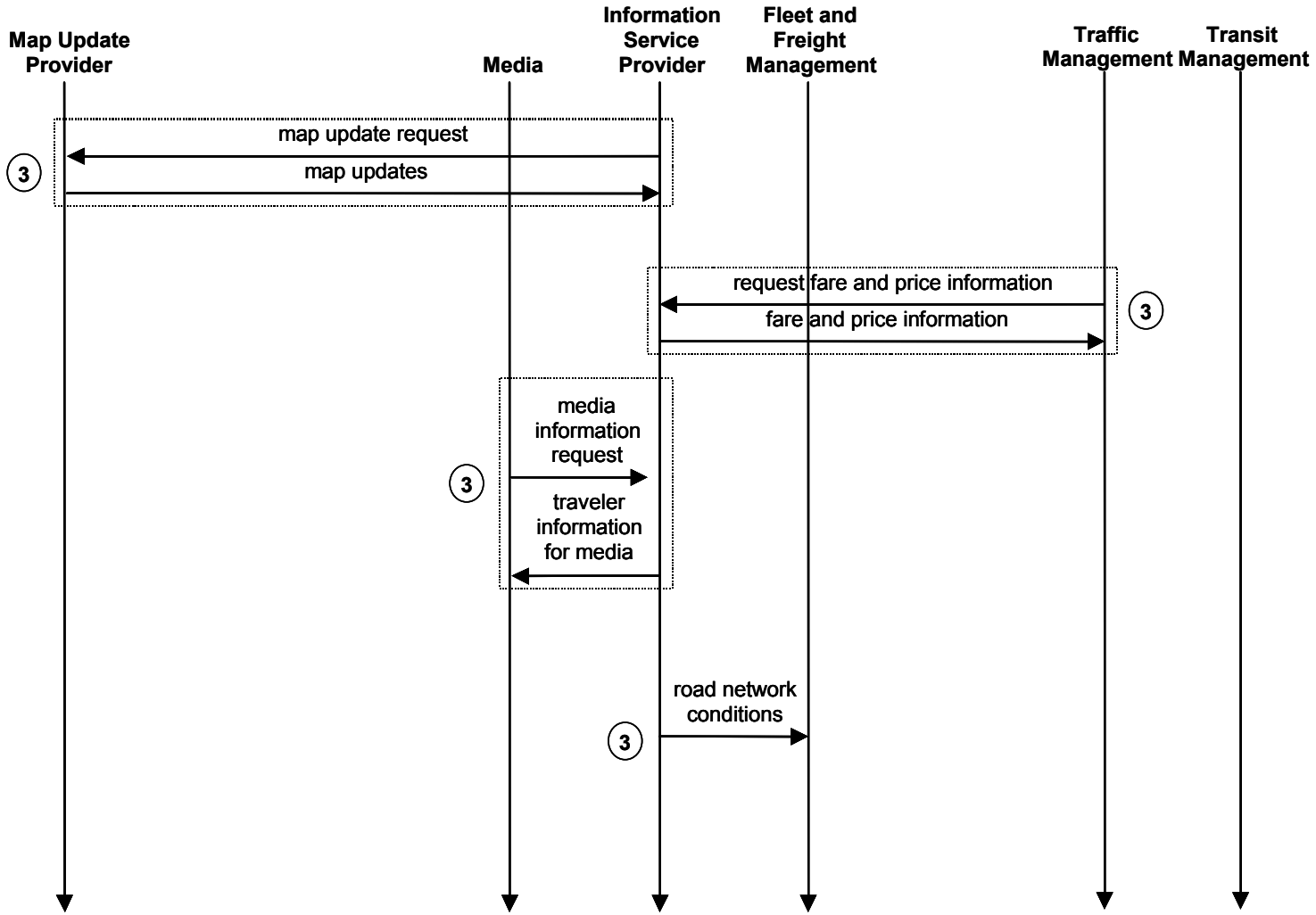
traveler requests and corresponding *traveler information* may be exchanged between a Vehicle and an ISP, and the result (*driver updates*) returned to the Driver.

8. 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.
9. 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.
10. Optionally, *traveler card updates* 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.
11. As a part of traveler information request, the Traveler may make reservations for demand responsive transit services. The flow *selected routes* can then be sent from the ISP to the Transit Management Subsystem to confirm the "reservation" for the service.

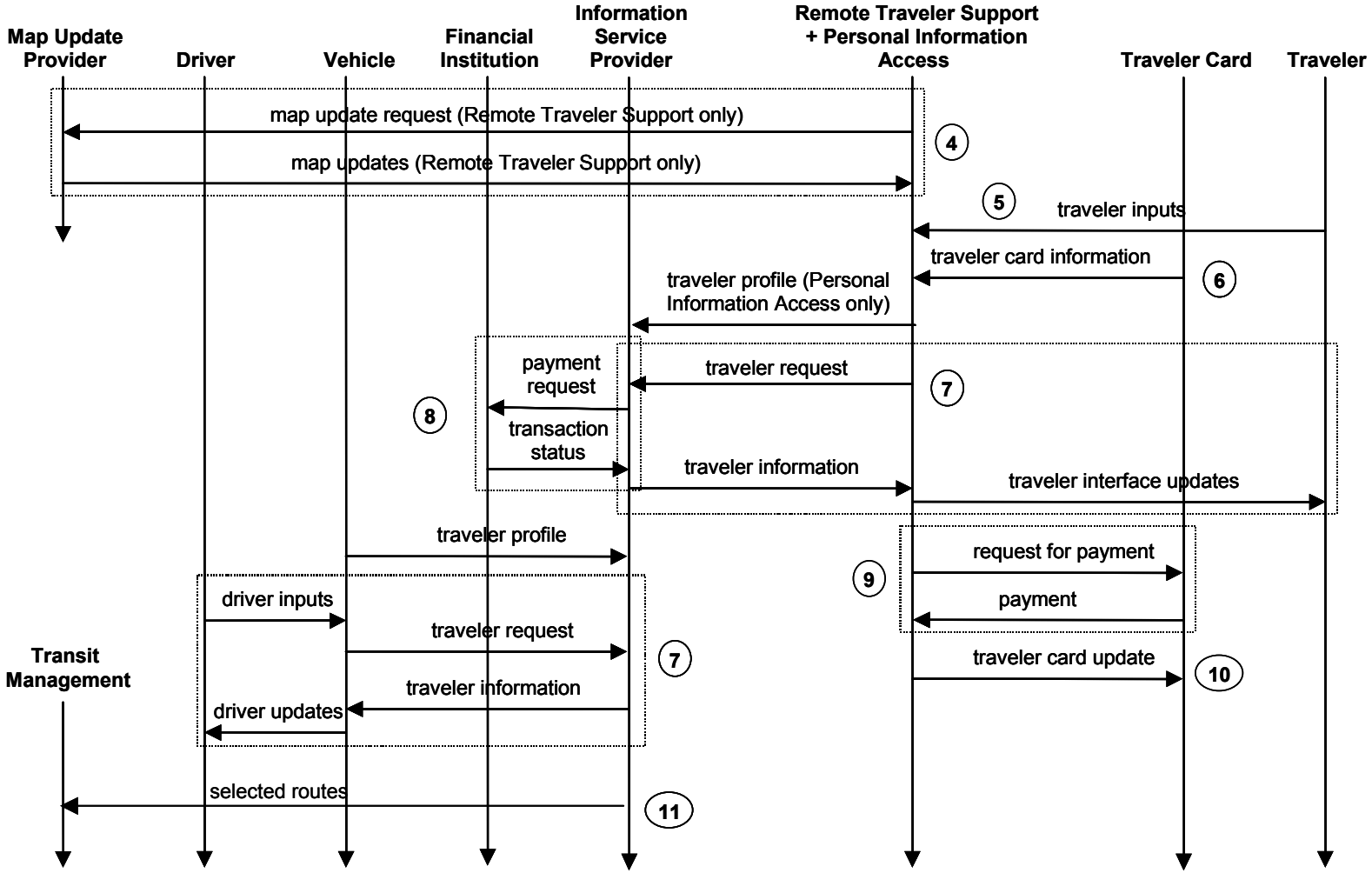
ATIS2: Interactive Traveler Information (1 of 3) (Information Collection)



ATIS2: Interactive Traveler Information (2 of 3)
(Center-to-Center Information Dissemination)



ATIS2: Interactive Traveler Information (3 of 3) (Driver/Personal Information Dissemination)



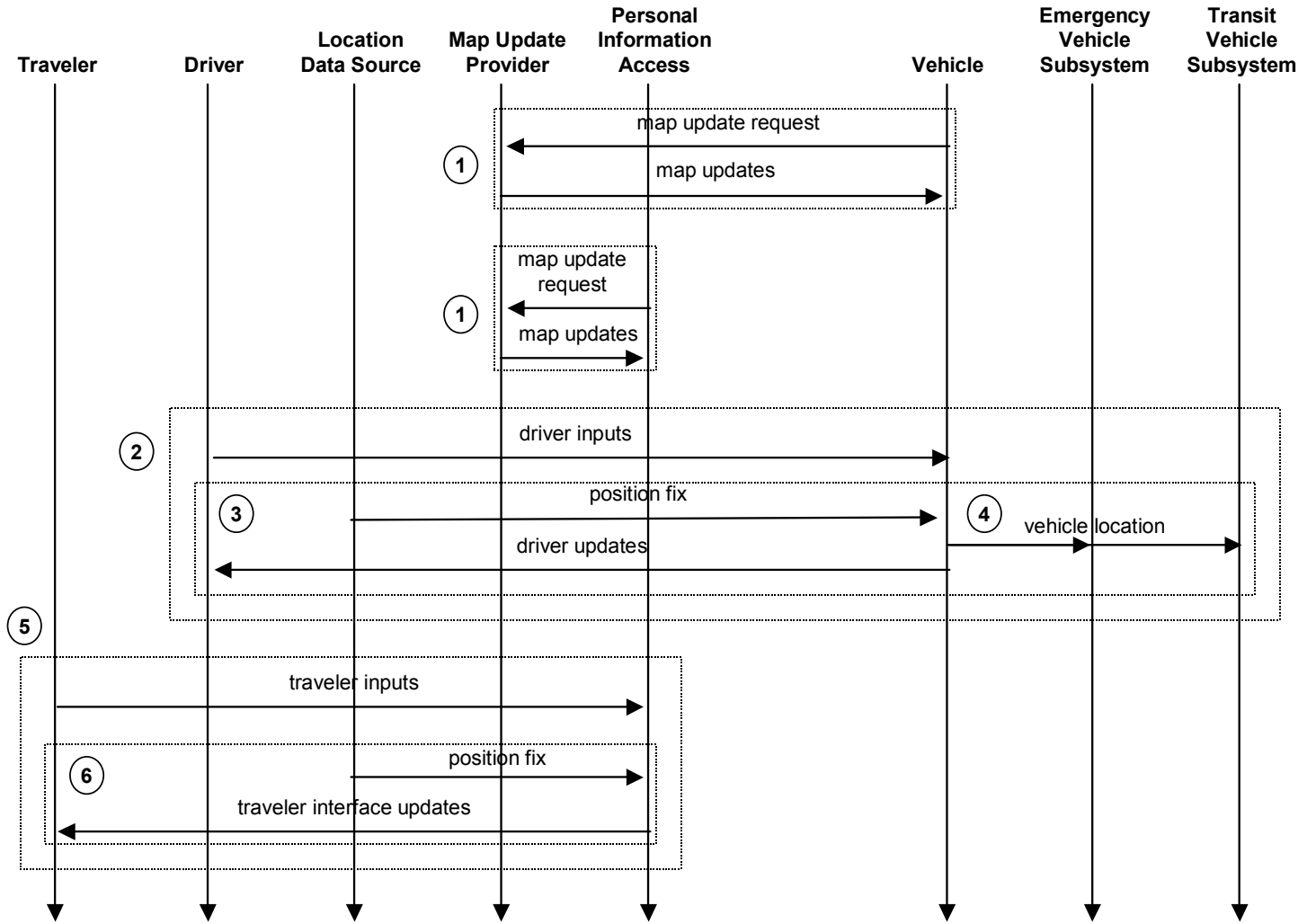
3.3. ATIS3: Autonomous Route Guidance

This market package enables 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 market package. Each numbered item describes the operation of that portion of the market 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 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, depending upon the type of vehicle being driven, the vehicle subsystem may also relay position fixes to either the emergency vehicle subsystem or the transit vehicle subsystem.
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 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.

ATIS3: Autonomous Route Guidance



3.4. ATIS4: Dynamic Route Guidance

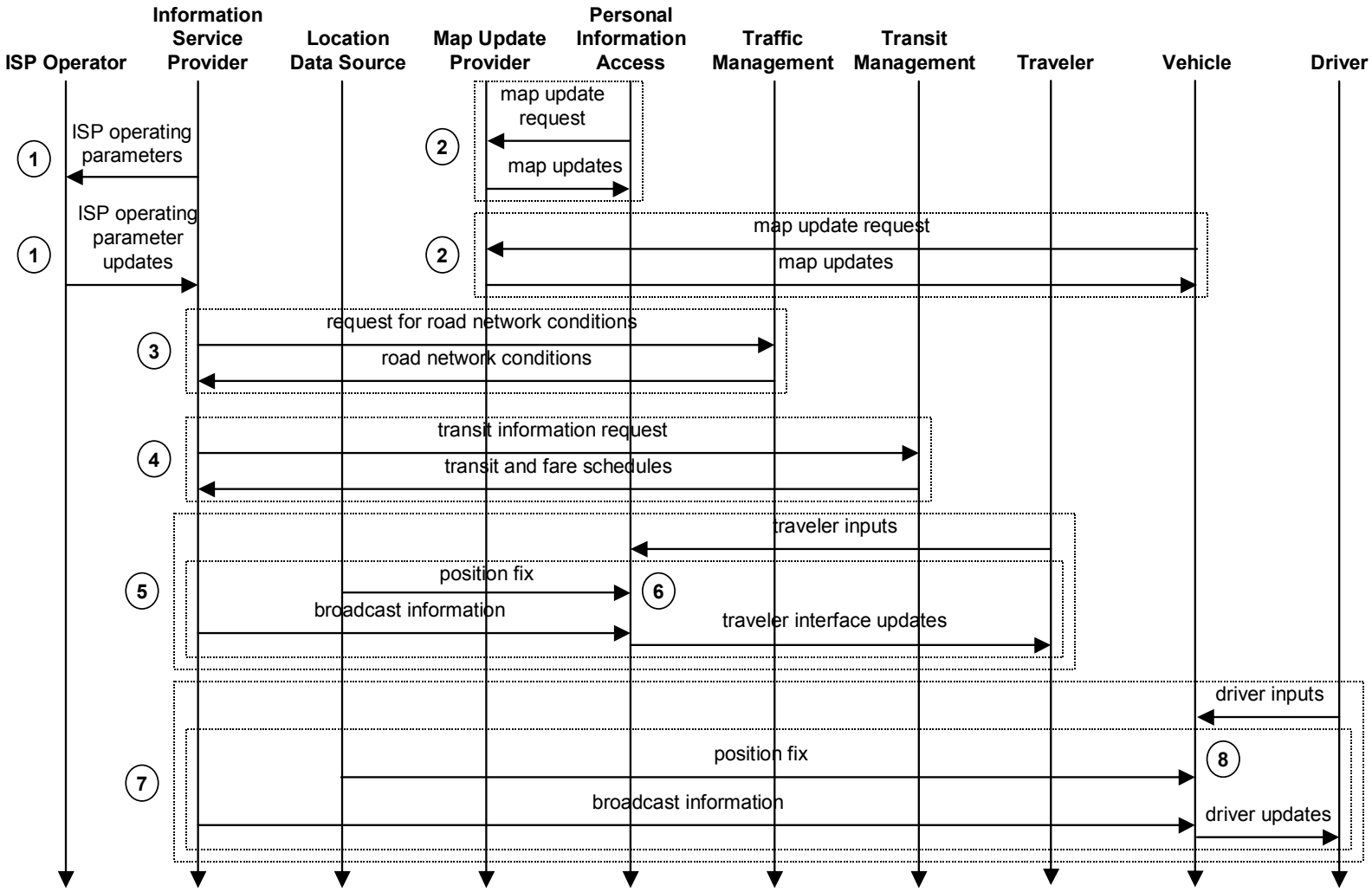
This market package offers advanced route planning and guidance that is responsive to current conditions, using real-time traffic, transit, and road condition information.

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

1. The entire process is under the asynchronous monitoring (*ISP operating parameters*) and control (*ISP operating parameter updates*) by the ISP Operator.
2. Periodically, possibly by subscription or by regularly scheduled requests, vehicle systems and personal devices may request and download map updates from a Map Update Provider.
3. All (or selected) collected *road network conditions* 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 (*request for road network conditions*).

   All (or selected) *transit and fare schedules* 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 (*transit information request*).
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 Information Service Provider sends real-time, route-affecting information (*broadcast 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.
6. Optionally, asynchronously, and as often as desired, a driver may request (*driver inputs*) a route from the vehicle.
7. 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 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.

ATIS4: Dynamic Route Guidance



3.5. ATIS5: ISP Based Route Guidance

This market package offers the user pre-trip route planning and turn-by-turn route guidance services. 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 market package. This approach simplifies the user equipment requirements and can provide the infrastructure better information on which to predict future traffic. The package includes two way data communications and optionally also equips the vehicle with the databases, location determination capability, and display technology to support turn by turn route guidance.

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

1. The entire process is under the asynchronous monitoring (*ISP operating parameters*) and control (*ISP operating parameter updates*) by the ISP Operator.

   ISPs may exchange information (*ISP coordination*) for a variety of reasons: contractual information access restrictions, proprietary data sources, economy of scale, cooperative agreements, etc.

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 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* 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 (*request for road network conditions*).

   All (or selected) *transit and fare schedules* are received from the Transit Management Subsystem 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 (*transit information request*).

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

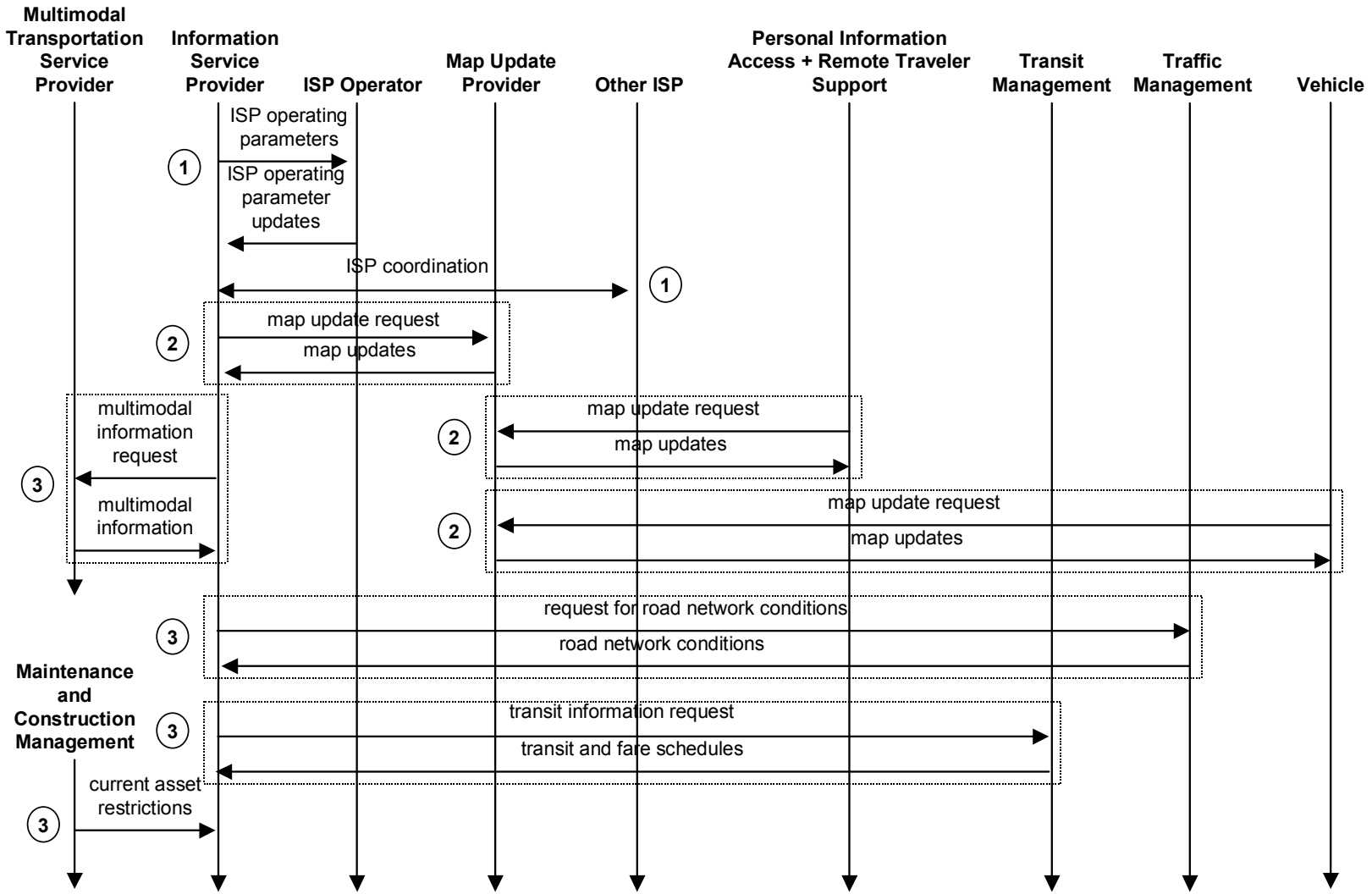
4. Optionally, asynchronously, and as often as desired, a traveler may request (*traveler inputs*) a route through the Personal Information Access Subsystem, PIAS (e.g. a personal computing

device such as a PDA, cell phone, PC, or other mobile device) or via the Remote Traveler Support Subsystem, RTS (e.g. a kiosk).

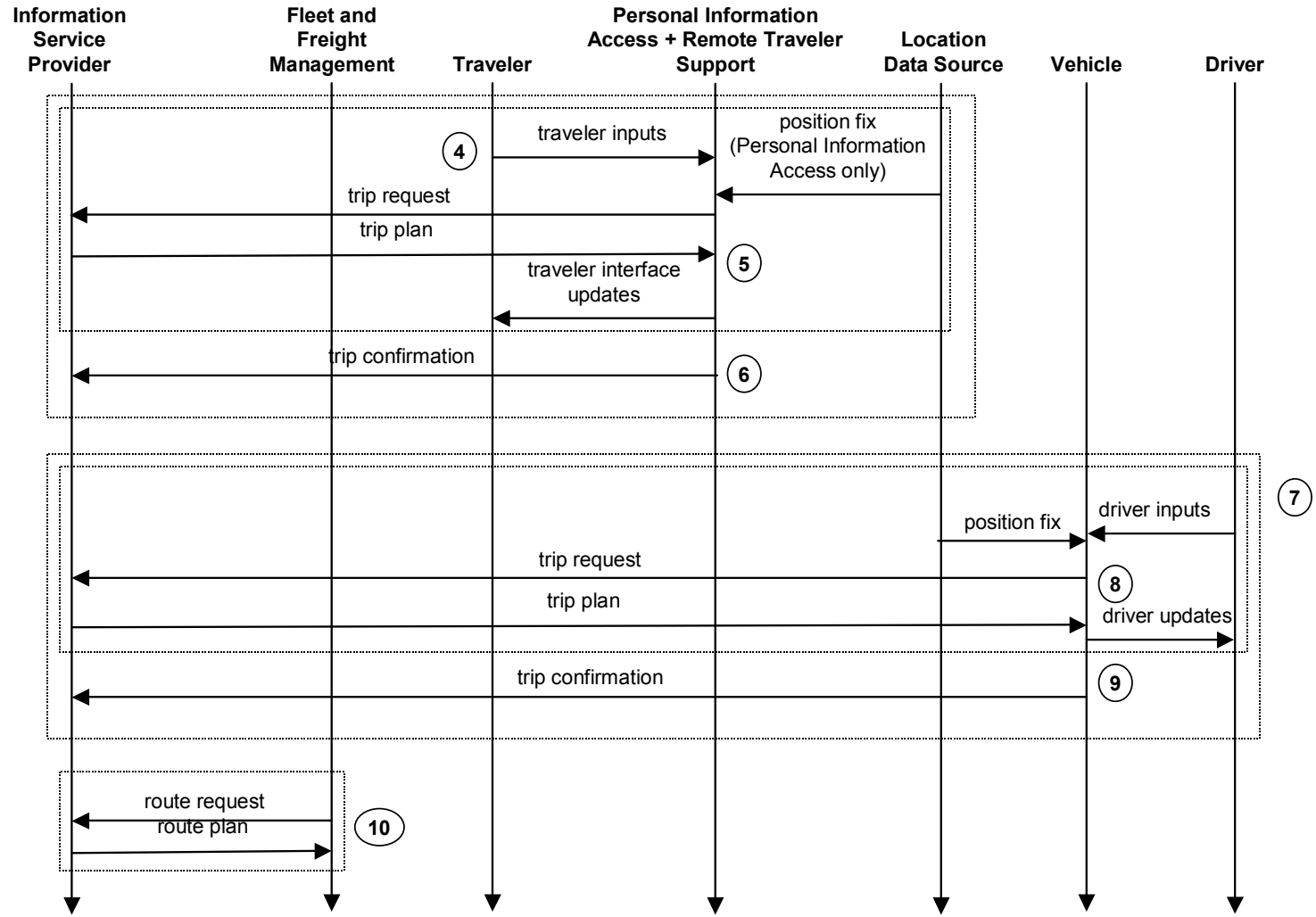
5. Once a route is requested by the traveler, a continuous cycle occurs, consisting of these steps:
    - The updated position of the traveler (*position fix*) may be obtained for the case of a mobile user making the route request via the PIAS.
    - The traveler's trip request is sent (*trip request*) 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 confirmation that the trip has been accepted is sent back to the ISP (*trip confirmation)*.
7. A similar set of flows can be used by a Driver to obtain route information. 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 (*trip request*) 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 confirmation that the trip has been accepted is sent back to the ISP (*trip confirmation*).

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*).

ATIS5: ISP Based Route Guidance (1 of 2)
(ISP Information Collection)



ATIS5: ISP Based Route Guidance (2 of 2)
(ISP Information Service)



3.6. ATIS6: Integrated Transportation Management/Route Guidance

This market package provides advanced route planning and guidance which is responsive to current conditions, and supports collection of near-real time information on intended routes for a portion of the vehicles in the network. This comprehensive road network probe information can be used by the Traffic Management Subsystem to optimize the traffic control strategy based on anticipated vehicle routes. The Traffic Management Subsystem would utilize the individual and ISP route planning information to optimize signal timing while at the same time providing updated signal timing information to allow optimized route plans.

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

1. The entire process is under the asynchronous monitoring (*ISP operating parameters*) and control (*ISP operating parameter updates*) by the ISP Operator.

   ISPs may exchange information (*ISP coordination*) for a variety of reasons: contractual information access restrictions, proprietary data sources, economy of scale, cooperative agreements, etc.

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

3. All (or selected) collected *road network conditions* 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 (*request for road network conditions*).

   In addition, probe information about the road network conditions (*road network probe information*) collected by the Internet Service Provider from subscribers may be provided to the Traffic Management Subsystem.

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

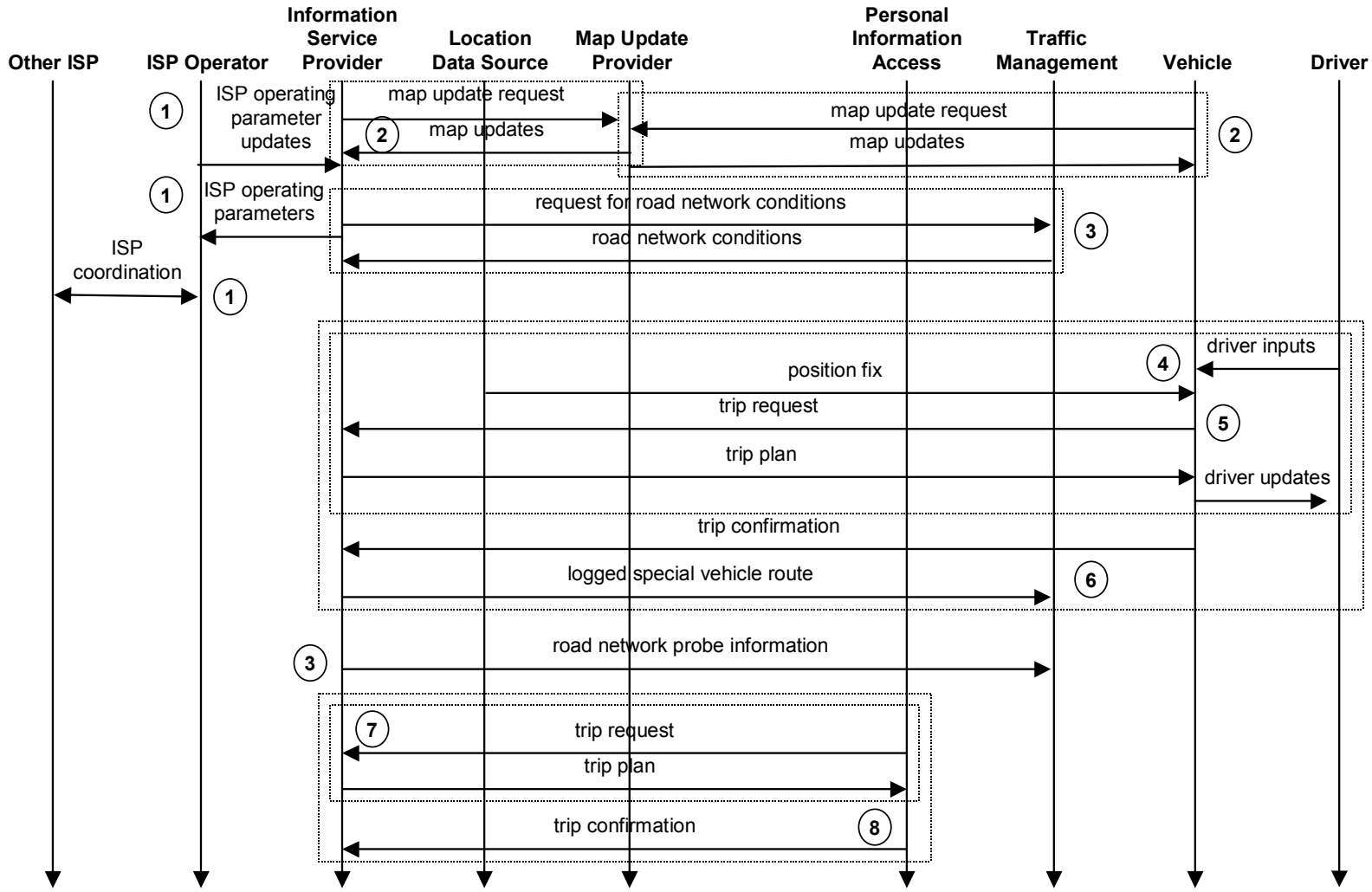
5. Once a route is requested by the driver (*driver inputs*), a continuous cycle occurs, consisting of these steps: the updated position of the driver (*position fix*) is obtained, the driver's trip request is sent (*trip request*), the Information Service Provider sends a suggested route information (*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).

6. Once the Driver has accepted a route, a confirmation that the trip has been accepted is sent back to the ISP (*trip confirmation*). Certain special vehicles, motorcades, oversized vehicles,

and other high profile vehicles are logged (*logged special vehicle route*) with the Traffic Management Subsystem so that a capacity management strategy can be implemented.

7. Optionally, asynchronously, and as often as desired, advanced trip planning can be done via a personal computing device (PIAS) by submitting a *trip request* and receiving a suggested route (*trip plan*) from the ISP. This cycle is repeated until an acceptable route is provided.
8. Once an acceptable route is selected, the selection is confirmed by sending a *trip confirmation* back to the ISP.

ATIS6: Integrated Transportation Management/Route Guidance



3.7. ATIS7: Yellow Pages and Reservation

This market package provides yellow pages 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 market package provides multiple ways for accessing information either while en route in a vehicle using wide-area wireless communications or pre-trip via wireline connections.

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

1. The entire process is under the asynchronous monitoring (*ISP operating parameters*) and control (*ISP operating parameter updates*) by the ISP Operator.
2. Periodically, possibly by subscription or by regularly scheduled requests, Information Service Providers and kiosks may request and download map updates from a Map Update Provider.
3. Periodically, information may supplied by service providers (e.g., a hotel or restaurant) that identifies the service providers and details of the services offered. This flow covers initial registration of a service provider and subsequent submittal of new information and status updates so that data currency is maintained. Confirmation of receipt of this information is sent back by the ISP.
4. Optionally, asynchronously, and as often as desired, a Driver may request (*driver inputs*) a yellow page information or reservations from an in-vehicle system.
5. Yellow page information requests or requests for reservations are passed from the in-vehicle system to the ISP.
6. An ISP may present a request for payment (*payment request*) and then receive *transaction status* on that request from a Financial Institution.
7. Reservations for parking may be requested (*parking reservations request*) and confirmed (*parking reservations reservation confirmation*). When requested, notification of confirmation will be returned (*parking reservations reservation confirmation*).

   Yellow pages and/or *travel service requests* may be made. When made, the *travel service information* is returned.

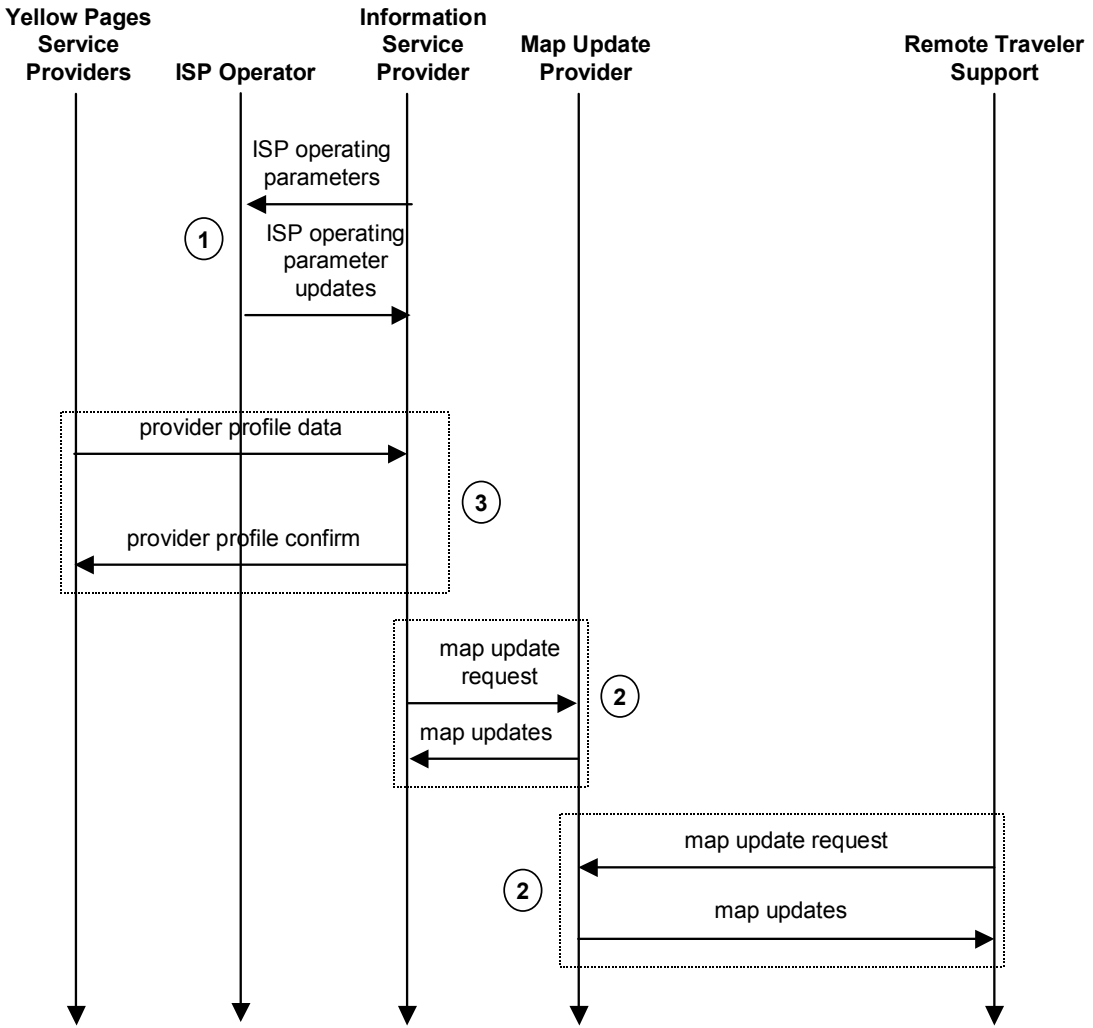
   Yellow Pages requests, travel service requests and/or parking requests may be forwarded (*ISP coordination*) to other Information Service Providers operating in conjunction with the primary ISP originating the request.
8. Once the information is collected, the ISP will send the information (*yellow pages information*) back to the in-vehicle system.
9. The yellow pages information is sent to the driver (*driver updates*).

10. Optionally, asynchronously, and as often as desired, a Traveler may request (*driver inputs*) a yellow page information or reservations from a personal computing device or kiosk.
11. 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.
12. Yellow page information requests or requests for reservations are passed from the personal computing device or kiosk to the ISP.
13. An ISP may present a request for payment (*payment request*) and then receive *transaction status* on that request from a Financial Institution.
14. Reservations for parking may be requested (*parking reservations request*). When requested, notification of confirmation will be returned (*parking reservations reservation confirmation*).

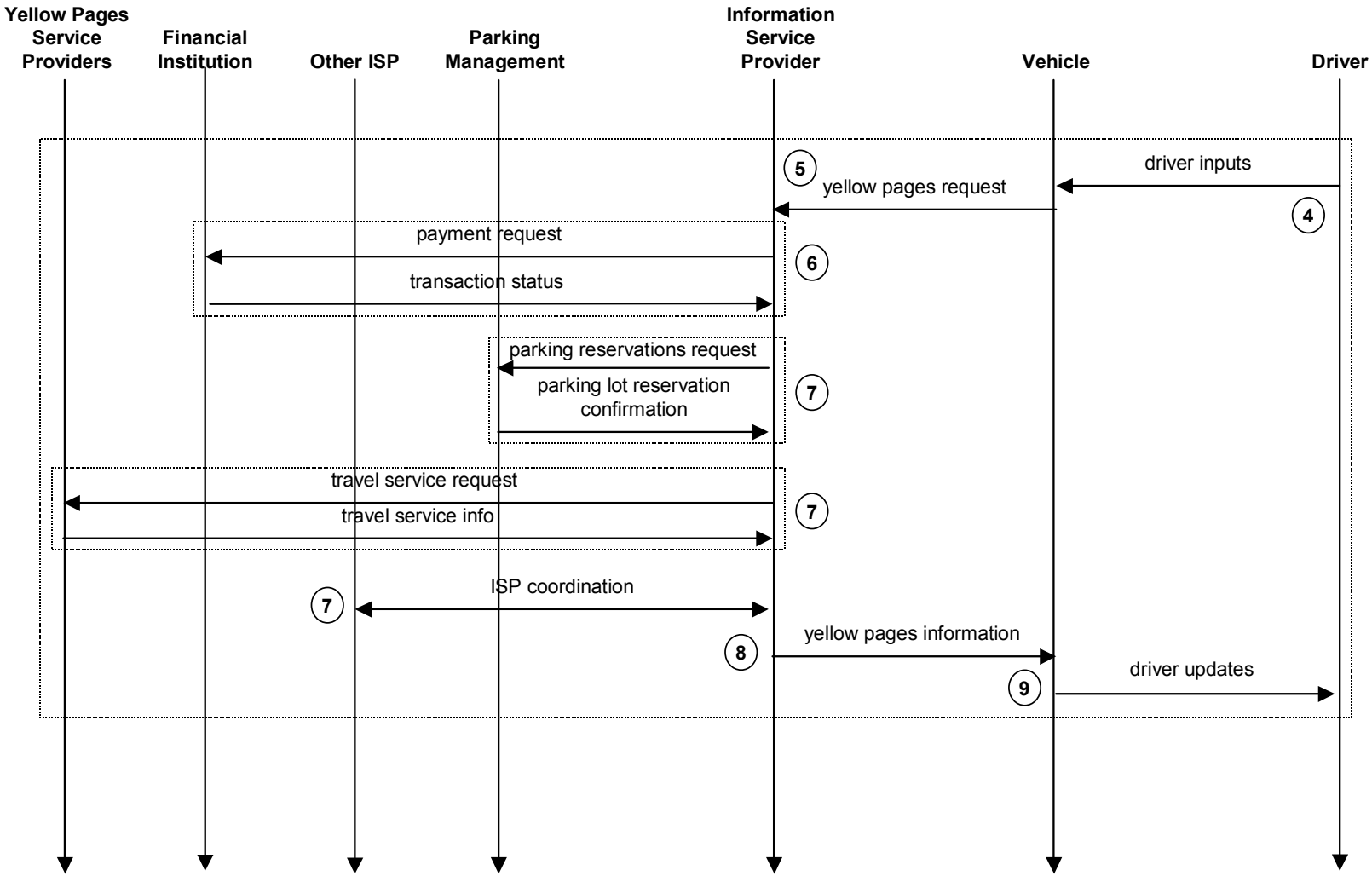
    Yellow pages and/or *travel service requests* may be made. When made, the *travel service information* is returned.

    Yellow Pages requests, travel service requests and/or parking requests may be forwarded (*ISP coordination*) to other Information Service Providers operating in conjunction with the primary ISP originating the request.
15. Once the information is collected, the ISP will send the information (*yellow pages information*) back to the originating device (from Step 12).
16. The yellow pages information is sent to the Traveler (*traveler interface updates*).

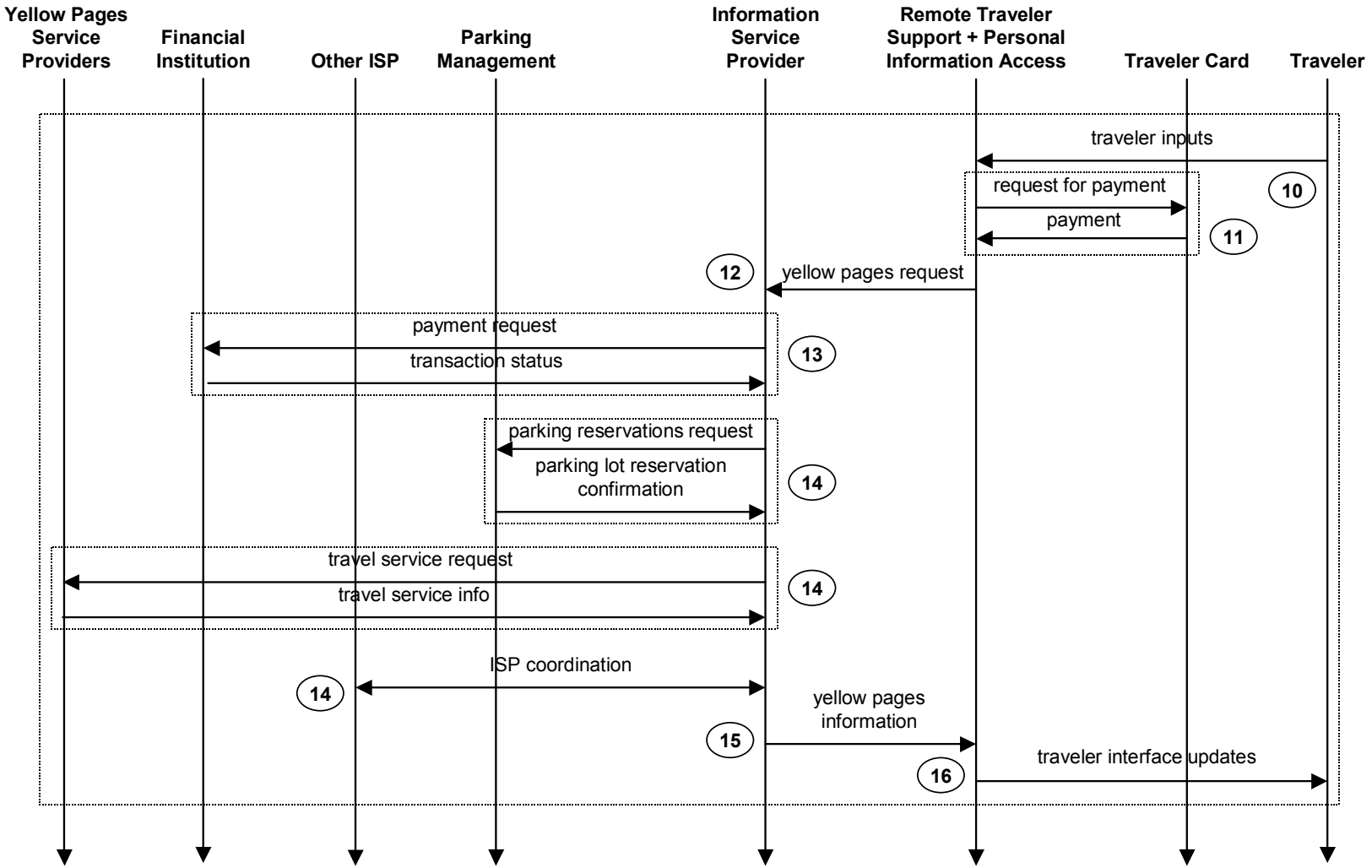
ATIS7: Yellow Pages and Reservation (1 of 3)
(Initializations / Information Collection)



ATIS7: Yellow Pages and Reservation (2 of 3) (Operations for Vehicle)



ATIS7: Yellow Pages and Reservation (3 of 3) (Operation for RTS and PIAS)



3.8. ATIS8: Dynamic Ridesharing

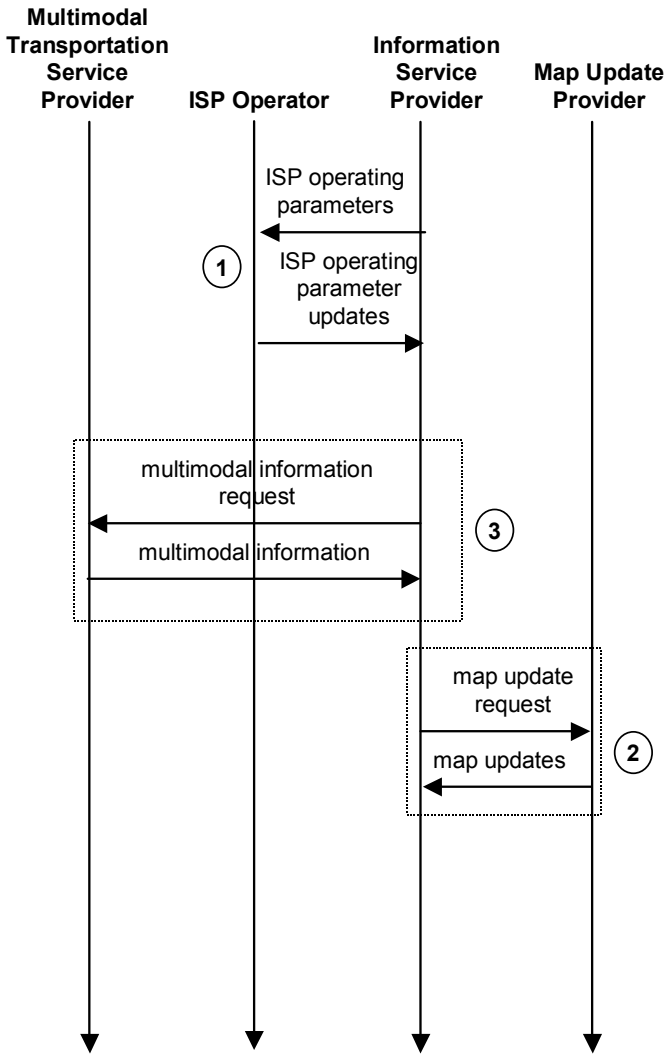
This market package provides dynamic ridesharing/ride matching services to travelers. This service could allow near real time ridesharing reservations to be made through the same basic user equipment used for Interactive Traveler Information. This ridesharing/ride matching capability also includes arranging connections to transit or other multimodal services. Drivers may also participate, either as individuals wanting to carpool or possibly as shuttle service providers.

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

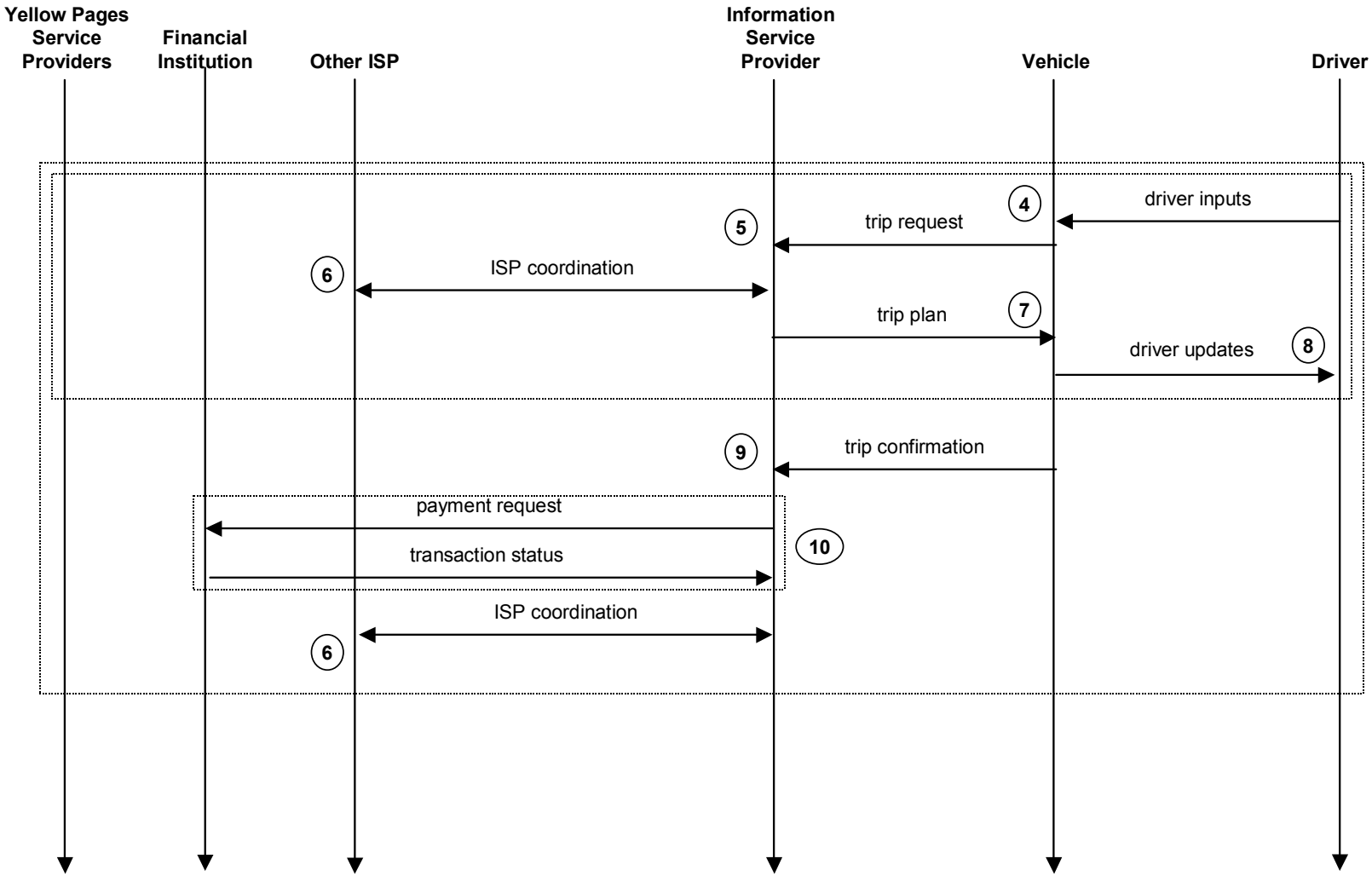
1. The entire process is under the asynchronous monitoring (*ISP operating parameters*) and control (*ISP operating parameter updates*) by the ISP Operator.
2. Periodically, possibly by subscription or by regularly scheduled requests, Information Service Providers may request and download map updates 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 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*).
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. ISPs may exchange information (*ISP coordination*) for a variety of reasons: contractual information access restrictions, proprietary data sources, economy of scale, cooperative agreements, etc. This information about traffic conditions, special events, link travel times, etc. may be subsequently used in determining the best ride-match. Potentially, there could be two ISPs offering ride-matching services in a cooperative situation with a driver coming in on one service and a rider on another service. Once a match has been confirmed, then further *ISP coordination* occurs.
7. The Information Service Provider sends a suggested ride-match and its associated information (*trip plan*) back to the Vehicle.
8. 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).
9. Once the Driver has accepted a ride-match, a confirmation that the match has been accepted is sent back to the ISP (*trip confirmation*).

10. 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.
11. Optionally, asynchronously, and as often as desired, a Traveler (passenger) may request (*traveler inputs*) a ride-match via personal computing device or kiosk.
12. 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*).
13. 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.
14. ISPs may exchange information (*ISP coordination*) for a variety of reasons: contractual information access restrictions, proprietary data sources, economy of scale, cooperative agreements, etc. This information about traffic conditions, special events, link travel times, etc. may be subsequently used in determining the best ride-match. Potentially, there could be two ISPs offering ride-matching services in a cooperative situation with a driver coming in on one service and a rider on another service, or two riders using different services. Once a match has been confirmed, then further *ISP coordination* occurs.
15. 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).
16. The ride-match is then presented 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 11).
17. 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.
18. Once the Traveler has accepted a ride-match, a confirmation that the match has been accepted is sent back to the ISP (*trip confirmation*).
19. 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*).
20. 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.

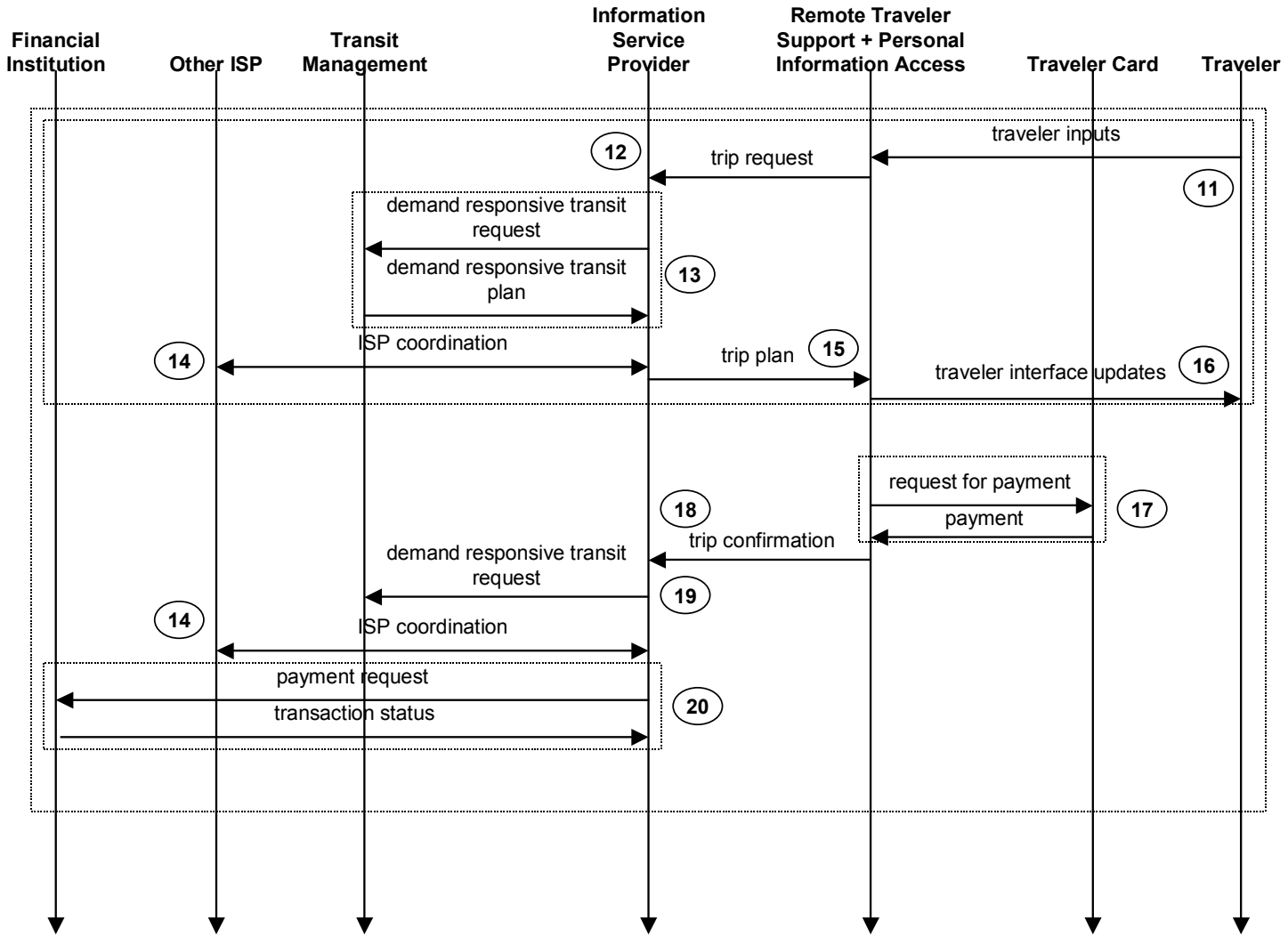
ATIS8: Dynamic Ridesharing (1 of 3) (Initializations / Information Collection)



ATIS8: Dynamic Ridesharing (2 of 3)
(Operations for Drivers)



ATIS8: Dynamic Ridesharing (3 of 3)
(Operation for Passengers)



3.9. ATIS9: In-Vehicle Signing

This market package supports distribution of traffic and travel advisory information to drivers through in-vehicle devices. It includes short range communications between roadside equipment and the vehicle and wireline connections to the Traffic Management Subsystem for coordination and control. This market package also informs the driver of both highway-highway and highway-rail intersection status.

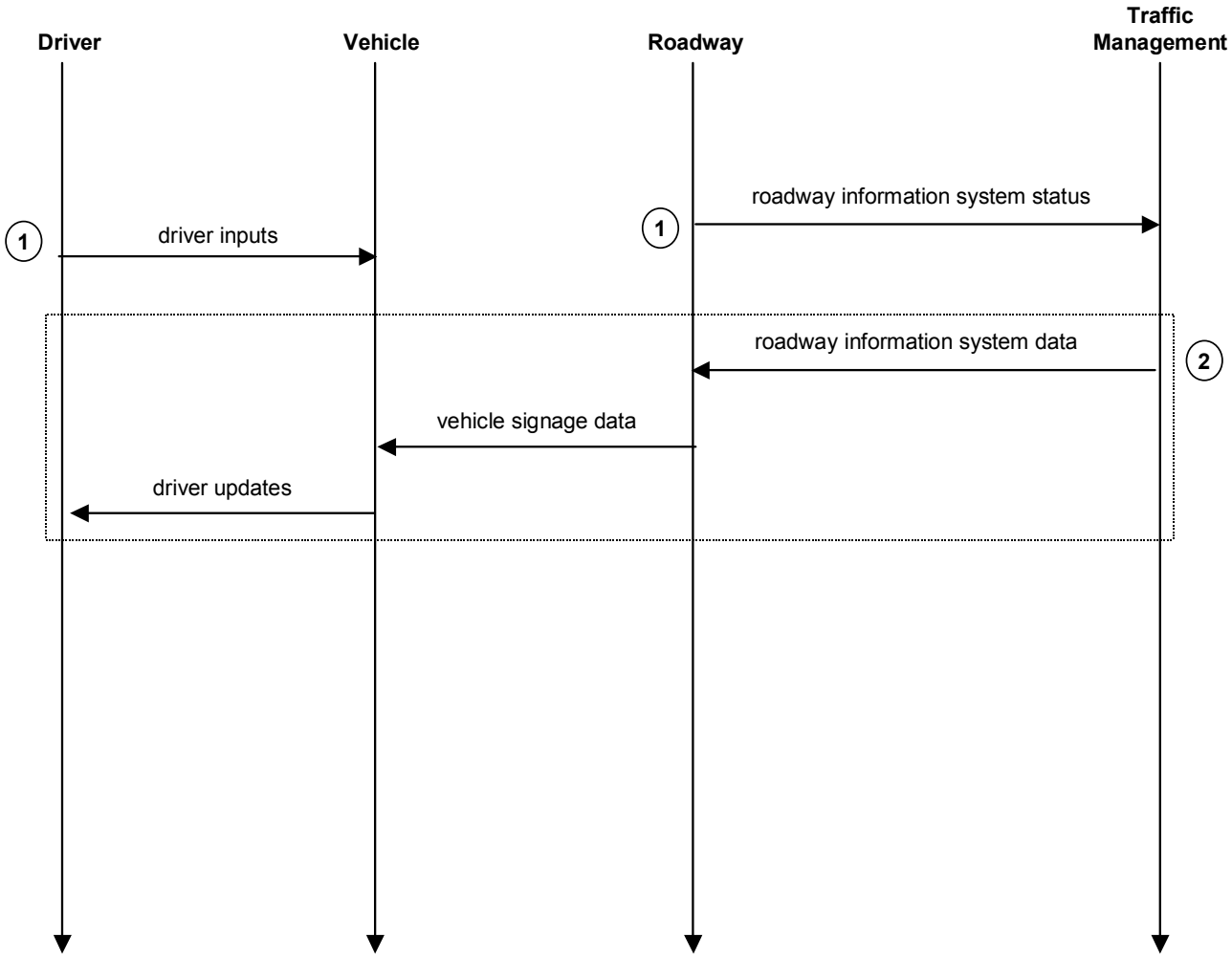
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. The entire process is under the asynchronous control (*driver inputs*) by the Driver.

   Periodically, information about the status of roadway equipment (*roadway information system status*) is sent back to the Traffic Management Subsystem.

2. A cycle of traffic and status information along with equipment control signals flow from the Traffic Management Subsystem (*roadway information system data*) to the Roadway and then relevant information flows to the Vehicle (*vehicle signage data*). This information is then presented to the driver (*driver updates*).

ATIS9: In Vehicle Signing



4. Transit Management

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

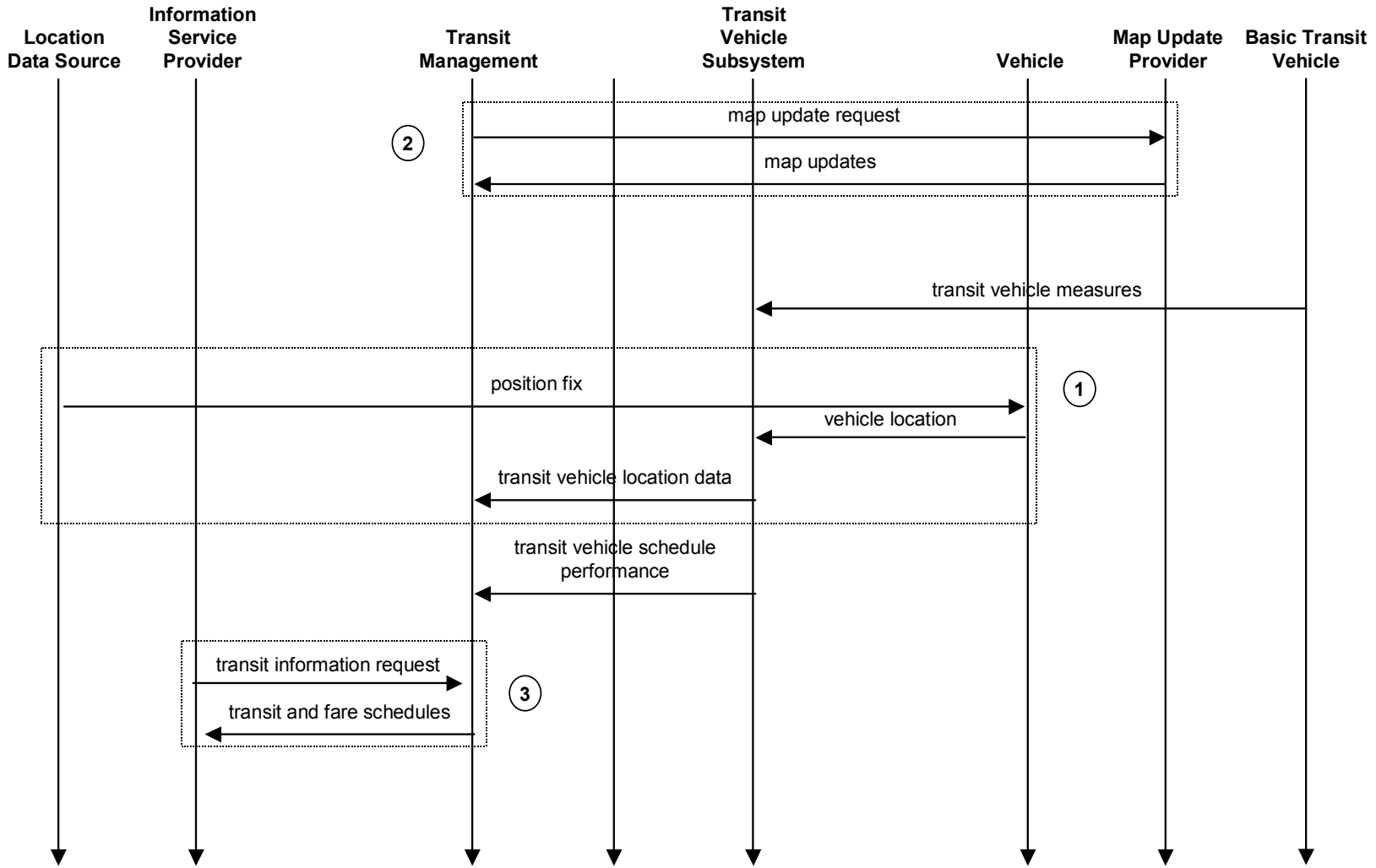
4.1. APTS1: Transit Vehicle Tracking

This market package will track the location of transit vehicles and determine schedule adherence of the transit vehicles.

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

1. In the National ITS Architecture, determining a vehicle's location (for all manners of fleet vehicles including the transit vehicle) has been assigned to the Vehicle Subsystem. This is because the basic function-- determining vehicle location-- is the same no matter what type of vehicle is considered. Exactly how that location is determined is not defined in the architecture. What is described is that the entity Location Data Source sends the flow *position fix* to the Vehicle Subsystem. The output of the vehicle tracking function in the Vehicle Subsystem (*vehicle location*) is sent to the Transit Vehicle Subsystem (TRVS) and that 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 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. Information about transit vehicle location and schedule adherence can be requested by the Information Service Provider for its clients (*transit information request*) and the TRMS will provide the information as part of the flow *transit and fare schedules*.

APTS1: Transit Vehicle Tracking



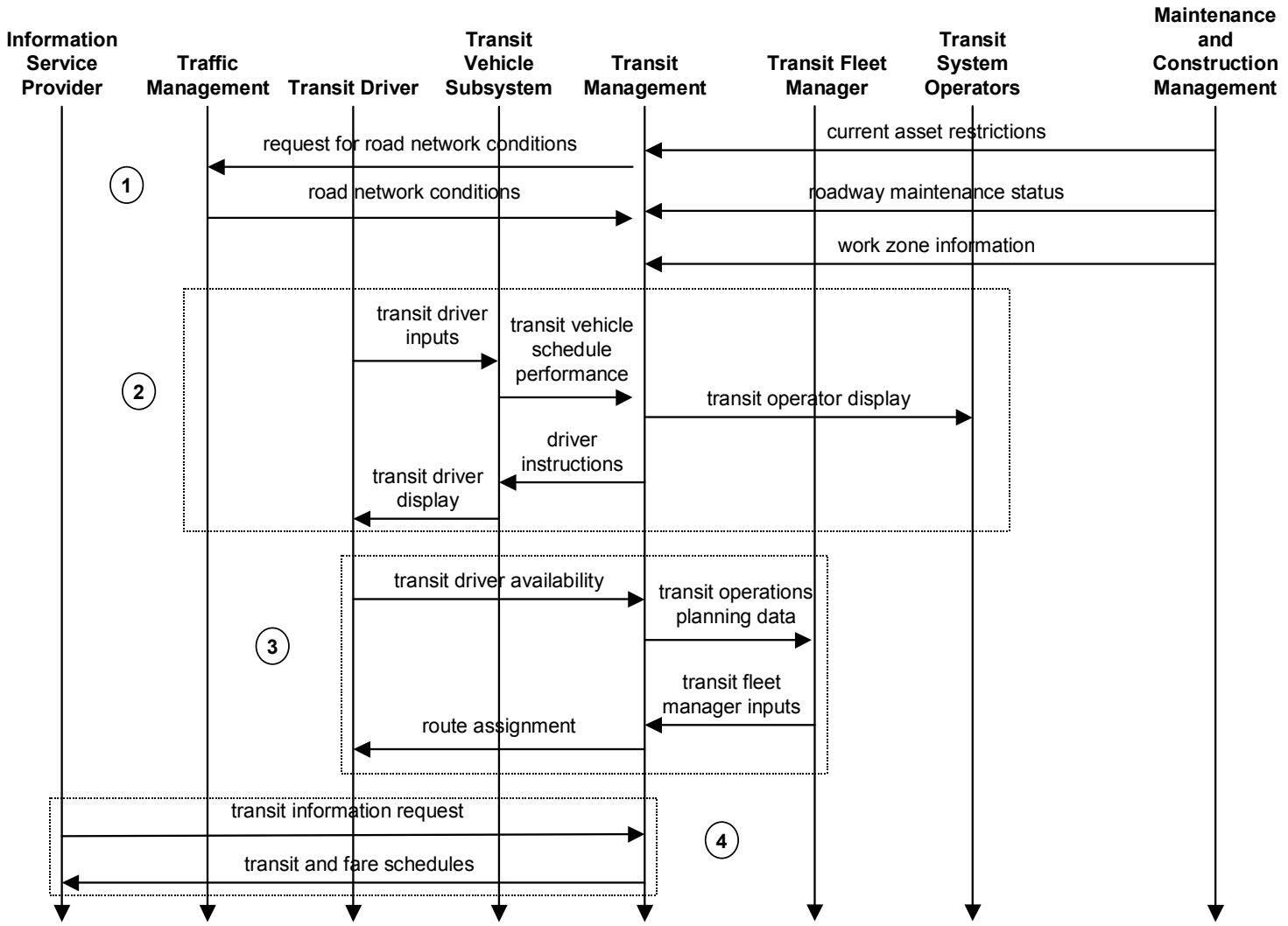
4.2. APTS2: Transit Fixed Route Operations

This market package performs vehicle routing and scheduling, as well as automatic driver assignment and system monitoring for fixed-route transit services.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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 and forecasted traffic information, road and weather conditions, and incident information obtained from the Traffic Management Subsystem (*road network conditions*). 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 wo*rk 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 fixed route operations is to assess the performance of the fleet vehicles and provide corrective actions if needed. The Transit Driver can provide an input on the vehicle's schedule status (*transit driver 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 System Operators (*transit operator display*), who can generate any needed *driver instructions* (note: flow from Transit System Operator to TRMS is not shown in figure).
3. Another function of the fixed route transit operations is to assign drivers to routes. To initiate this activity, the Transit Driver provides their availability to the TRMS (*transit driver availability*). This information is passed to the Transit Fleet Manager(as a part of *transit operations planning data*), who inputs driver assignments (as part of *transit fleet manager inputs*). The assignment information is provided to the Transit Driver 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 Information Service Provider requests both static and real time information from the TRMS (*transit information request*), who provides the information as *transit and fare schedules*.

APTS2: Transit Fixed-Route Operations



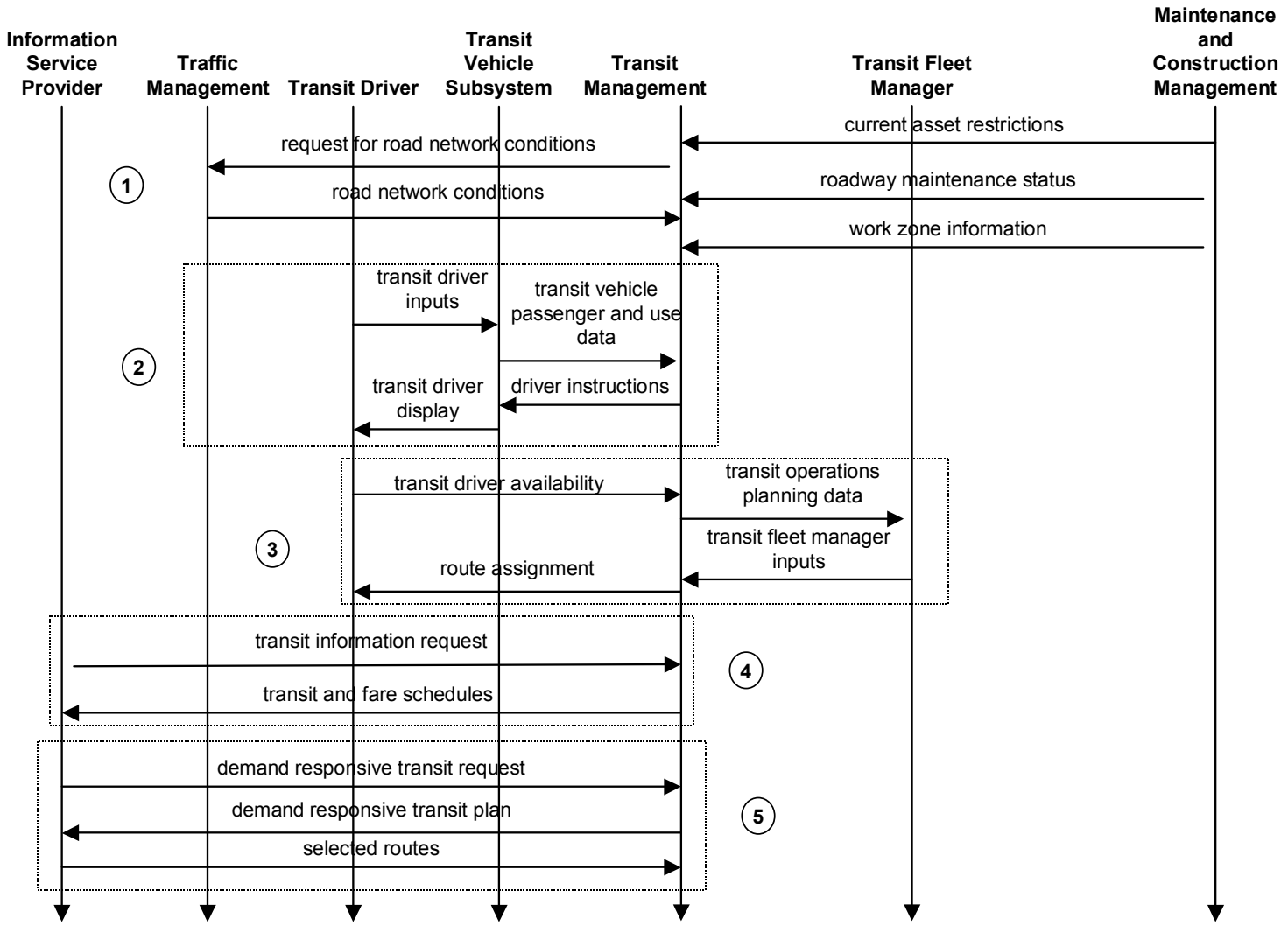
4.3. APTS3: Demand Response Transit Operations

This market package performs vehicle routing and scheduling as well as automatic driver assignment and monitoring for demand responsive transit services.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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 current and forecasted traffic information, road and weather conditions, and incident information obtained from the Traffic Management Subsystem (*road network conditions*). 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 wo*rk 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 Driver can provide an input on the vehicle's status (*transit driver 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 (*transit vehicle passenger and use data*). This information is provided to the Transit System Operators, who can generate any needed dispatch and routing *driver instructions* (note: flows to and from the Transit System Operator to TRMS are not shown in figure).
3. Another function of the fixed route transit operations is to assign drivers to routes. To initiate this activity, the Transit Driver provides their availability to the TRMS (*transit driver availability*). This information is passed to the Transit Fleet Manager (as a part of *transit operations planning data*), who inputs driver assignments (as part of *transit fleet manager inputs*). The assignment information is provided to the Transit Driver 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 Information Service Provider (ISP) requests both static and real time information from the TRMS (*transit information request*), who provides the information as *transit and fare schedules*.
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*).

APTS3: Demand Response Transit Operations



4.4. APTS4: Transit Passenger and Fare Management

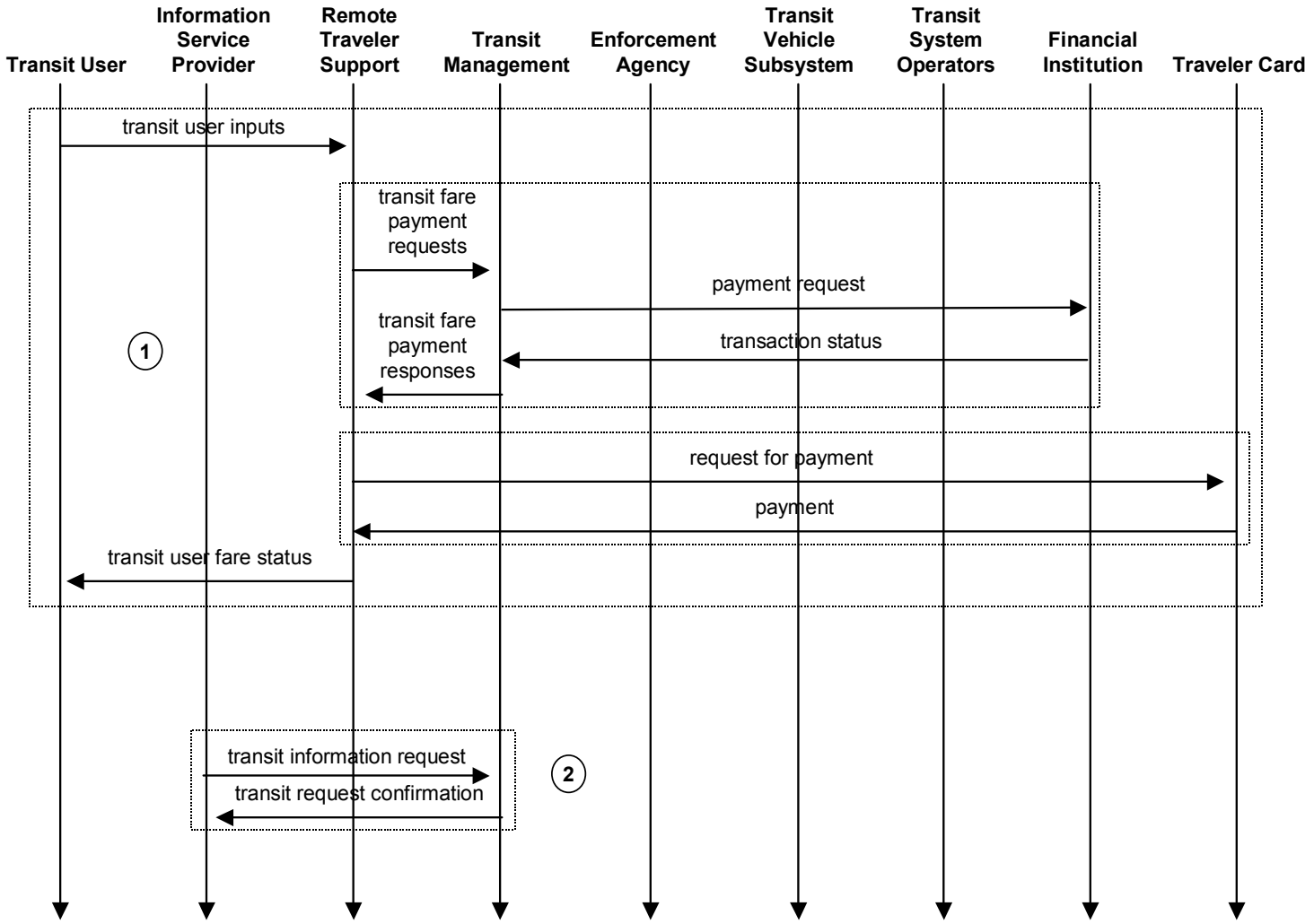
This market package manages fare payment by electronic means either on-board a transit vehicle or at roadside locations. The market package also includes automatic monitoring of passenger loading on-board vehicles. It allows transit users to use a traveler card or other electronic payment device.

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

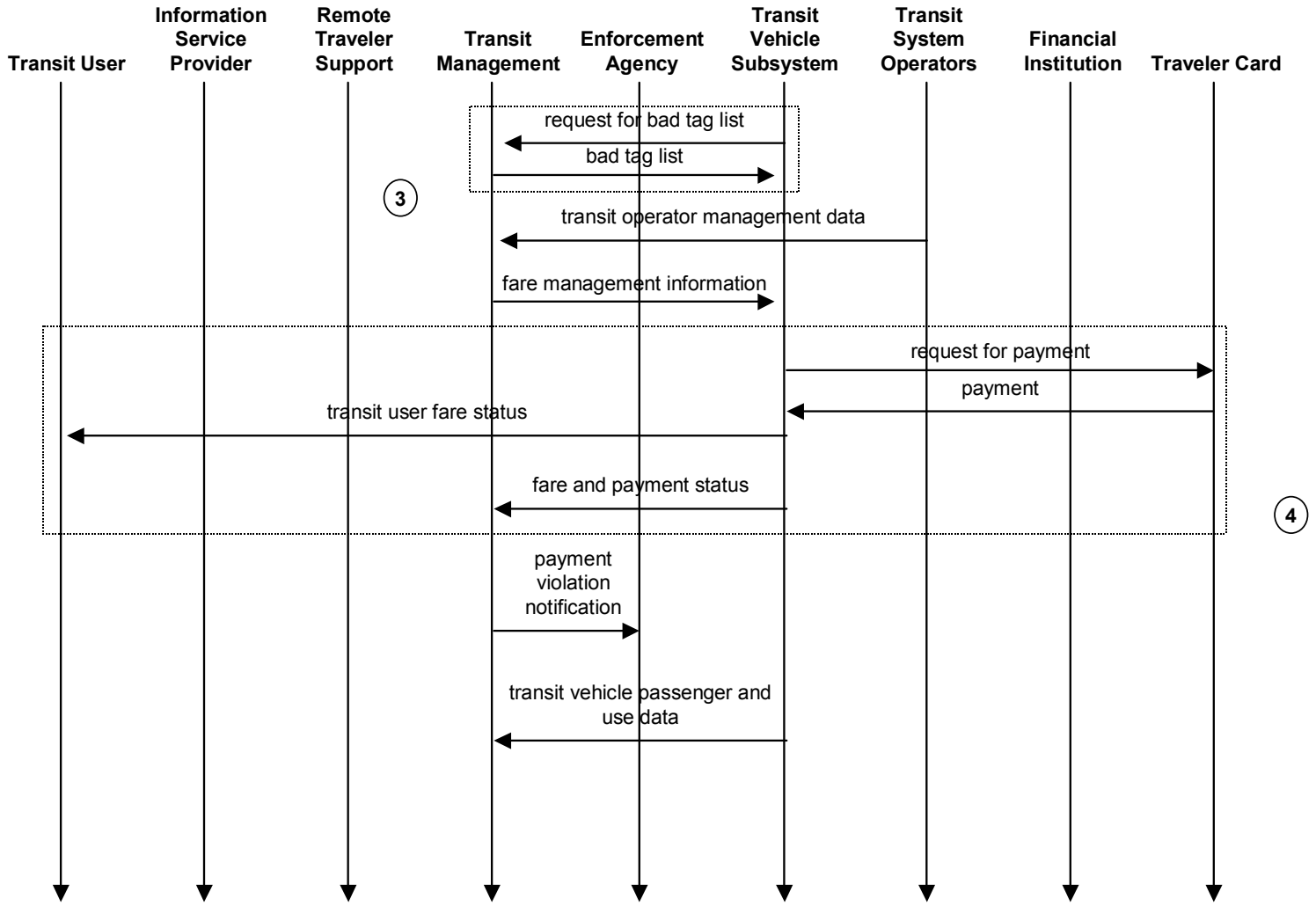
1. At roadside locations (e.g. a transit stop with a kiosk), a Transit User makes a request for a fare transaction (*transit user inputs*), which would include the desired destination to the Remote Traveler Support Subsystem (RTS). The RTS forwards the *transit fare payment request* to the Transit Management 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 payment responses* back to the RTS, which would provide an indication to the transit user (*transit user fare status*) 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 being a periodic, batch type update. A third concept supported in the diagram is for the Transit User to make the initial request (*transit user 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. 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, the Transit System Operators can initiate adjustments to the fares charged on various routes (transit operator management data). 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.
4. Another on-board electronic fare concept supported is to use a Traveler Card for the payment media. In this case the TRVS sends a *request for payment* to the Traveler Card, which responds with the *payment* information. The TRVS then informs the Transit User of the status of the transaction (*transit user fare status*). 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 and payment status*). 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 and payment status* to be a periodic, batch type transmission. If fare violations are collected, then payment violation notification is sent to the Enforcement Agency. In addition, the TRVS sends passenger counts associated with the fare collection system (*transit vehicle passenger and use data*).

APTS4: Transit Passenger and Fare Management (1 of 2) (Non-Mobile Transactions)



APTS4: Transit Passenger and Fare Management (2 of 2) (Transit Vehicle Transactions)



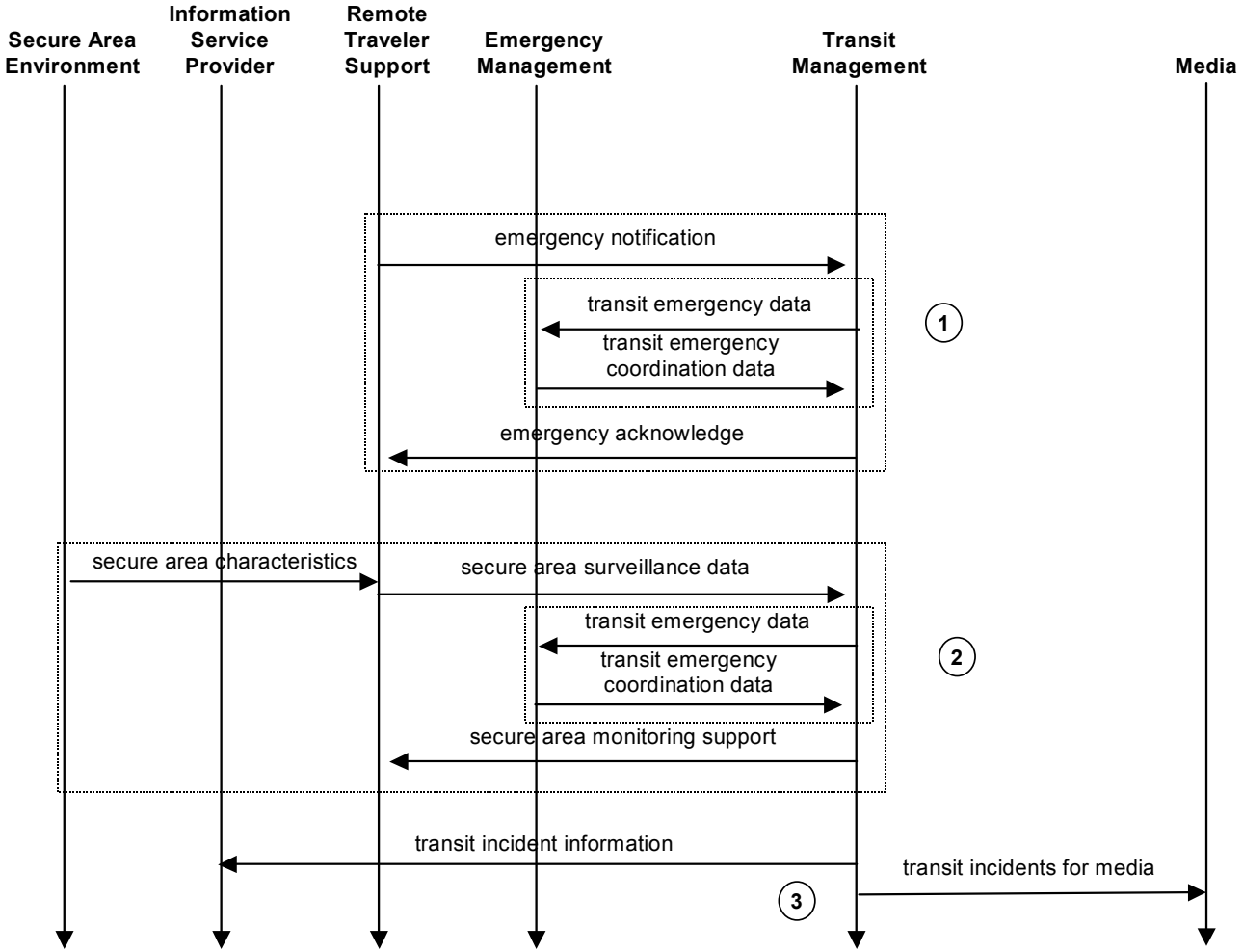
4.5. APTS5: Transit Security

This market package provides for the physical security of transit passengers and transit drivers. Both on-board security systems and security systems for public areas (e.g. stops, park and ride lots, stations) are covered by the market package.

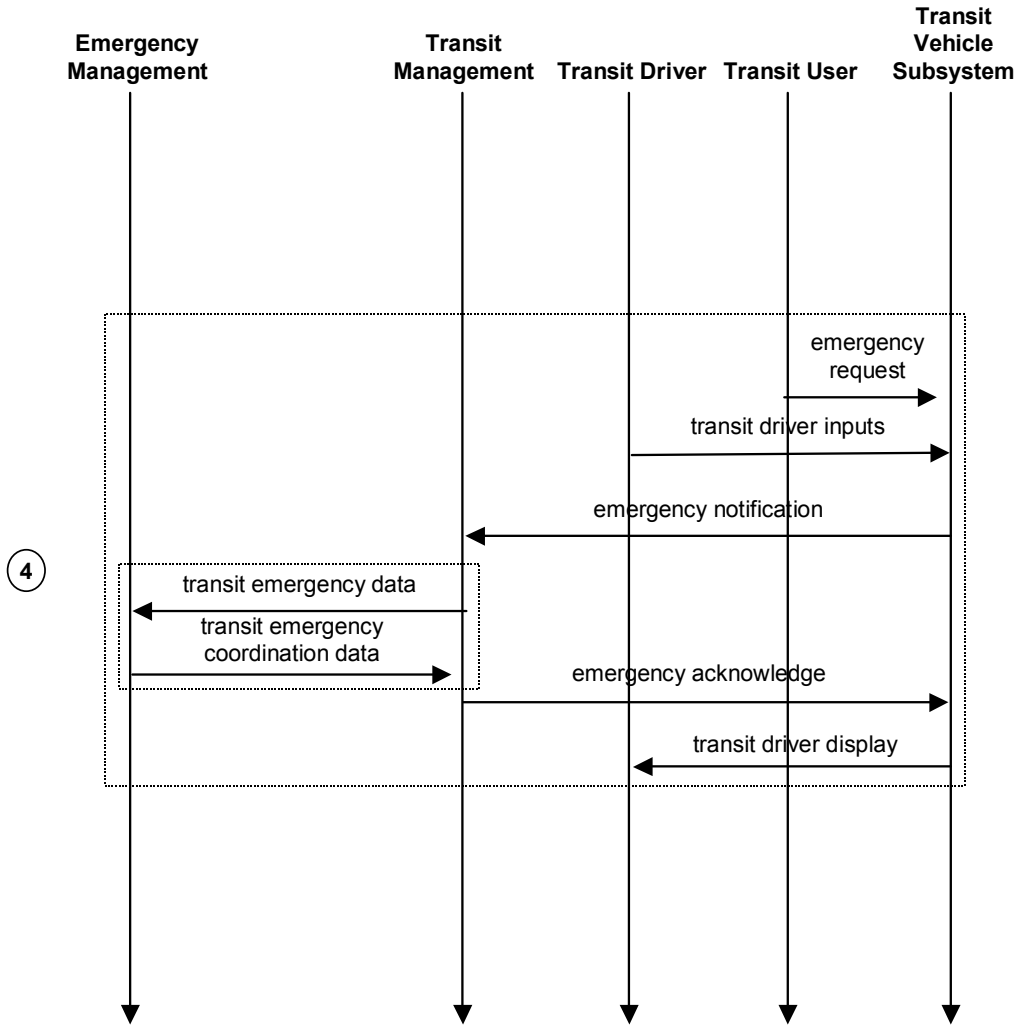
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagrams.

1. A transit user initiates a security alarm 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 *emergency notification* to the Transit Management Subsystem (TRMS). Based upon the emergency information received, the TRMS may contact the Emergency Management Subsystem, EM (transit emergency data) with information on the emergency. The EM responds with *transit emergency coordination data*. Finally, the TRMS provides an *emergency acknowledge* to the RTS, which provides an acknowledgement to the transit user who initiated the request for help.
2. In addition to a user initiated security alarm, the transit public areas may also be under video surveillance (*secure area characteristics*). The video images are sent from the RTS to the TRMS via *secure area surveillance data*. As in the previous set of flows, the TRMS can coordinate with the EM regarding the emergency. The TRMS also sends control the secure area monitoring equipment via the flow *secure area monitoring support*.
3. 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*).
4. A security alarm on-board a transit vehicle is initiated by a transit user (*emergency request*) or by the Transit Driver (a portion of the flow *transit driver inputs*). The emergency notification is sent by the TRVS to the TRMS. The TRMS can then coordinate with the EM as in flow set 1 above. An *emergency acknowledgement* is sent back to the TRVS and then to the Transit Driver (*transit driver display*) and the Transit User.

APTS5: Transit Security (1 of 2)
(Non-mobile Transactions)



APTS5: Transit Security (2 of 2)
(Mobile Transactions)



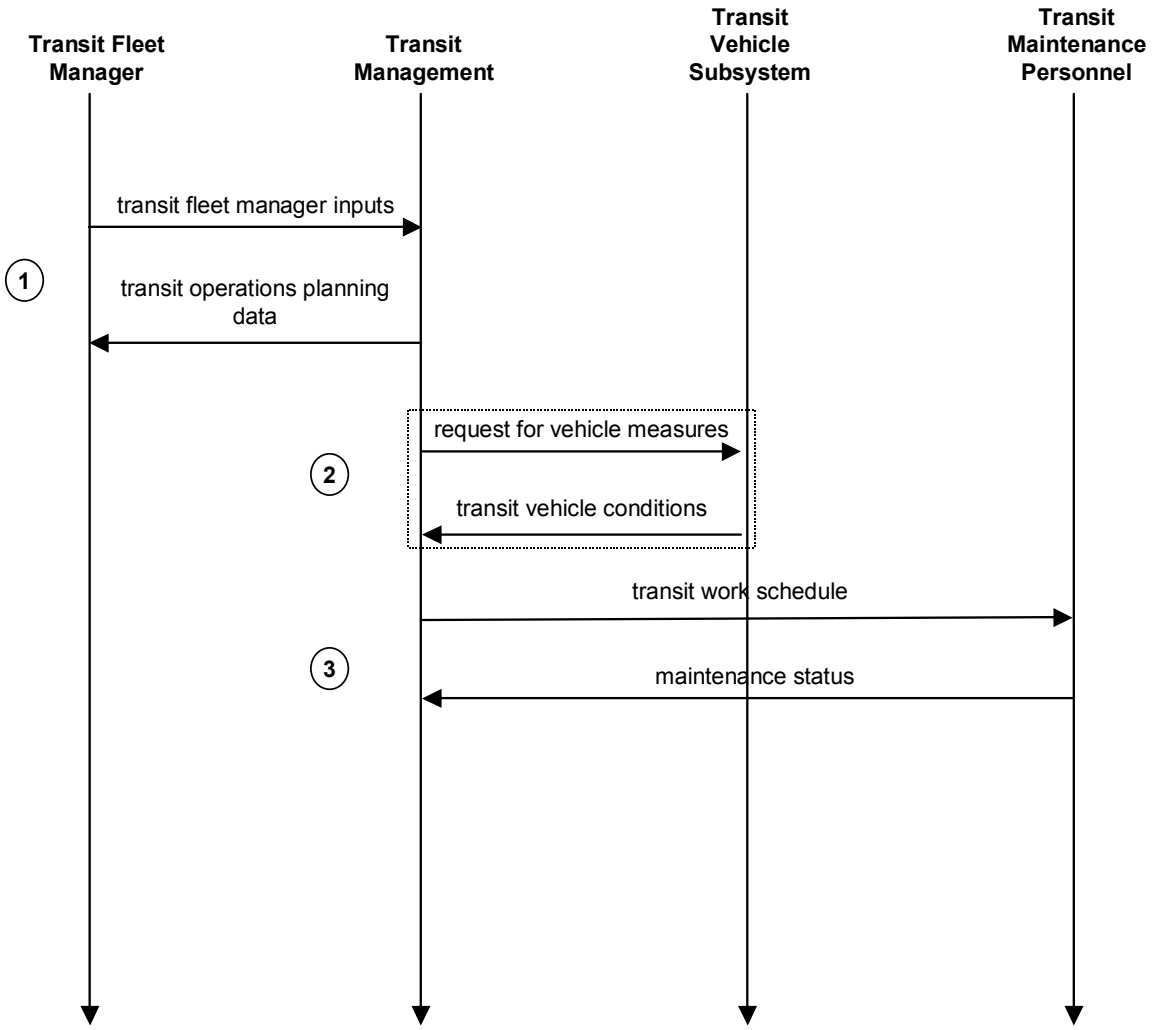
4.6. APTS6: Transit Maintenance

This market package supports automatic transit maintenance scheduling and monitoring.

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

1. The Transit Fleet Manager manages the overall process of transit vehicle maintenance, inputting transit maintenance requirements (*transit fleet manager inputs*) to the Transit Management Subsystem (TRMS). The overall status of vehicle maintenance activities would be presented to the Transit Fleet Manager (as a part of *transit operations planning data*).
2. 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 vehicles measures*). The TRVS responses with data containing vehicle performance and maintenance data collected by onboard sensors (*transit vehicle conditions*).
3. Based on the information received, the TRMS will send to Transit Maintenance Personnel requested maintenance actions (*transit maintenance schedules*), who will return information about the status of vehicle maintenance (*maintenance status*).

APTS6: Transit Maintenance



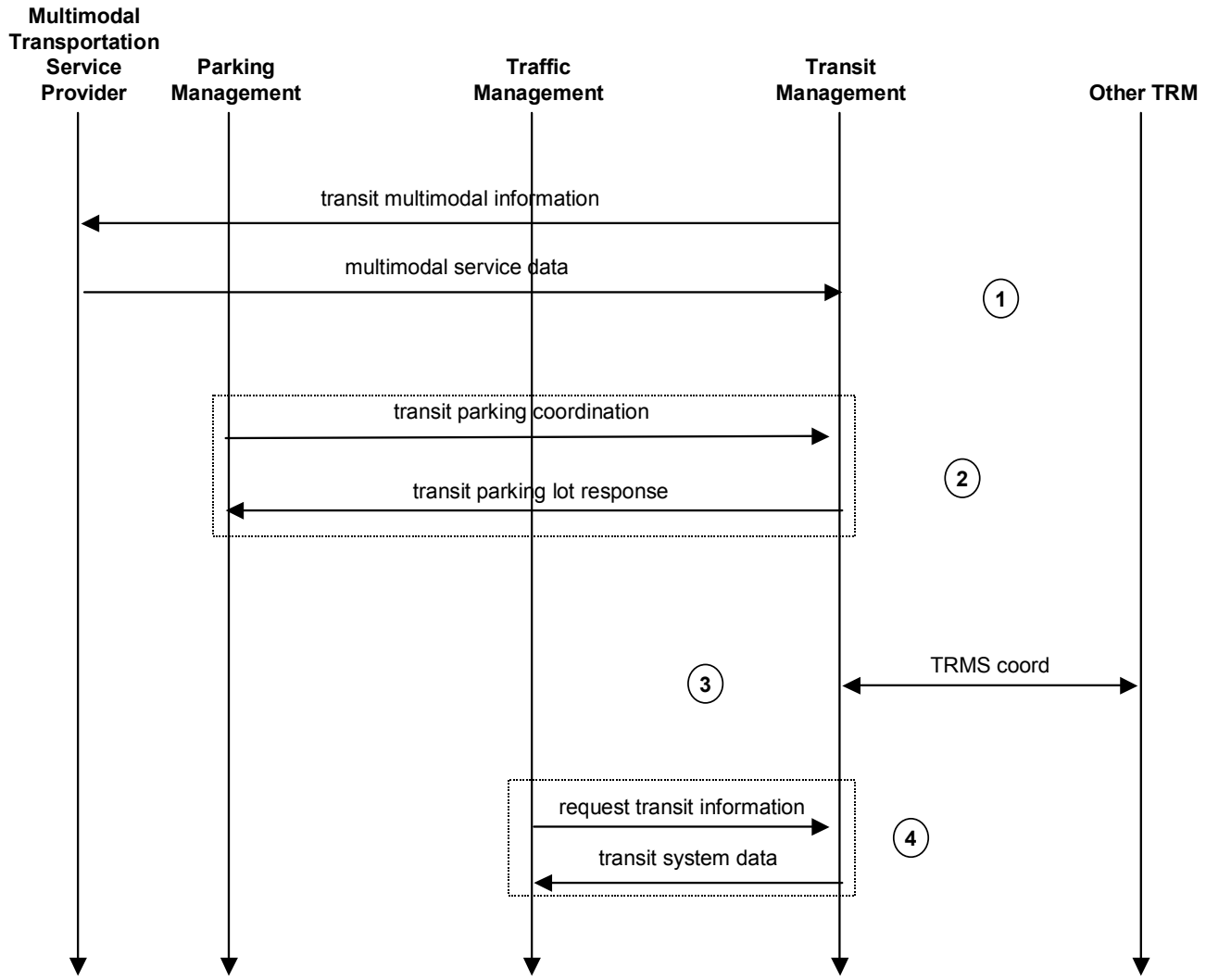
4.7. APTS7: Multimodal Coordination

This market package provides coordination between a Transit Management Subsystem (TRMS) and other transit entities, parking entities or other modes of transportation. It also provides coordination between the TRMS and a Traffic Management Subsystem (TMS).

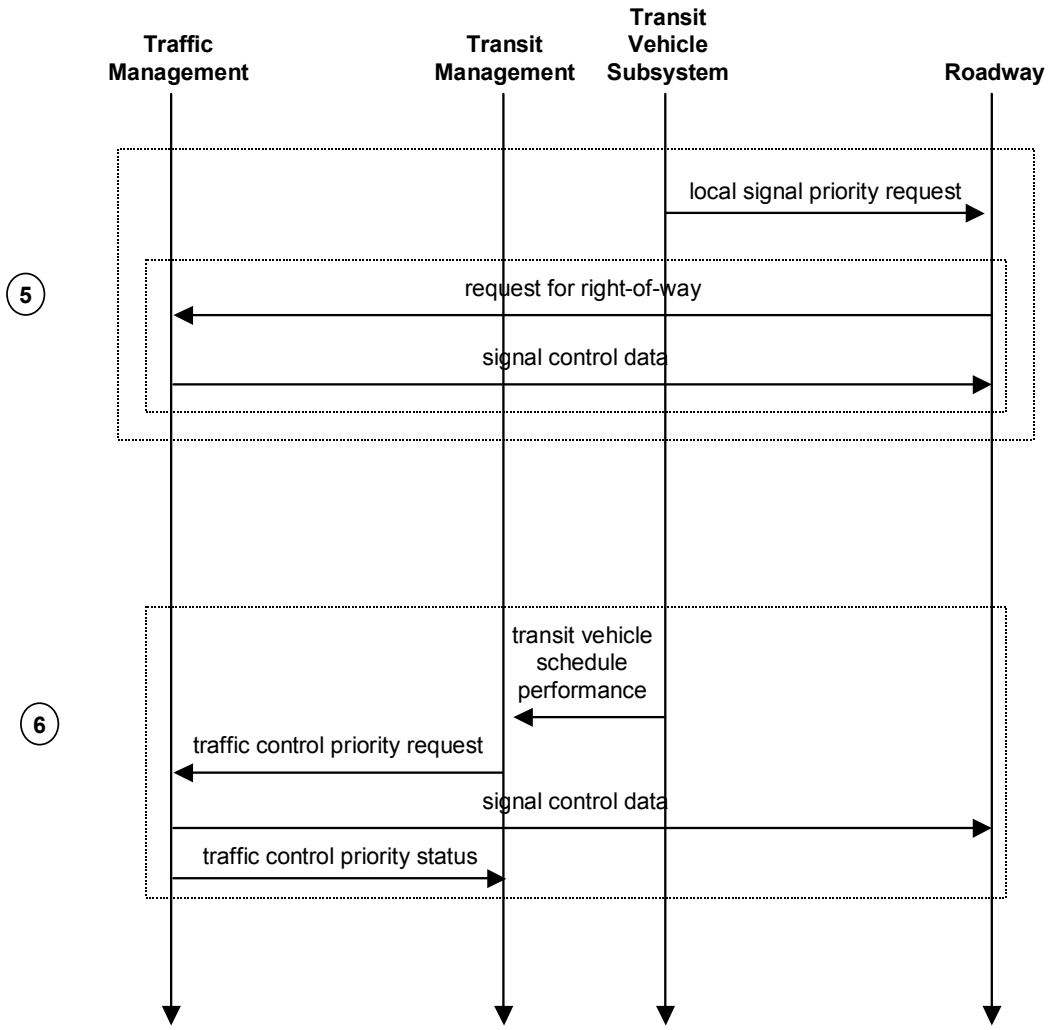
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagrams.

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 Park and Ride Services. The *transit parking coordination* flow from the Parking Management Subsystem to the TRMS contains a request for additional transit services for park and ride lots. The *transit parking lot response* provides the response of TRMS to this request.
3. Another key coordination function is from one transit agency to another, represented in this market package by the *TRMS coord* flow that goes both ways between TRMS and Other TRM. The coordination between agencies might be on schedule, on-time information, incident information, and ridership.
4. Coordination with a TMS takes the form of a *request transit information* 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.
5. The market package describes two concepts for transit vehicle signal priority. In the first the Transit Vehicle Subsystem (TRVS) communicates directly with the Roadway Subsystem to request that priority be given at the approaching intersection (*local signal priority request*). The intersection controller may grant the priority on its own, based upon pre-established criteria and then inform the TMS that priority has been given (in the flow *request for right-of-way*), or the Roadway device may forward the request to the TMS who adjusts the timing of the controller (with the flow *signal control data*).
6. 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*). The TRMS makes the decision to request signal priority from the TMS at one or more intersections upcoming on the route (*traffic control priority request*). The TMS grants the signal priority (*signal control data*) and informs the TRMS of its actions (*traffic control priority status*).

APTS7: Multi-modal Coordination (1 of 2) (Center-to-Center)



APTS7: Multi-modal Coordination (2 of 2) (Signal Priority)



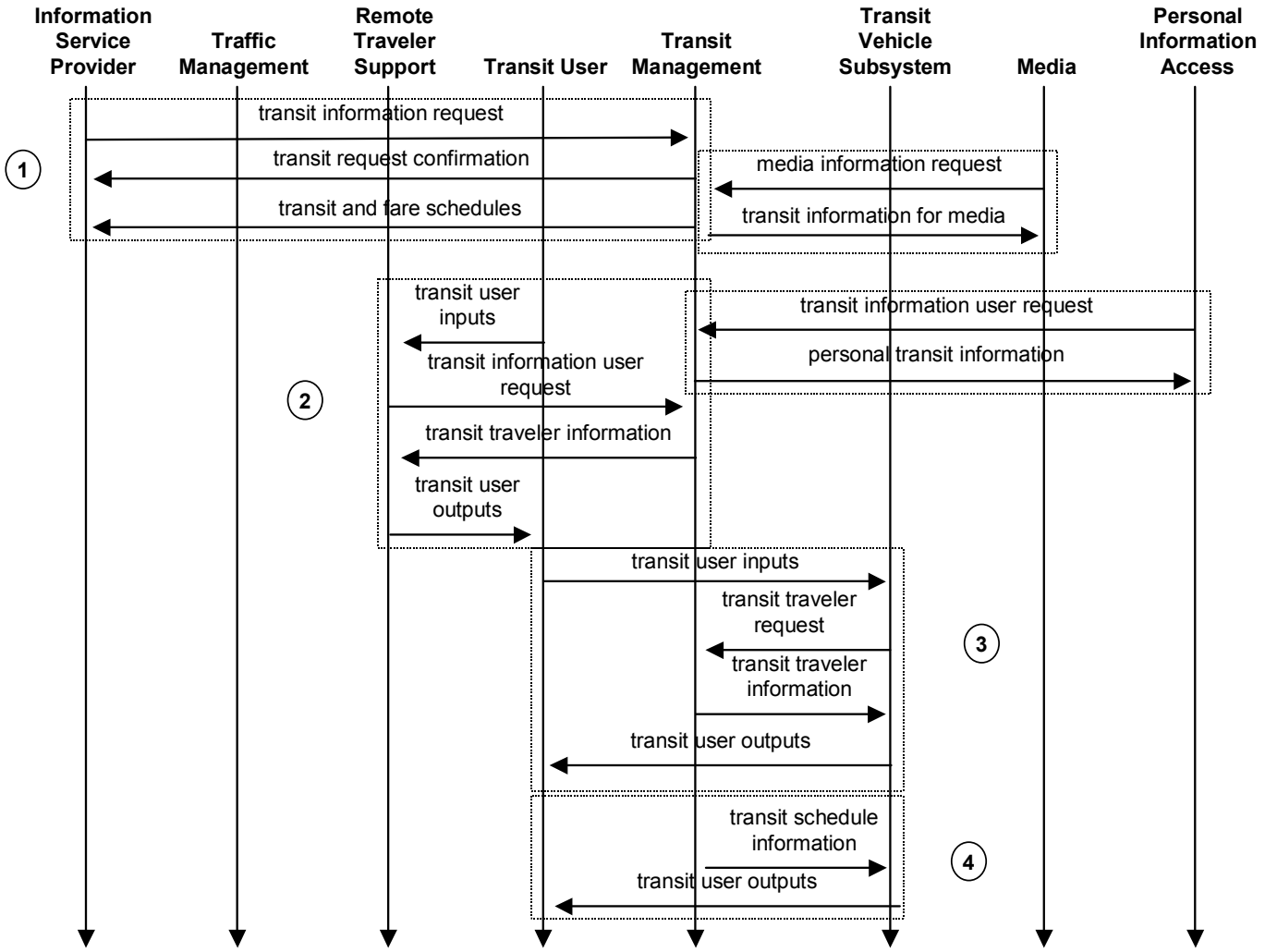
4.8. APTS8: Transit Traveler Information

This market 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 market package.

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

1. The Information Service Provider Subsystem makes a *transit information request* on behalf of its clients. This request could be for general transit schedule and fare updates, specific transit routes for a specific client, or even for the reservation of an advanced service. The Transit Management Subsystem (TRMS) responds with the *transit and fare schedules* and a *transit request confirmation* in the case of an advanced service. The Media also request transit information such as schedule changes or routes where service is behind schedule (*media information request*), which is provided by the TRMS (*transit information for media*).
2. There are two ways for Transit Users to request transit traveler information prior to boarding a transit vehicle. The Transit User can provide inputs (*transit user 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 Transit User (*transit user outputs*). 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 transit center responds with *personal transit information*.
3. On-board a Transit Vehicle Subsystem (TRVS) a Transit User may also provide *transit user 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 Transit User *(transit user outputs*).
4. This market package also supports a simpler operational concept where information is "pushed" to the TRVS by the TRMS (*transit schedule information*) and provided as a broadcast message to the Transit Users as *transit user outputs* (possibly as stop annunciation or message signs within the TRVS).

APTS8: Transit Traveler Information



5. Emergency Management

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

5.1. EM1: Emergency Response

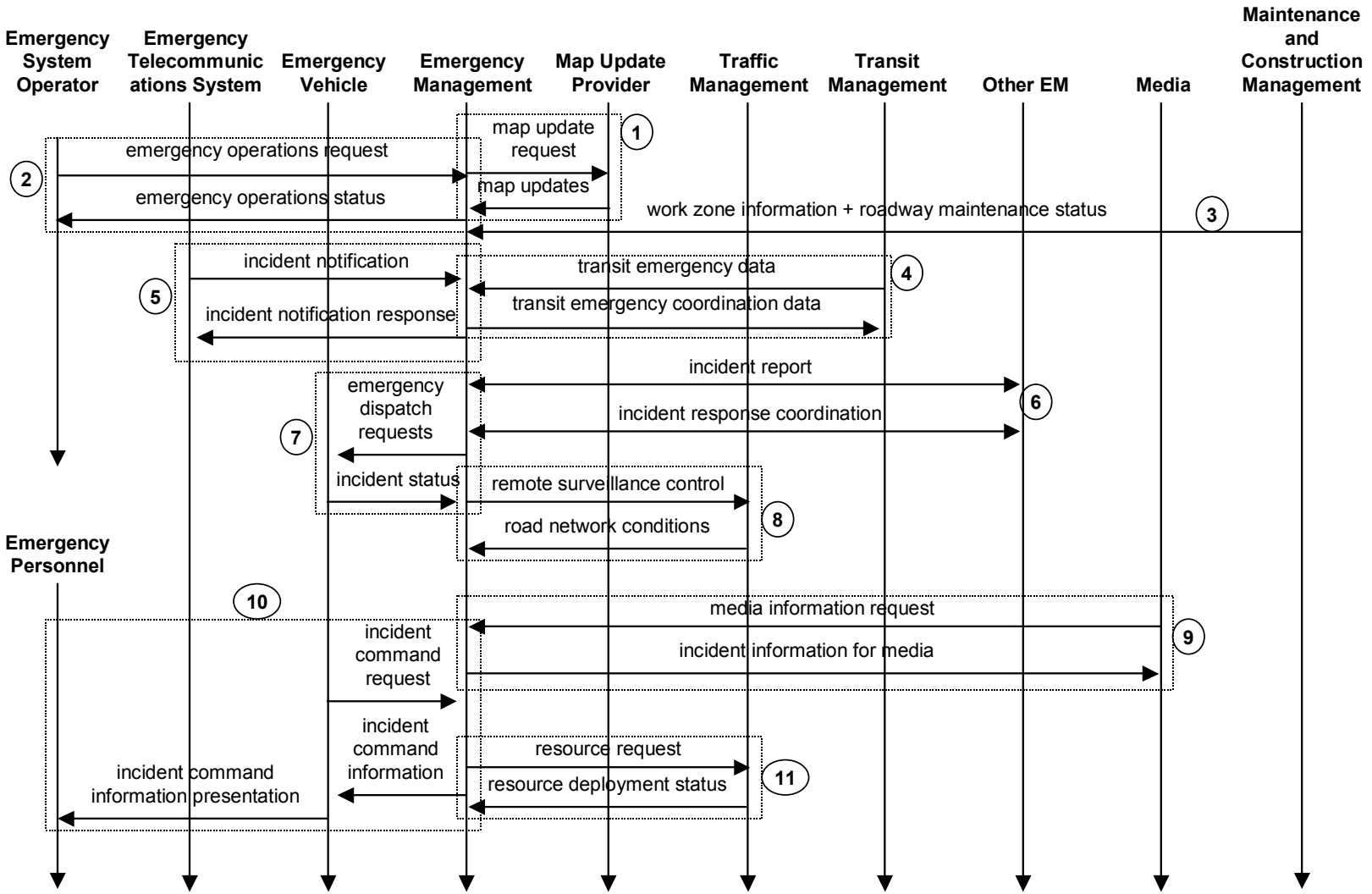
This Market Package models how the Emergency Management subsystem can collect and process information before the occurrence of incidents, and then coordinate resources during the response to an incident.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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. This information can be used later in preparing the emergency dispatch request to Emergency Vehicles.
2. The Emergency System Operator can request and receive Emergency Management Subsystem status.
3. Information from the Maintenance and Construction Management Subsystem about construction and maintenance status on the roadway is collected. This information can be used later in preparing the emergency dispatch request to Emergency Vehicles.
4. Transit Management can notify Emergency Management about incidents associated with the transit system. Transit then receives a message indicating what response may be expected.
5. The Emergency Telecommunications System routes incident notification to the Emergency Management System. This is essentially the data equivalent of a 9-1-1 voice call. A response message is issued.
6. The Emergency Management Subsystem can share incident information with other (peer) Emergency Management subsystems. Also, coordinated responses to incidents can be prepared ("mutual aid").
7. Emergency Vehicles can be dispatched, and the vehicles can report status of incidents from the field.
8. If Traffic Management permits, the Emergency Management subsystem can control the field surveillance equipment associated with a Traffic Management subsystem (e.g. the pan/tilt/zoom of a video camera). Road network conditions can be returned that contains the product of that surveillance.
9. The Emergency Management subsystem can respond to requests (or subscriptions) from the broadcast or print media for incident information.

10. Emergency vehicles in the field can request instructions from their dispatch function at the Emergency Management subsystem, and receive commands in response. This information can be presented to the Emergency Personnel in the field.
11. The Emergency Management subsystem can make requests to the Traffic Management subsystem in support of management of an incident. For example, this could be to deploy/remove cones, or to dispatch equipment to clear debris after an incident.

EM1: Emergency Response



5.2. EM2: Emergency Routing

This Market Package models how the Emergency Management subsystem as well as the Emergency Vehicle can collect and process information before and during the occurrence of incidents, and then coordinate resources during the response to an incident. In particular, coordination of information with Care Facilities (e.g. a hospital emergency room) can be coordinated to improve timeliness and quality of incident patient care.

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

1. The Emergency Management Subsystem can keep its mapping system current by subscribing to a map update service. This information can be used later in preparing a suggested route to Emergency Vehicles.
2. Information from the Maintenance and Construction Management Subsystem about construction and maintenance status and asset restrictions (e.g. dimensional constraints for bridges, tunnels and overhead clearances) on the roadway is collected. This information can be used later in preparing the emergency dispatch request for Emergency Vehicles.
3. The Emergency System Operator can request and receive Emergency Management Subsystem status.
4. An individual Emergency Vehicle can request status from one or more Care Facilities. This information can be used to decide to which Care Facility to bring an incident victim.
5. An Emergency Management subsystem can request status from one or more Care Facilities. This information can be used to decide to which Care Facility to bring an incident victim.
6. En route, an Emergency Vehicle can report its progress delivering a patient to the Care Facility as well as the status of the patient being transported.
7. An Emergency Vehicle can periodically report its actual position to the Emergency Management subsystem dispatch function. Along with current road network conditions collected from the Traffic Management subsystem as well as information collected earlier (see 1 and 2 above), the Emergency Management dispatch function can suggest a best route for the Emergency vehicle to get to a destination. This can be relayed to Emergency Personnel in the Emergency Vehicle who can confirm receipt and whether they are going to follow the suggested route.

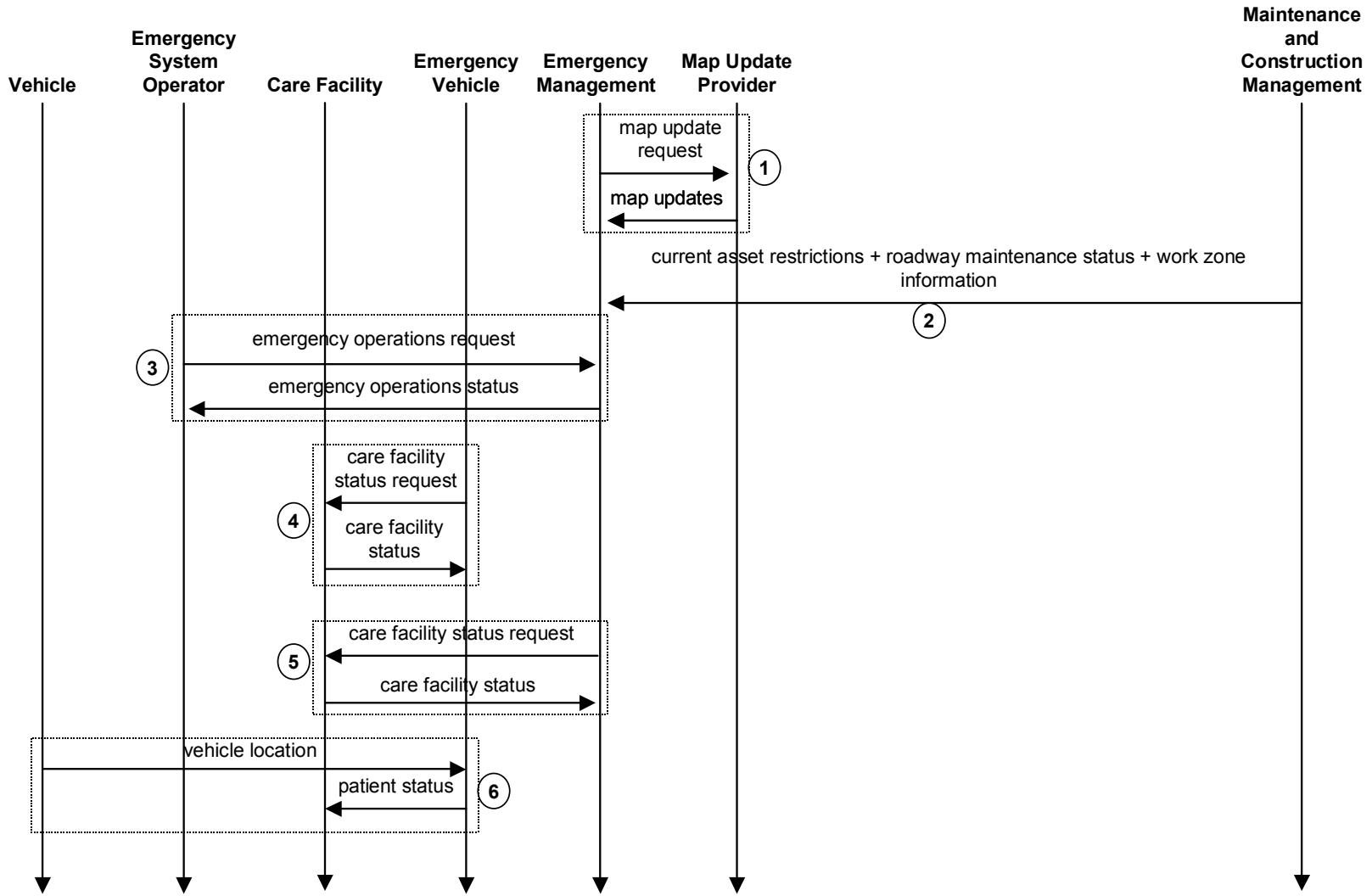
There are two options in the National ITS Architecture for signal preemption to be effected for Emergency Vehicles. The first is Center-to-Center based, and the second is DSRC (Dedicated Short Range Communication) from Emergency Vehicle to Roadway based. Both approaches have their advantages.

8. *Center-To-Center based Signal Preemption*. The Emergency Vehicle subsystem reports its progress to an incident to the Emergency Management subsystem. The Emergency Management subsystem reports the position and expected velocity, possibly including anticipated turning movements that the Emergency Vehicle will follow, to the Traffic

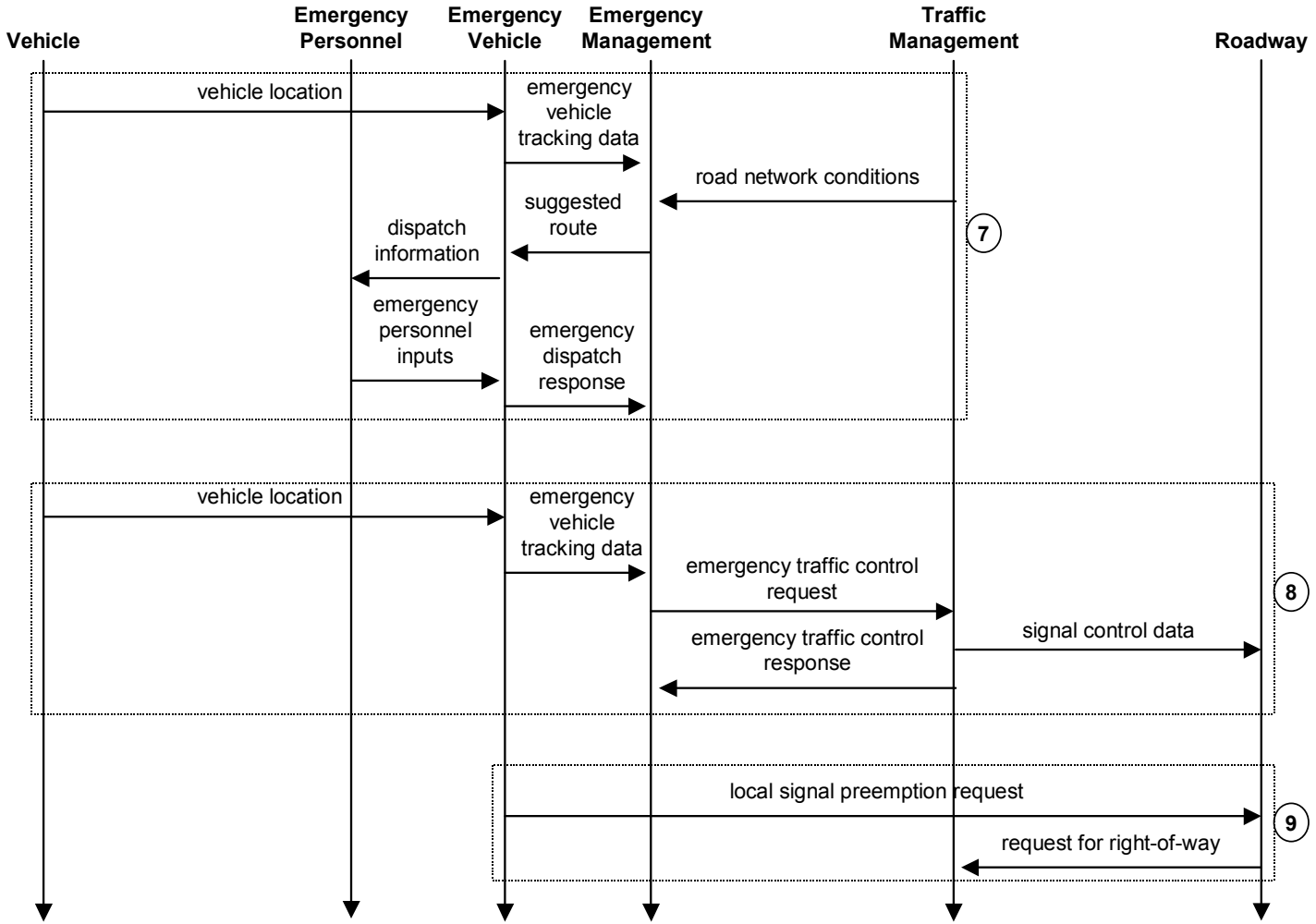
Management subsystem. The Traffic Management subsystem can adjust the signal timing plans to accommodate the Emergency Vehicle by either adjusting the timing so that the Emergency Vehicle has a green signal when it arrives at an intersection, or the intersections can "go flashing red" until the Emergency Vehicle is known to have passed. Traffic Management can notify Emergency Management as to whether they can expect signal preemption or not. 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 install a beacon and communicate directly (DSRC) with Roadway equipment at or near the intersection to preempt the signals as the Emergency Vehicle approaches. The Roadway equipment may optionally notify the Traffic Management subsystem that it has been preempted (request for right-of-way). 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.

EM2: Emergency Routing (1 of 2)
(EM Center Information Collection and Care Facility Coordination)



EM2: Emergency Routing (2 of 2)
(Routing and Signal Preemption)



5.3. EM3: Mayday Support

This Market Package models the ways that an Emergency Management function in a region might receive and acknowledge "Mayday"[1] requests originating from vehicles, Personal Information Access subsystem devices (i.e. portable or fixed personal computers with wireless or wireline connectivity to Emergency Management) or Remote Traveler Support subsystems (i.e. kiosks).

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

1. *Mayday originating from a Driver*. The Driver communicates a request for Mayday service to the Vehicle subsystem, which issues the emergency notification message to the Emergency Management subsystem, which indicates the information from the driver to the Emergency System Operator. The operator indicates an acknowledgment message back the same path to the driver.
2. 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.

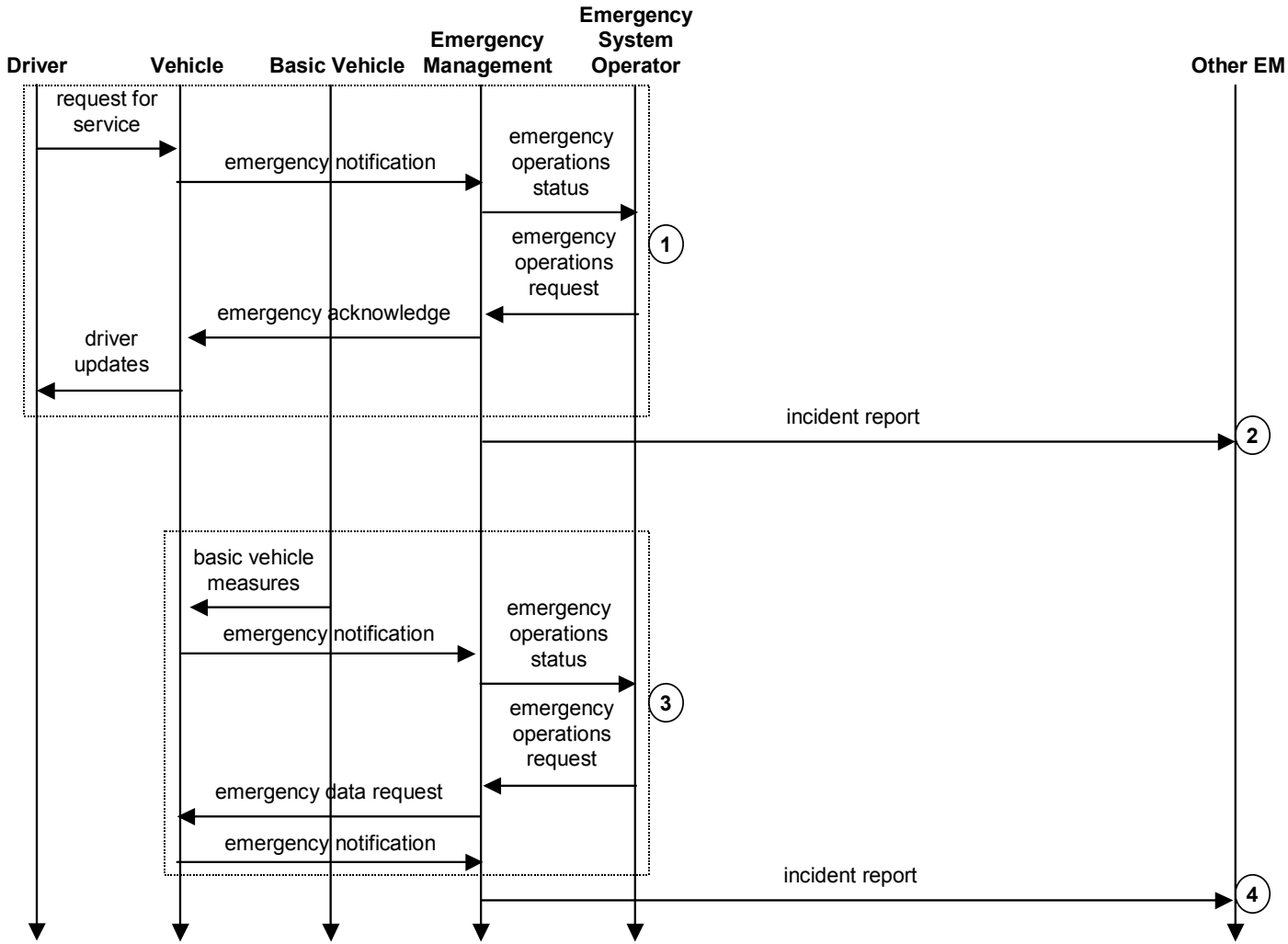
Note that this scenario corresponds roughly to the model of a voice call to a 9-1-1 function, except that in this case all the communication is done with data communications.

3. *Mayday originating from the Vehicle subsystem*. In this case, basic vehicle measures are sent by the Basic Vehicle to the ITS Vehicle subsystem, and based on this information, when an incident condition is detected (e.g. airbag deployment, unusual vehicle attitude, extreme acceleration/deceleration), 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 can be issued to query the vehicle subsystem for any change in incident status.
4. 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.
5. *Mayday originating from a Traveler with a Personal Information Access subsystem (PIAS)*. The Traveler communicates a request for Mayday service to the PIAS, which issues the emergency notification message to the Emergency Management subsystem, which indicates the information from the traveler to the Emergency System Operator. The operator indicates an acknowledgment message back the same path to the traveler.
6. 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.

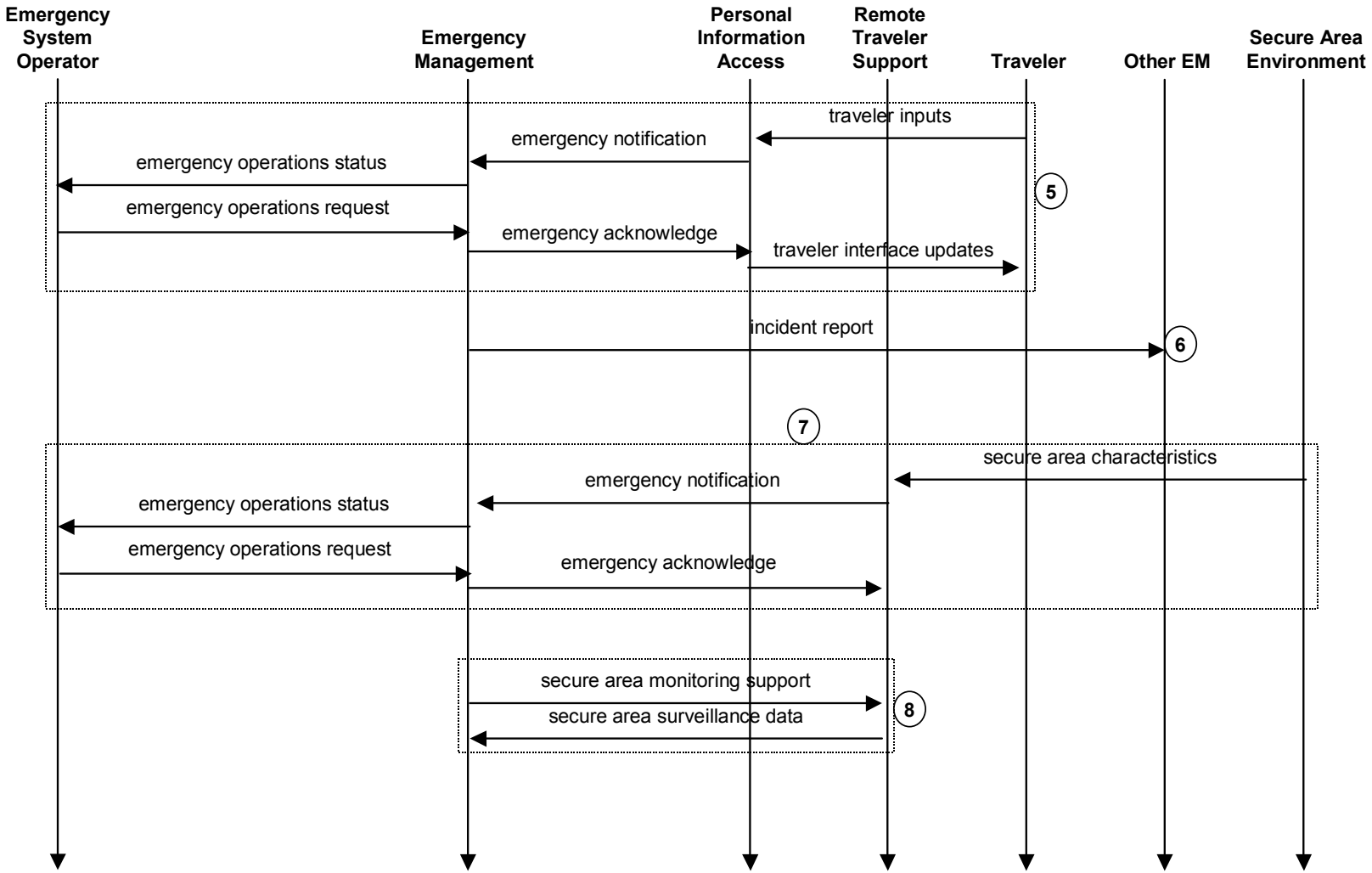
[1] The term "Mayday" has been (freely) adapted by the ITS Community for surface transportation use from its original maritime and aviation use meaning "grave and imminent danger."

7. *Mayday originating from a Remote Traveler Support subsystem (RTS)*. The RTS may sense the environment, and when a "Mayday" condition is detected by the RTS, issues the emergency notification message to the Emergency Management subsystem, which indicates the information from the RTS to the Emergency System Operator. The operator indicates an acknowledgment message back the same path to the RTS for output.
8. The Emergency Management subsystem may control the RTS surveillance equipment (e.g. pan/tilt/zoom for a TV camera) and correspondingly receive secure area surveillance data from the RTS in order to classify or monitor the incident.

EM3: Mayday Support (1 of 2)
(Vehicle Mayday)



EM3: Mayday Support (2 of 2)
(PIAS or RTS Mayday)



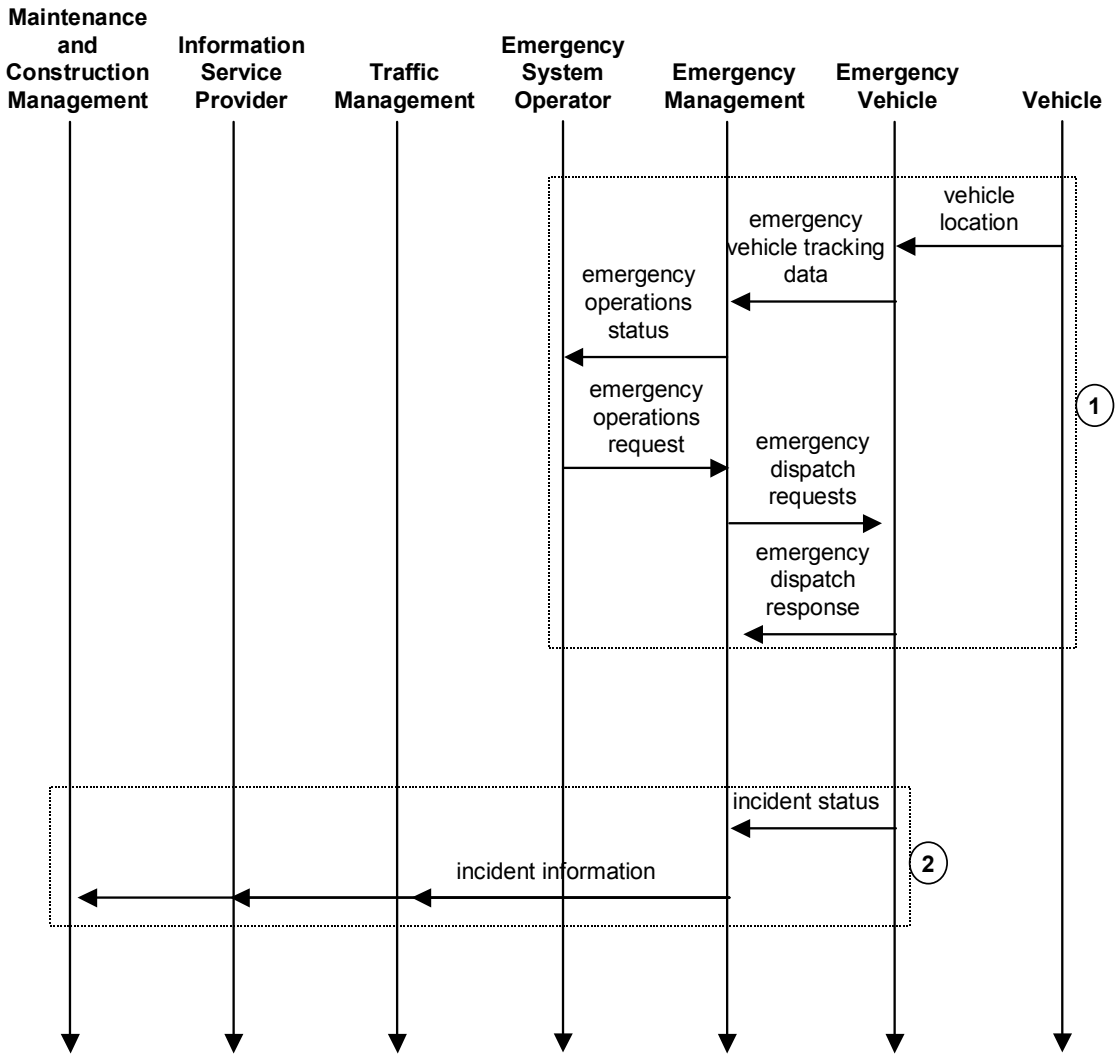
5.4. EM4: Roadway Service Patrols

This market package models the tracking and dispatch of Roadway Service Patrol Vehicles, as well as using their field reports to manage incidents.

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

1. The Emergency Vehicle (i.e. the *service patrol* vehicle) reports its position to the Emergency Management dispatch function, which reports the position of the vehicle (or fleet of operational vehicles) to the Emergency System Operator. When necessary, the Emergency System Operator can send an emergency dispatch request to an appropriate Emergency Vehicle. The dispatched vehicle can acknowledge the dispatch request.
2. At the scene of an incident, an Emergency 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.

EM4: Roadway Service Patrols



6. Commercial Vehicle Operations

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

6.1. CVO01: Fleet Administration

This market package provides the capabilities to manage a fleet of commercial vehicles. The Fleet and Freight Management subsystem would provide the route for a commercial vehicle. 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.

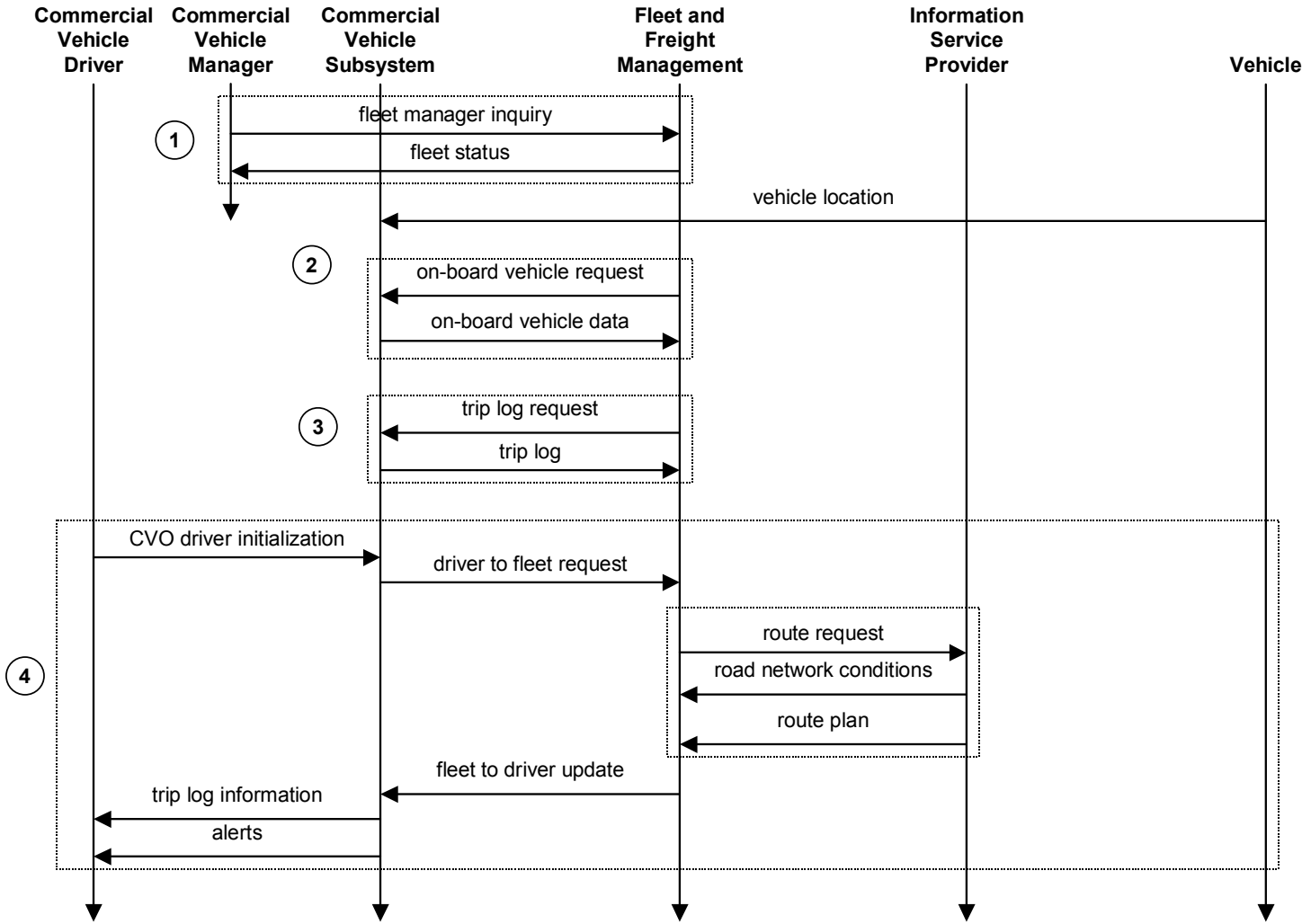
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. The Commercial Vehicle Manager can inquire (*fleet manager inquiry)* from the Fleet and Freight Management Subsystem the status of their fleet (*fleet status*). This status information may include enrollment status, routing information, current vehicle information and emergency information.
2. On an asynchronous basis the Vehicle Subsystem sends vehicle location data to the Commercial Vehicle Subsystem (*vehicle location).* 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. When preparing for a trip, the Commercial Vehicle Driver can setup 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, the Information Service Provider Subsystem generates a route and sends it to the Fleet and Freight Management Subsystem *(route plan)*. The Information Service Provider Subsystem can also provide the Fleet and Freight Management Subsystem with current and forecasted traffic information, which could be used to alter an existing route or be a parameter for the Fleet and Freight Management Subsystem's route generation program (*road network conditions*). The route information, along with any messages or special instructions, is sent to the Commercial

Vehicle Subsystem (*fleet to driver update*). The Commercial Vehicle Driver can receive alerts or messages (*alerts*) or responses to requests to update the trip log (*trip log information*).

CVO01: Fleet Administration



6.2. CVO02: Freight Administration

This market package tracks the movement of cargo and monitors the cargo condition.

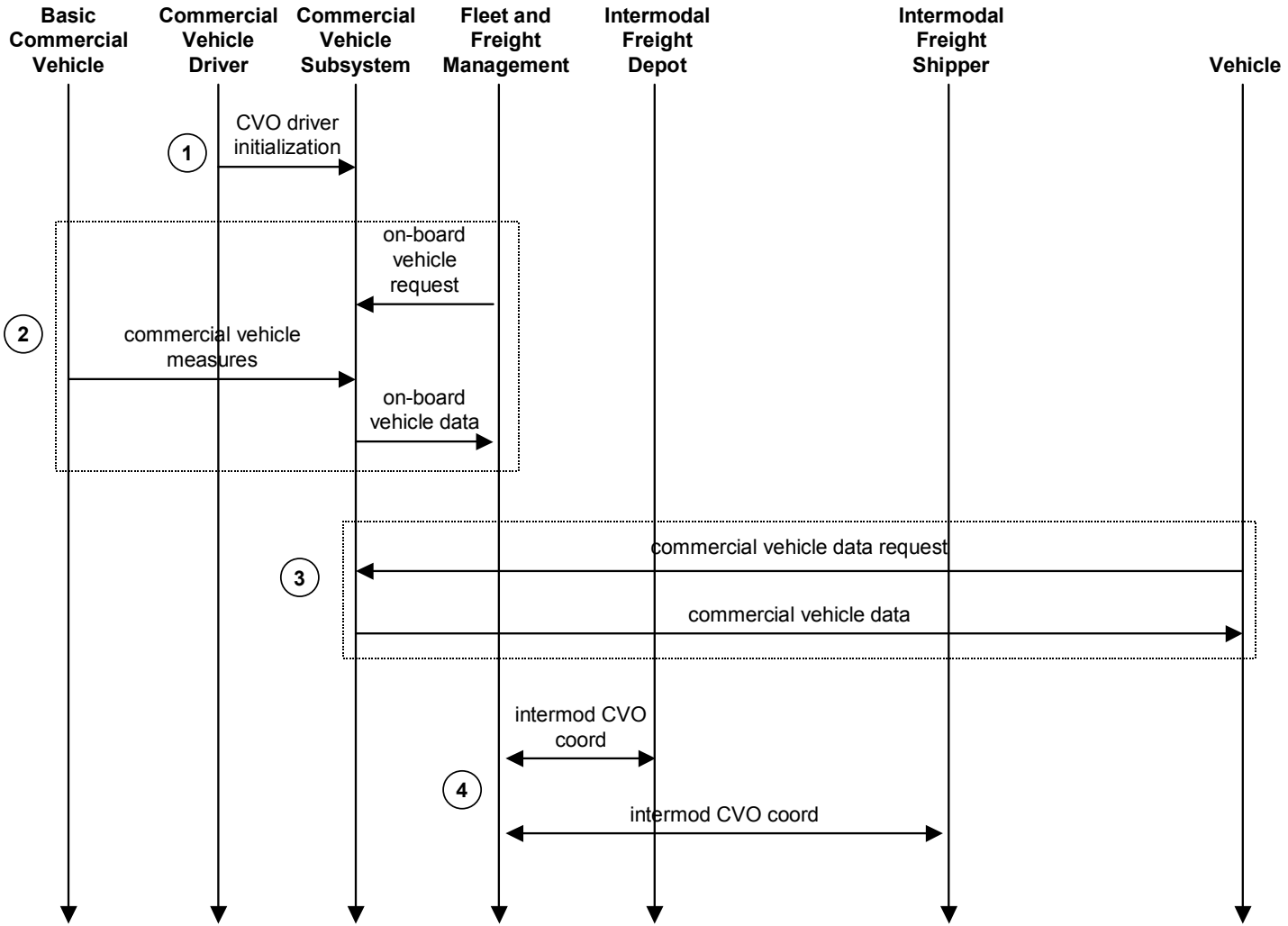
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. On an asynchronous basis, the Commercial Vehicle Driver can send driver and vehicle information to the Commercial Vehicle Subsystem (*CVO driver initialization*).
2. 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 Basic Commercial Vehicle (*commercial vehicle measures*) and forward the information to the Fleet and Freight Management Subsystem (*on-board vehicle data*).

3. Cargo information can be requested from the Commercial Vehicle Subsystem by the Vehicle Subsystem (*commercial vehicle data request*). The Vehicle Subsystem must obtain cargo information due to the fact that all Mayday support functions within the National ITS Architecture have been assigned to the Vehicle Subsystem. The Commercial Vehicle Subsystem will forward the cargo data to the Vehicle Subsystem (*commercial vehicle data*).

4. On an asynchronous basis, the Intermodal Freight Shipper and Intermodal Freight Depot can exchange information regarding cargo movement logs, routing information, and cargo ID's with the Fleet and Freight Management Subsystem (*intermod CVO coord*).

CVO02: Freight Administration



6.3. CVO03: Electronic Clearance

This market package provides for automated clearance at roadside check facilities. One goal of this market package is to allow good drivers and carriers to pass roadside check facilities at mainline speeds.

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

1. The Commercial Vehicle Administration Subsystem maintains the necessary credentials data in support of electronic clearance. The Commercial Vehicle Administration Subsystem can communicate with the Other CVAS in different jurisdictions to exchange credentials information (*credentials information*). The Commercial Vehicle Administration Subsystem will send the credentials information to the Commercial Vehicle Check Subsystem (*credentials information*).

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 (*credentials status information*) with other jurisdictions. The Commercial Vehicle Administration Subsystem will send the credentials status information to the Commercial Vehicle Check Subsystem (*credentials status information*).

3. The Commercial Vehicle Administration Subsystem maintains the necessary safety data in support of electronic clearance. The Commercial Vehicle Administration Subsystem can communicate with the Other CVAS to exchange safety information (*safety status information*) with other jurisdictions. The Commercial Vehicle Administration Subsystem will send the safety information to the Commercial Vehicle Check Subsystem (*safety status information*). On an asynchronous basis, the Commercial Vehicle Check Subsystem will receive information on violators from the Enforcement Agency (*information on violators*). Also on an asynchronous basis, the Commercial Vehicle Driver will send vehicle and driver information to the Commercial Vehicle Subsystem (*CVO driver initialization*).

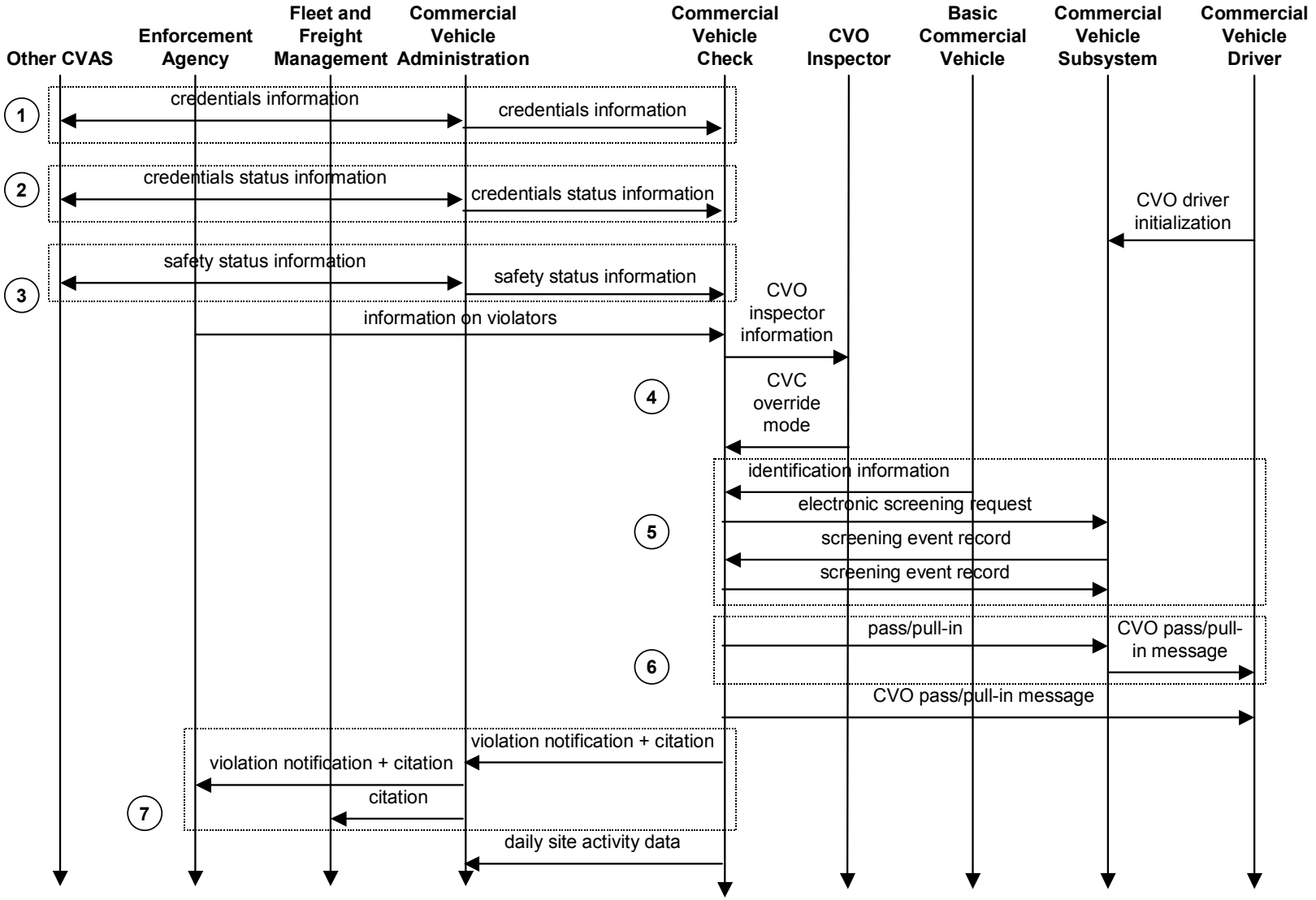
4. The entire screening process is under the asynchronous monitoring (*CVO inspector information*) and control (*CVC override mode*) of the CVO Inspector.

5. The Commercial Vehicle Check Subsystem 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, the Commercial Vehicle Check Subsystem can request identification information from the tag contained in the Commercial Vehicle Subsystem (*electronic screening request*). The Commercial Vehicle Subsystem will send the stored screening data to the Commercial Vehicle Check Subsystem (*screening event record*). Results of the screening process can be sent to the Commercial Vehicle Subsystem (*screening event record*) for future activities.

6. After analyzing the safety and credentials data, the Commercial Vehicle Check Subsystem makes a pass or pull-in decision. 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*) by using a roadside sign.

7. Violation or citations information can be distributed to the proper authorities after a screening event. The Commercial Vehicle Check Subsystem can send this information to the Commercial Vehicle Administration Subsystem (*violation notification, citation).* The Commercial Vehicle Administration Subsystem can forward the information to the Enforcement Agency (*violation notification, citation*) or to the Fleet and Freight Management Subsystem (*citation*). On an asynchronous basis, the Commercial Vehicle Check Subsystem can send a record of daily activities at commercial vehicle check stations including summaries of screening events and inspections to the Commercial Vehicle Administration Subsystem (*daily site activity data*).

CVO03: Electronic Clearance



6.4. CVO04: CV Administrative Processes

This market package provides for electronic application, processing, fee collection, issuance, and distribution of CVO credential and tax filing.

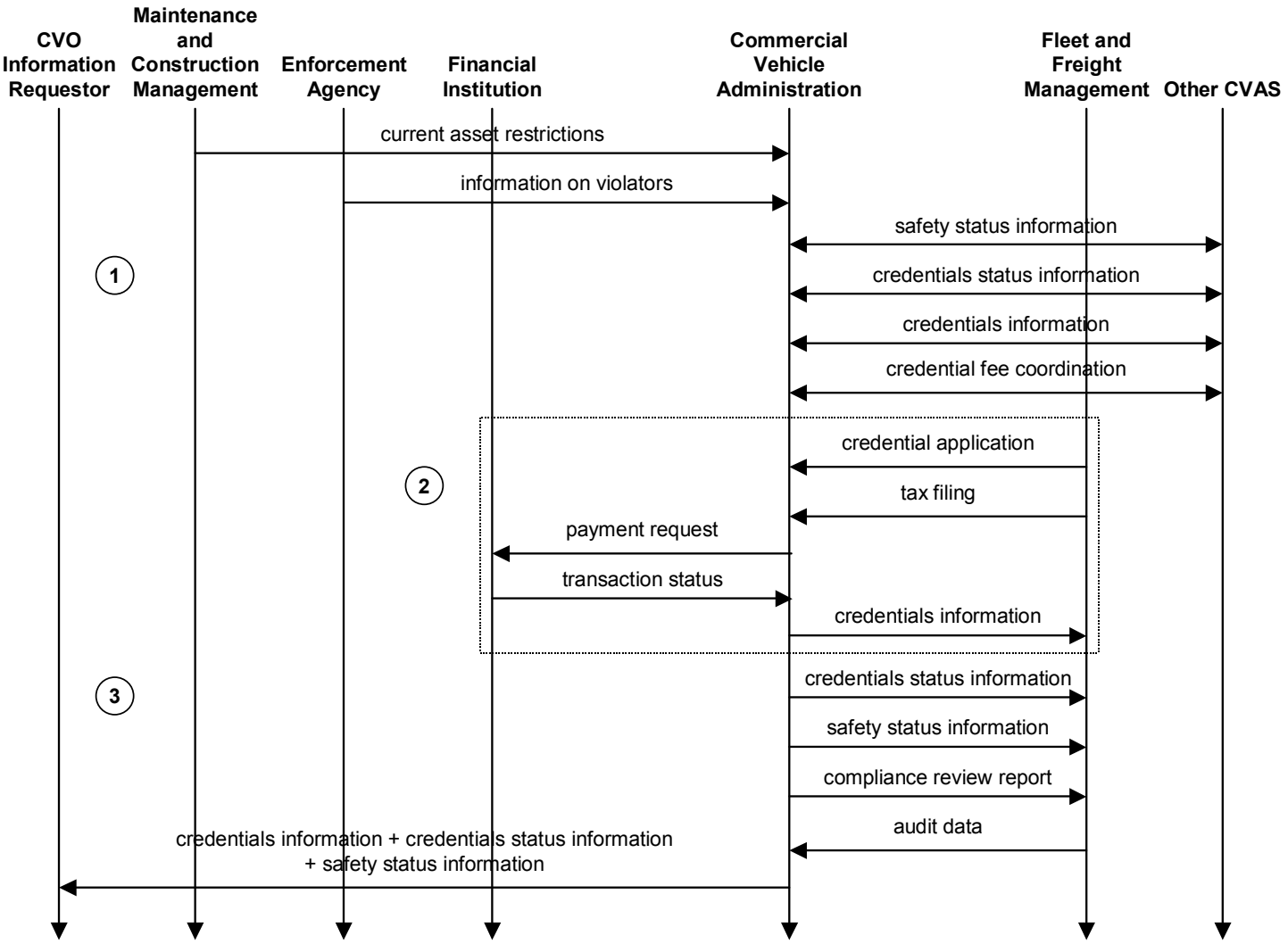
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. Before a credentials application is received, the Commercial Vehicle Administration Subsystem can collect the necessary information used in support of the approval process. On an asynchronous basis, the Commercial Vehicle Administration Subsystem 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 Commercial Vehicle Administration Subsystem can receive information about commercial vehicle violations from the Enforcement Agency (information on violators). The Commercial Vehicle Administration Subsystem 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).

2. The Fleet and Freight Management Subsystem can send a credential application to the Commercial Vehicle Administration Subsystem (*credential application*). The Commercial Vehicle Administration Subsystem will use the information obtained in item 1 above as a basis for granting CVO credentials and determining associated fees and taxes. After the Commercial Vehicle Administration Subsystem receives authorization to pay all taxes and fees from the Fleet and Freight Management Subsystem (*tax filing*), the Commercial Vehicle Administration Subsystem will request payment from the Financial Institution (*payment request)*. The Financial Institution will provide a payment status the Commercial Vehicle Administration Subsystem (*transaction status)*. The Fleet and Freight Management Subsystem will be notified when the process is complete (*credentials information*).

3. On an asynchronous basis, the Commercial Vehicle Administration Subsystem can send credentials data (*credentials status information*) and safety data (*safety status information*) to the Fleet and Freight Management Subsystem. The Commercial Vehicle Administration Subsystem can also send the Fleet and Freight Management Subsystem a compliance report, which contains the results of carrier compliance review (*compliance review report*). The Fleet and Freight Management Subsystem can send the Commercial Vehicle Administration Subsystem information to support a tax audit when necessary (*audit data*). There are occasions when a CVO Information Requester (e.g. insurance company) can receive credentials data (*credentials information, credentials status information*) and safety data (*safety status information*).

CVO04: CV Administrative Processes



6.5. CVO05: International Border Electronic Clearance

This market package provides for automated clearance at international border crossings.

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

1. On an asynchronous basis, the Commercial Vehicle Administration Subsystem can exchange credentials information (*credentials status information*) and safety information (*safety status information*) with the Other CVAS, which may represent non-U.S. commercial vehicle operation authorities (Mexico and Canada).

2. On an asynchronous basis, the Commercial Vehicle Administration Subsystem can exchange trade transportation activity data with the Trade Regulatory Agencies (*domestic transportation information*).

3. The Commercial Vehicle Administration Subsystem is notified of a pending commercial freight shipment into the U.S. by the Trade Regulatory Agencies (*declaration information*). The Commercial Vehicle Administration Subsystem will analyze the available trade data and make a decision regarding the granting of permission for the freight shipment and pass the results to the Commercial Vehicle Check Subsystem (*border agency clearance results*). Specific identifiers, including carrier, vehicle, and driver identification data, are extracted from the declaration information and forwarded to the Commercial Vehicle Check Subsystem (*trip declaration identifiers*).

4. As part of the analysis, the Commercial Vehicle Administration Subsystem generates a transportation assessment, which is sent to the Commercial Vehicle Check Subsystem (*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, the Commercial Vehicle Administration Subsystem can send a copy of the transportation assessment to the Trade Regulatory Agencies (*transportation border clearance assessment*).

5. At the start of each trip, a unique load number is to be loaded into the Commercial Vehicle Subsystem by the Fleet and Freight Management Subsystem, Commercial Vehicle Driver or Intermodal Freight Shipper (*trip identification number*).

6. On an asynchronous basis, the Commercial Vehicle Check Subsystem 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 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*).

7. The Commercial Vehicle Check Subsystem can request border crossing data from the Commercial Vehicle Subsystem (*border clearance data request*). The Commercial Vehicle Subsystem 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 Commercial Vehicle Subsystem at the end of the border clearance process (*border clearance event*).

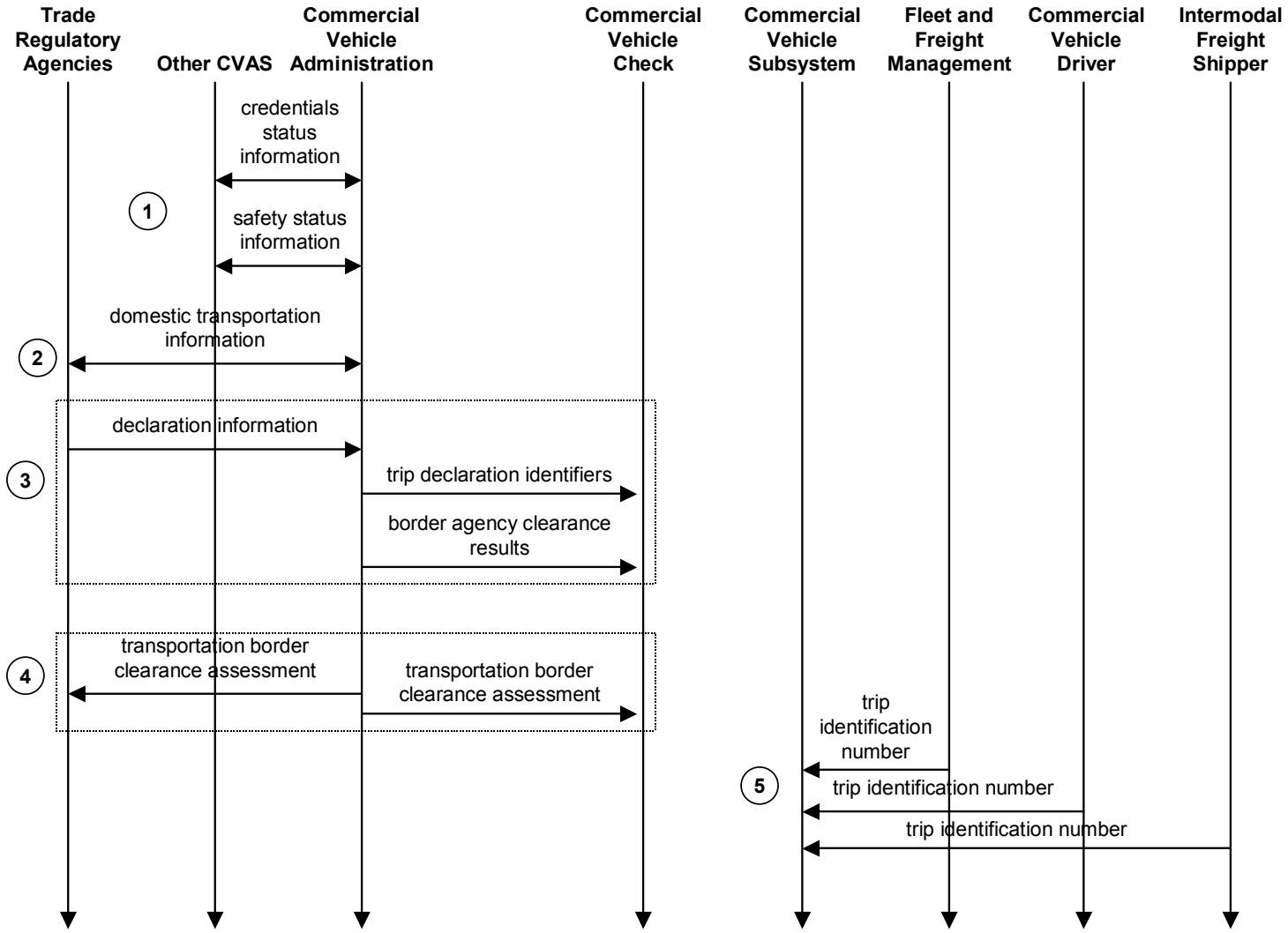
8. The Commercial Vehicle Check Subsystem can request data regarding presence and status of electronic cargo locks (*electronic lock data request*). If present, the Commercial Vehicle Subsystem will respond with presence and status of the cargo locks (*electronic lock data*).

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.

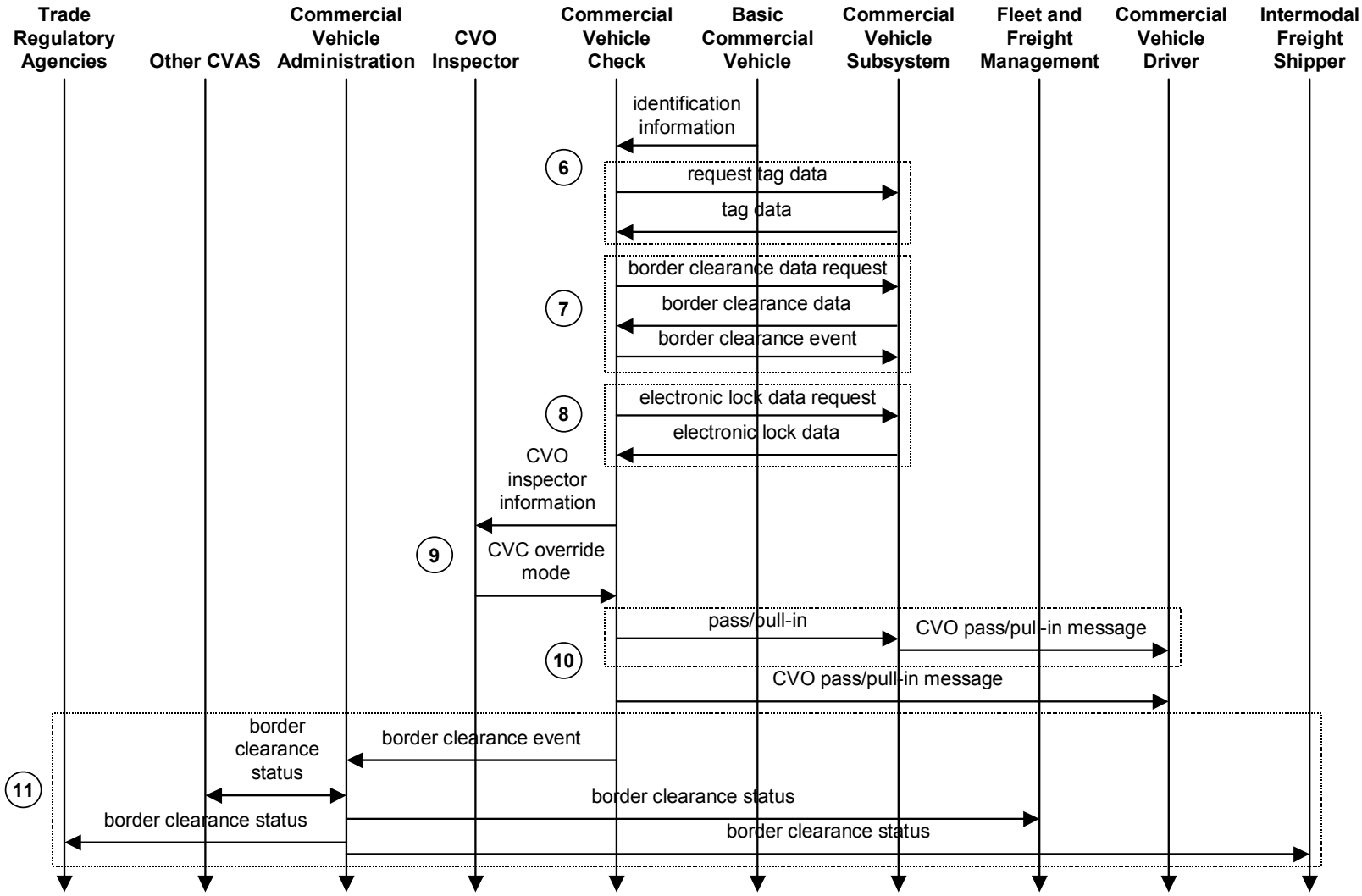
10. The pass/pull-in decision can be sent from the Commercial Vehicle Check subsystem to the Commercial Vehicle Subsystem (*pass/pull-in*), which is forwarded to the Commercial Vehicle Driver (*CVO pass/pull-in message*). Alternately it can be sent directly to the Commercial Vehicle Driver from the Commercial Vehicle Check Subsystem using a roadside sign (*CVO pass/pull-in message*).

11. Clearance event data 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 to the Commercial Vehicle Administration Subsystem (*border clearance event*). The Commercial Vehicle Administration Subsystem can forward the report to the Trade Regulatory Agencies, Fleet and Freight Management Subsystem and Intermodal Freight Shipper as well as exchange the information with the (*border clearance status*).

CVO05: International Border Electronic Clearance (1 of 2) (Pre-Clearance)



CVO05: International Border Electronic Clearance (2 of 2) (Clearance and Post Clearance)



6.6. CVO06: Weigh-In-Motion

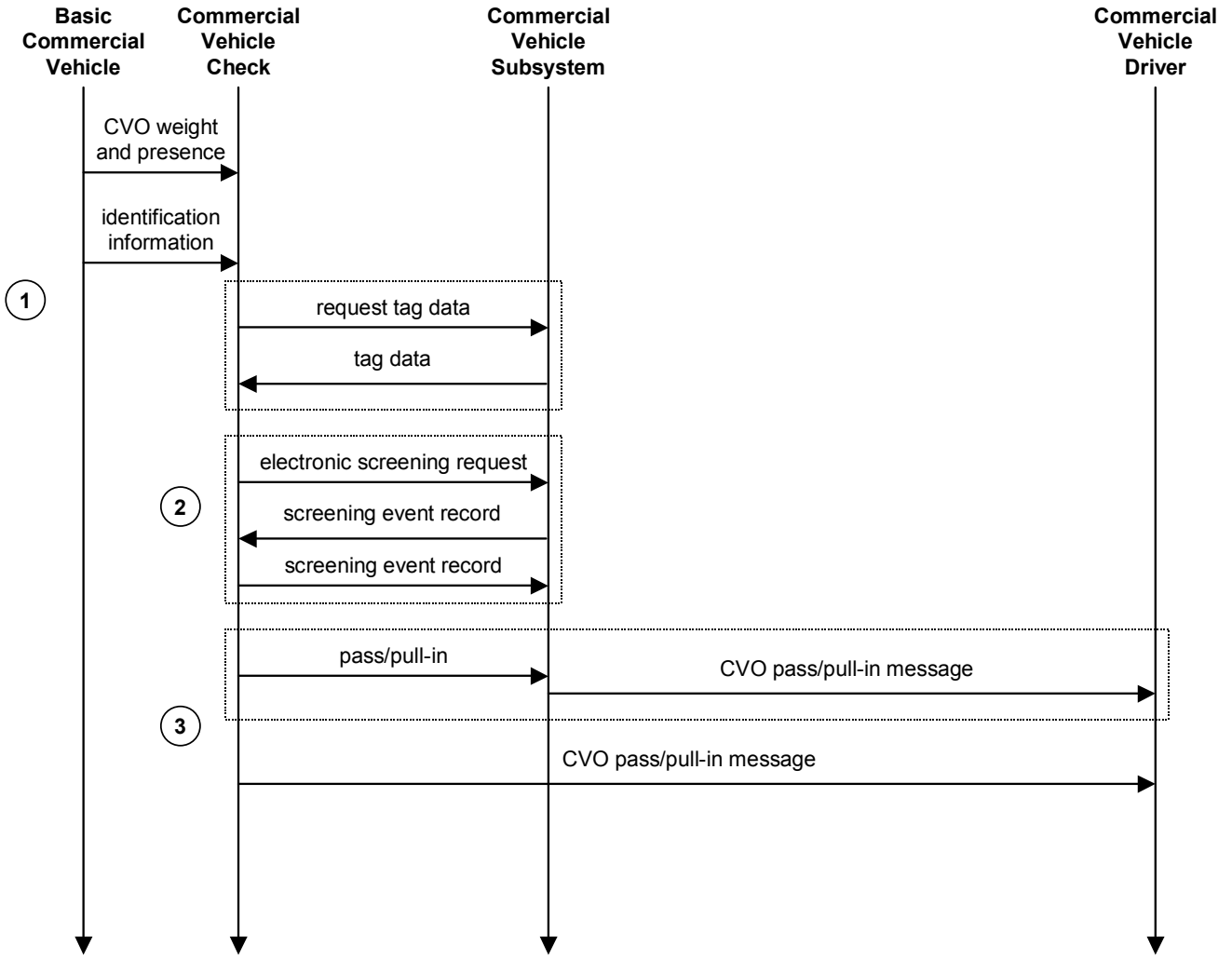
This market package provides for high speed weigh-in-motion with or without Automated Vehicle Identification (AVI) capabilities. This market package provides the roadside equipment that could be used as a stand-alone system or to augment the Electronic Clearance (CVO03) market package.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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 market package provides for automated roadside safety monitoring and reporting. It automates commercial vehicle safety inspections at the roadside check facilities.

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

1. The Commercial Vehicle Administration Subsystem maintains the required safety reports in support of a roadside safety inspection. The Commercial Vehicle Administration Subsystem can communicate with the Other CVAS to exchange safety inspection reports (*safety inspection report*) with other jurisdictions. The Commercial Vehicle Administration Subsystem will send the safety inspection report to the Commercial Vehicle Check Subsystem (*safety inspection report*). On an asynchronous basis, the Enforcement Agency can provide the Commercial Vehicle Check Subsystem with information about commercial vehicle violations (*information on violators*).
2. The Commercial Vehicle Administration Subsystem maintains the required safety status, the safety portion of the CVISN "snapshot", in support of a roadside safety inspection. The Commercial Vehicle Administration Subsystem can communicate with the Other CVAS to exchange safety status data (*safety status information*) with other jurisdictions. The Commercial Vehicle Administration Subsystem will send safety status data to the Commercial Vehicle Check Subsystem (*safety status information*).
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 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*) as well as the vehicle characteristics (size, number of axles, use of trailer, etc.) (*CVO weight and presence*). Alternately the Commercial Vehicle Check Subsystem can request safety information from the tag contained in the Commercial Vehicle Subsystem (*safety inspection request*). The Commercial Vehicle Subsystem will respond with the inspection data stored in the tag (*safety inspection record*). At the end of the inspection, the Commercial Vehicle Check Subsystem can send the results to the Commercial Vehicle Subsystem (*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.

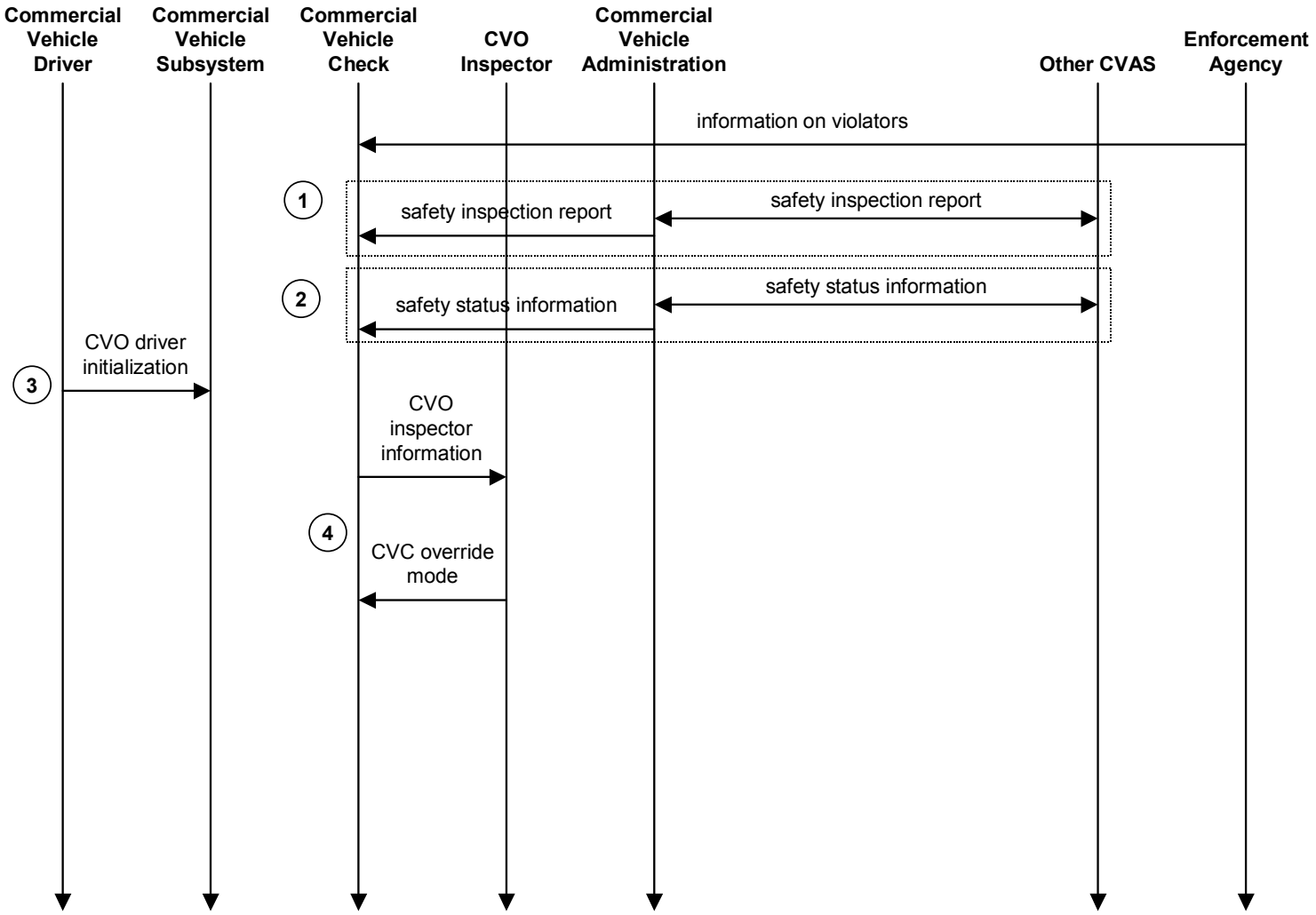
7. If the commercial vehicle was pulled-in for inspection, the CVO Inspector can perform a safety inspection and send the results to the Commercial Vehicle Check Subsystem (*CVO inspector input*). After the safety inspection, the Commercial Vehicle Check Subsystem can send the report to the Commercial Vehicle Administration Subsystem (*safety inspection report*), which can be sent to the Fleet and Freight Management Subsystem (*safety inspection report*).

8. If any statutes or regulations were violated, the Commercial Vehicle Check Subsystem can send information on violators to the Commercial Vehicle Administration Subsystem (*violation notification*), which will be forwarded to the Enforcement Agency (*violation notification*).

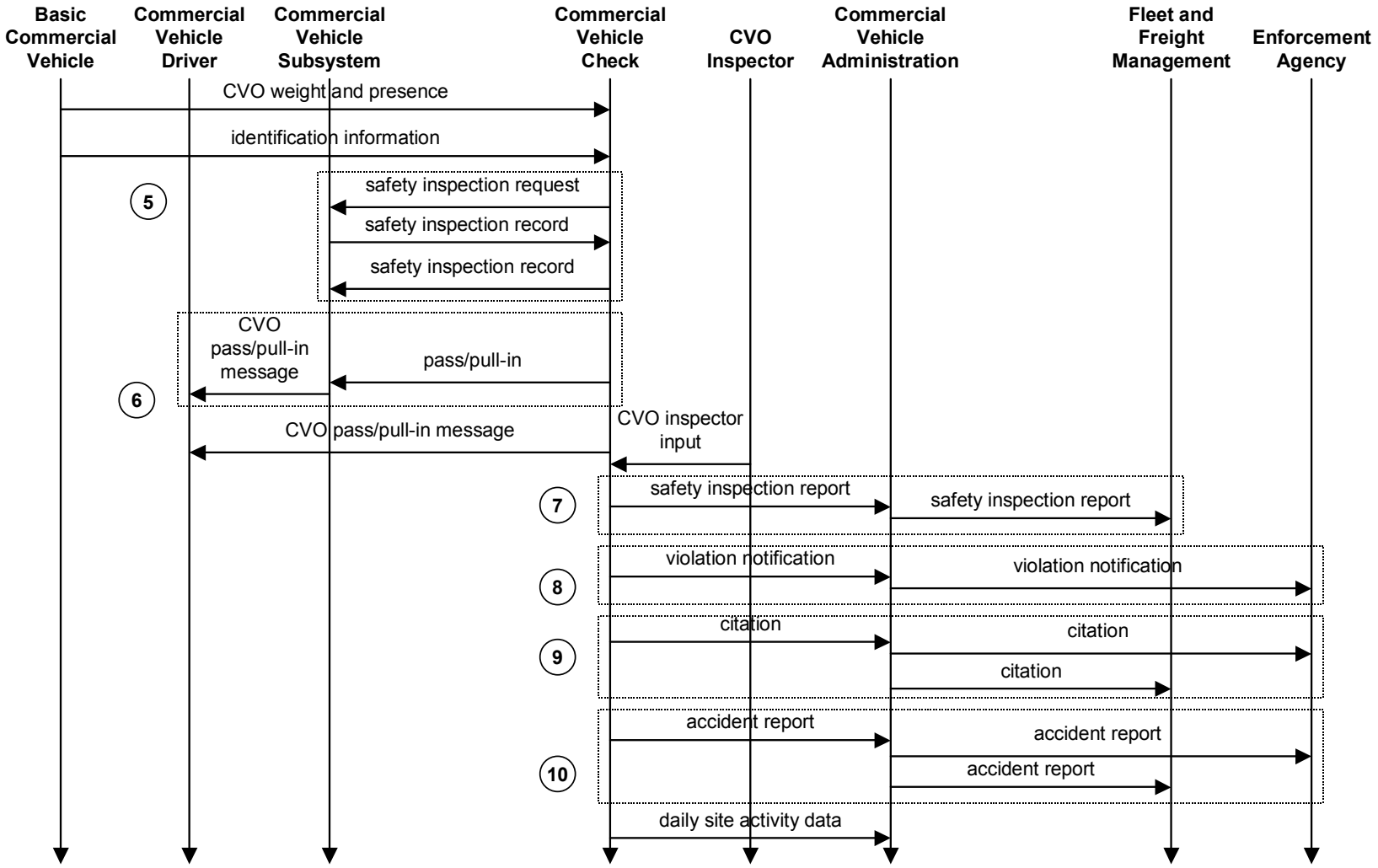
9. Similarly, if a citation was issued during the inspection process, the Commercial Vehicle Check Subsystem can send this data to the Commercial Vehicle Administration Subsystem (*citation*) for distribution to the Enforcement Agency (*citation*) and the Fleet and Freight Management Subsystem (*citation*).

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)



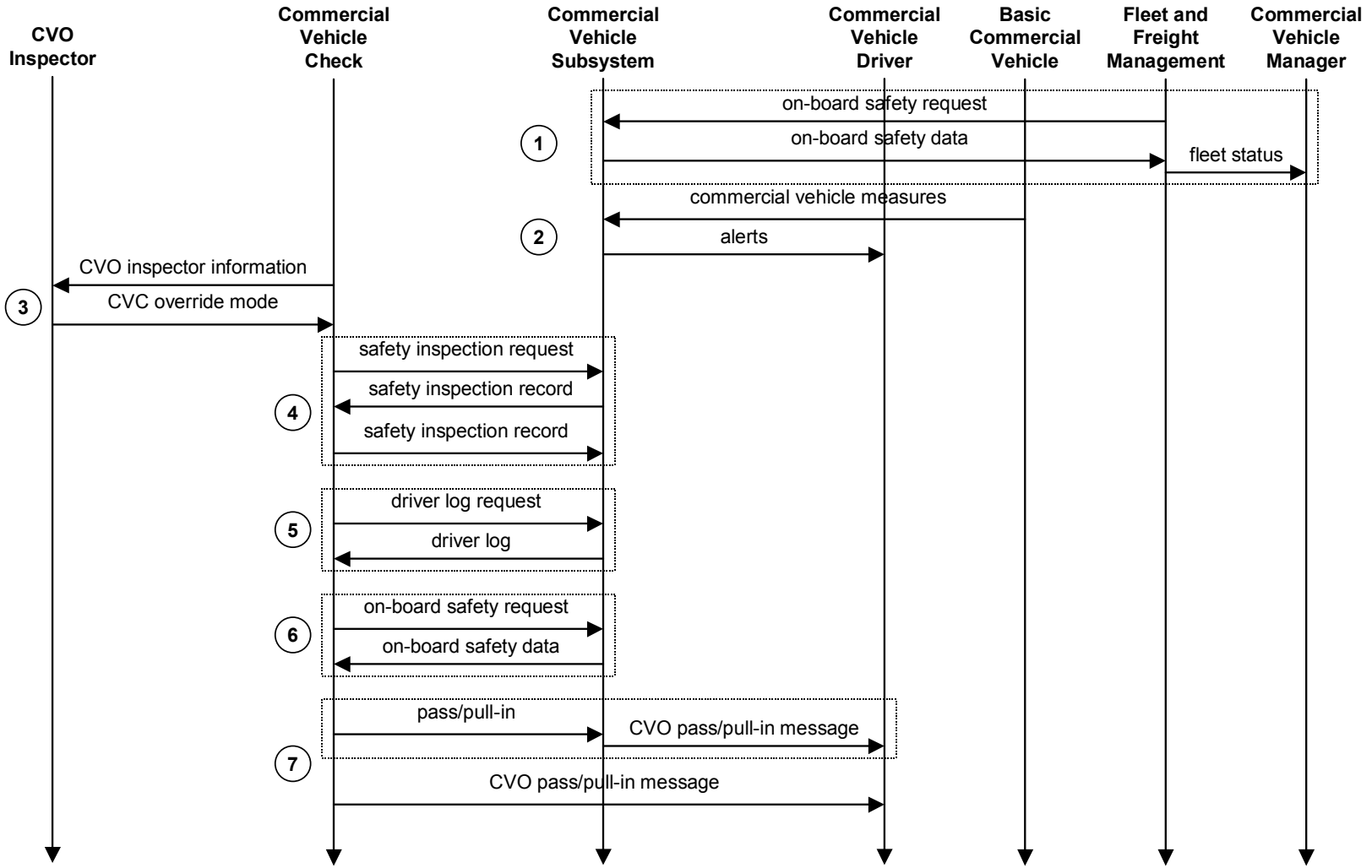
6.8. CVO08: On-board CVO Safety

This market package provides for on-board commercial vehicle safety monitoring and reporting. It is an enhancement of the Roadside CVO Safety (CVO07) Market Package and includes roadside support for reading on-board safety data via transponders.

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

1. The Commercial Vehicle Subsystem is responsible for collecting the on-board safety data. The Fleet and Freight Management Subsystem can make a request for the on-board safety data (*on-board safety request*). The Commercial Vehicle Subsystem will respond with vehicle and cargo data (*on-board safety data*), which can be forwarded to the Commercial Vehicle Manager (*fleet status*).
2. On an asynchronous basis, the Basic Commercial Vehicle can send vehicle and cargo safety information measured by non-ITS equipment to the Commercial Vehicle Subsystem (*commercial vehicle measures*). The Commercial Vehicle Subsystem will process this data and forward any safety related warnings to the Commercial Vehicle Driver (*alerts*).
3. As an enhancement to the roadside CVO safety market package, the on-board safety data can be sent to a roadside check station. This part of the process is under the asynchronous monitoring (*CVO inspector information*) and control (*CVC override mode*) of the CVO Inspector.
4. The Commercial Vehicle Check Subsystem can request a record of containing the results of a commercial vehicle safety inspection (*safety inspection request*). This data will be provided to the Commercial Vehicle Check Subsystem by the Commercial Vehicle Subsystem (*safety inspection record*). A record of the roadside activity can be sent back to the Commercial Vehicle Subsystem for future reference (*safety inspection record*).
5. The Commercial Vehicle Check Subsystem can request the driver's log (driver log request). In response, the Commercial Vehicle Subsystem will provide the daily log indicating the hours of service for the current driver (*driver log*).
6. The Commercial Vehicle Check 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*).
7. 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 send 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 using a roadside sign (*CVO pass/pull-in message*).

CVO08: On-board CVO Safety



6.9. CVO09: CVO Fleet Maintenance

This market package supports maintenance of CVO fleet vehicles with on-board monitoring equipment and Automated Vehicle Location (AVL) capabilities with in the Fleet and Freight Management Subsystem. Records of vehicle mileage, repairs, and safety violations are maintained to assure safe vehicles on the highway.

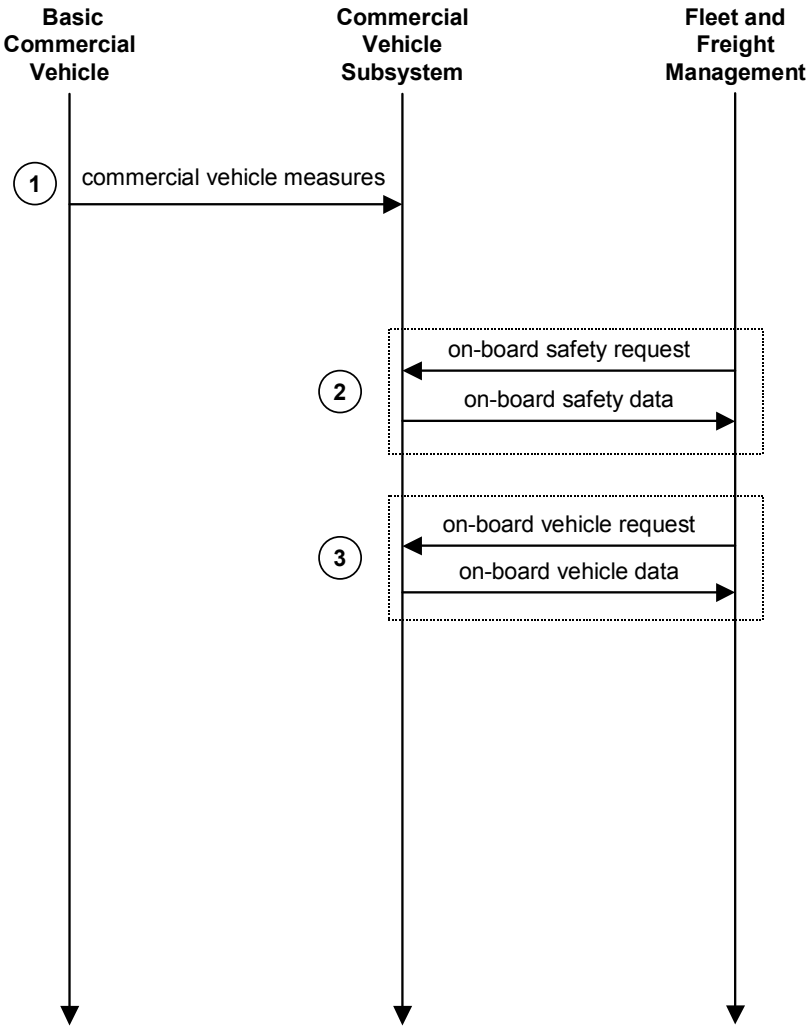
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

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 Fleet and Freight Management Subsystem can also make a request to the Commercial Vehicle Subsystem for on-board vehicle data (*on-board vehicle request*). The Commercial Vehicle Subsystem will respond with on-board information for maintenance purposes, gate access, cargo status, lock status, etc. (*on-board vehicle data*).

CVO09: CVO Fleet Maintenance



6.10. CVO10: HAZMAT Management

This market package integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. The Fleet and Freight Management Subsystem performs HAZMAT tracking. The Emergency Management Subsystem can receive incident information from either the Commercial Vehicle Subsystem or Vehicle Subsystem.

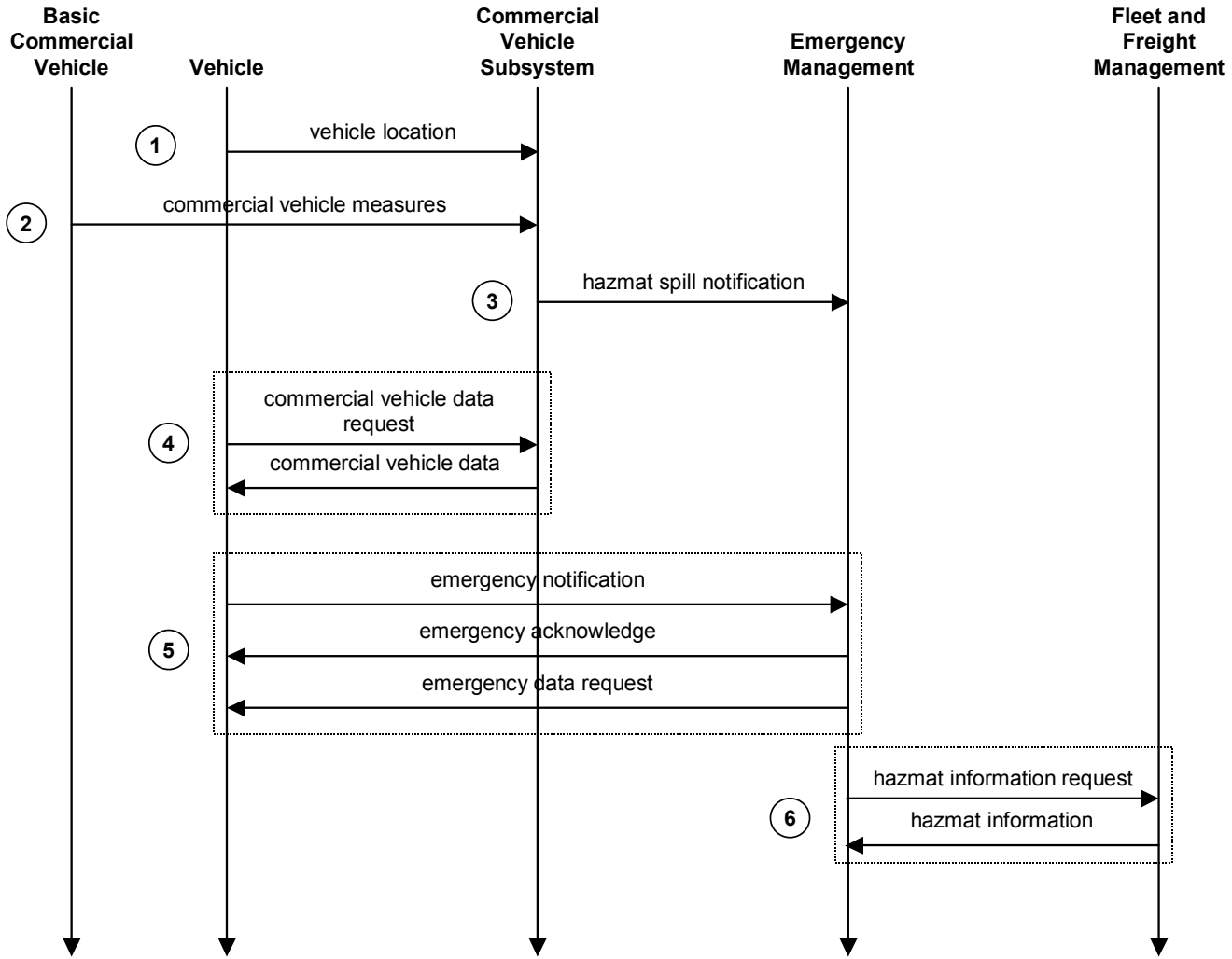
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. On an asynchronous basis, location information is passed from the Vehicle Subsystem to the Commercial Vehicle Subsystem (*vehicle location*).
2. When the monitoring equipment of the Basic Commercial Vehicle detects a release of HAZMAT material, cargo and vehicle information is sent to the Commercial Vehicle Subsystem (*commercial vehicle measures*).
3. The Commercial Vehicle Subsystem can send a HAZMAT message, which includes vehicle location data, to the Emergency Management Subsystem (*hazmat spill notification)*.
4. Alternately, HAZMAT information can be requested by the Vehicle Subsystem from the Commercial Vehicle Subsystem (*commercial vehicle data*). In response to the previous request, the Commercial Vehicle Subsystem will send HAZMAT information to the Vehicle Subsystem. However, the Commercial Vehicle Subsystem can 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 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 (*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



7. Maintenance and Construction Operations

This section provides the Theory of Operations for the Maintenance and Construction Operations Market Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each market package section) to identify these market packages is MCO—Maintenance and Construction Operations.

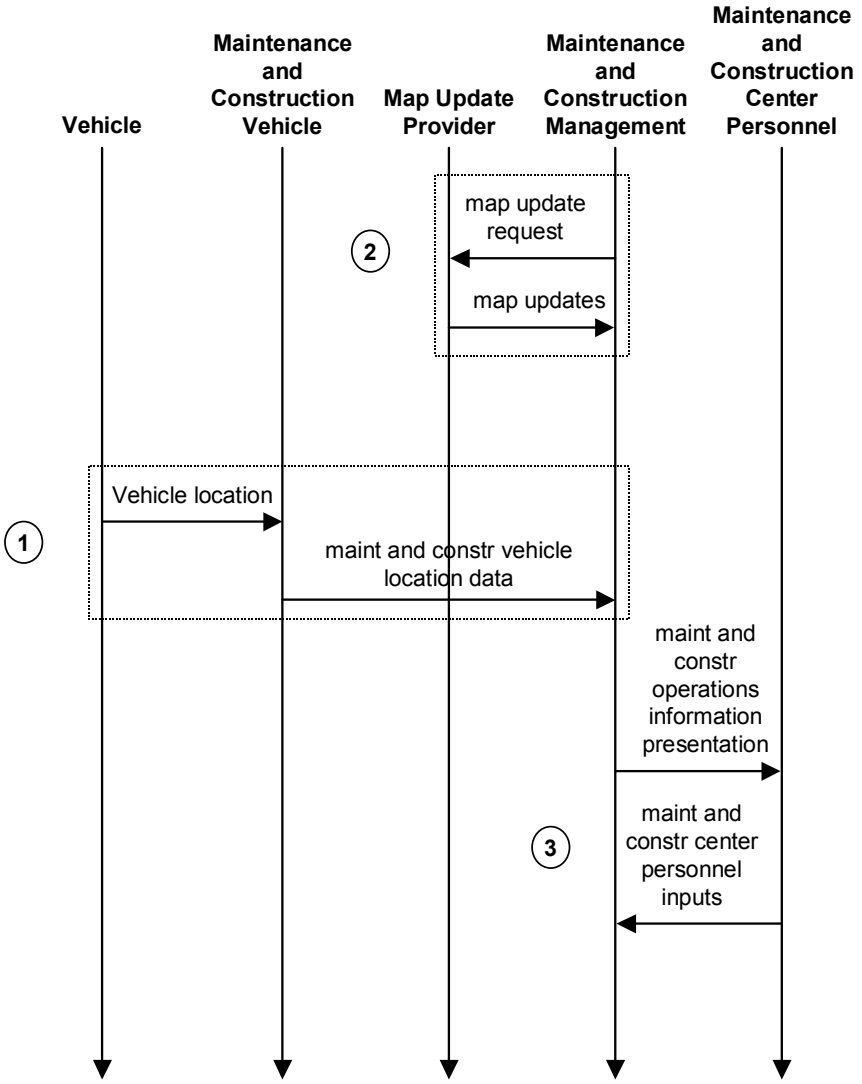
7.1. MC01: Maintenance and Construction Vehicle Tracking

This market package will track the location of maintenance and construction vehicles and other equipment to ascertain the progress of their activities.

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

1. Vehicle tracking in the National ITS Architecture for all manners of fleet vehicles (including the maintenance and construction vehicle) has been assigned to the Vehicle Subsystem. This is because the basic function-- determining vehicle location-- is the same no matter what type of vehicle is considered. Therefore the output of the vehicle tracking function in the Vehicle Subsystem (*vehicle location*) is sent to the Maintenance and Construction Vehicle Subsystem (MCVS) and that location information is passed along to the Maintenance and Construction Management Subsystem (MCMS) via the architecture flow *maint and const 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 const operations information presentation*) and control (*maint and const center personnel inputs*) of Maintenance and Construction Center Personnel.

MC01: Maintenance and Construction Vehicle Tracking



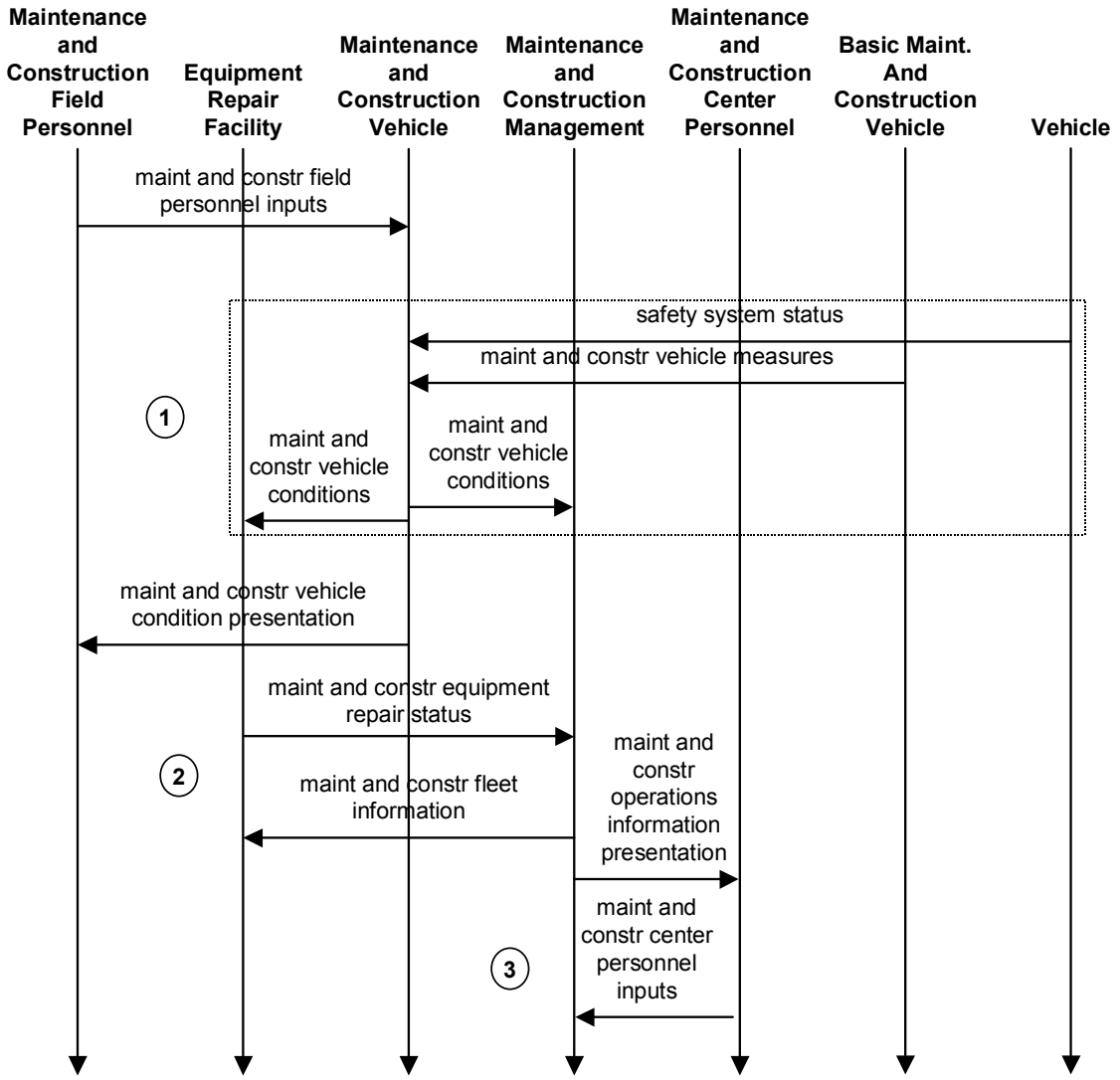
7.2. MC02: Maintenance and Construction Vehicle Maintenance

This market package performs vehicle maintenance scheduling and manages both routine and corrective maintenance activities on vehicles and other maintenance and construction equipment.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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 (*system safety status*) and data from operational systems on-board the vehicle (*maint and const 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. This data 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 const vehicle condition 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 const 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 const fleet information*).
3. The entire process is under the asynchronous monitoring (*maint and const operations information presentation*) and control (*maint and const center personnel inputs*) of Maintenance and Construction Center Personnel.

MC02: Maintenance and Construction Vehicle Maintenance



7.3. MC03: Road Weather Data Collection

This market 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 and on-board sensors located on other fleet or private vehicles. There are a number of different options for collecting the road and weather sensor data as described below.

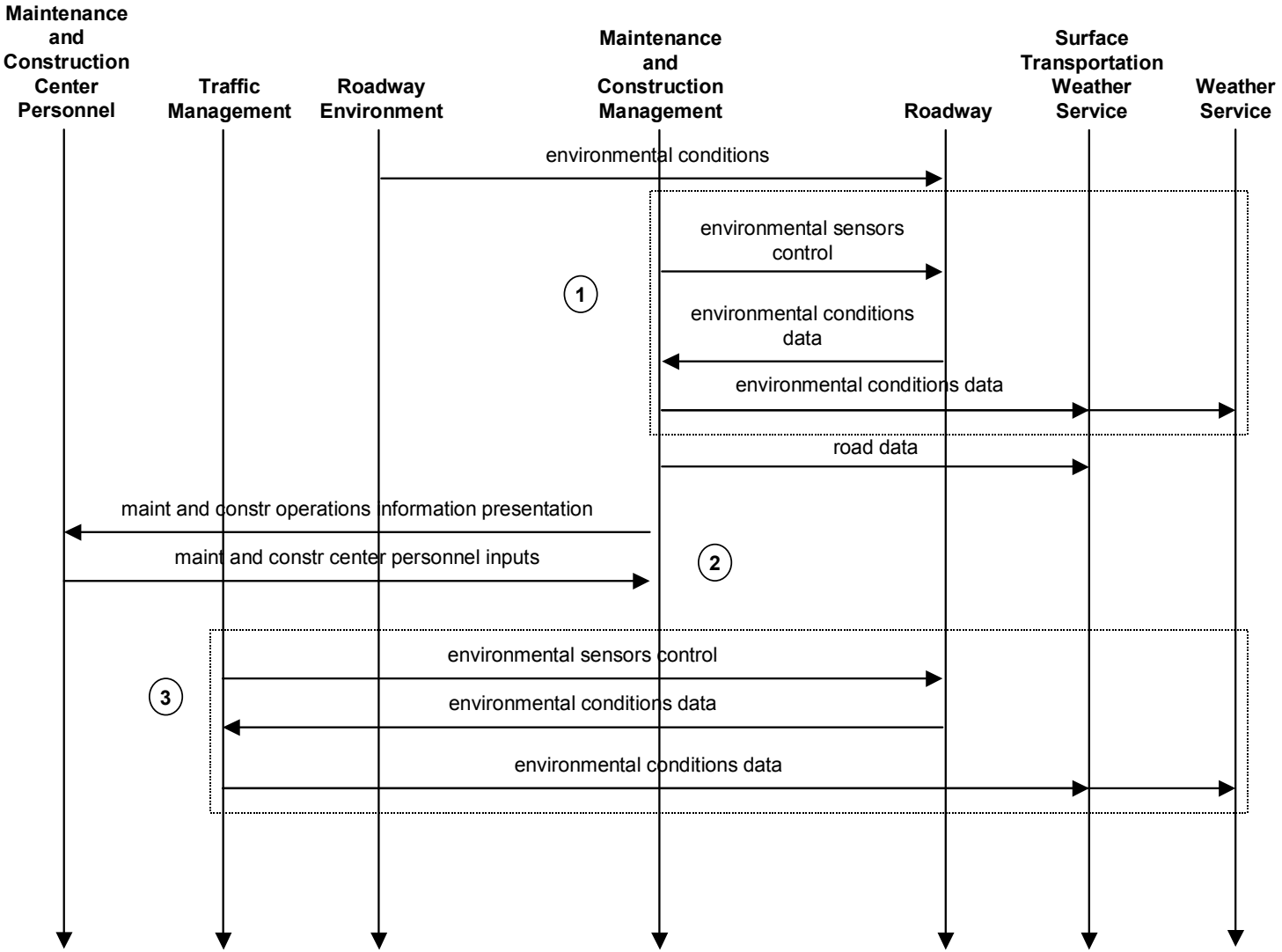
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagrams.

1. The Maintenance and Construction Management Subsystem (MCMS) can control (*environmental sensors control*) and monitor (*environmental conditions 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. Note that asynchronously to this the MCMS provides road facility and treatment information that supports road conditions forecasts (*road data*).
2. Within the MCMS the above process is under the asynchronous monitoring (*maint and const operations information presentation*) and control (*maint and const center personnel inputs*) of Maintenance and Construction Center Personnel.
3. The Traffic Management Subsystem (TMS) can also control (*environmental sensors control*) and monitor (*environmental conditions 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.
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 conditions data*) the road and weather condition sensors at the Roadway. The Weather Service may then pass this *environmental conditions data* along either to the MCMS or the TMS (or both).
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 conditions 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. 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 sensor control*) and monitors (*environmental probe data*) the road and weather condition sensors on board the vehicle. Alternately the control could

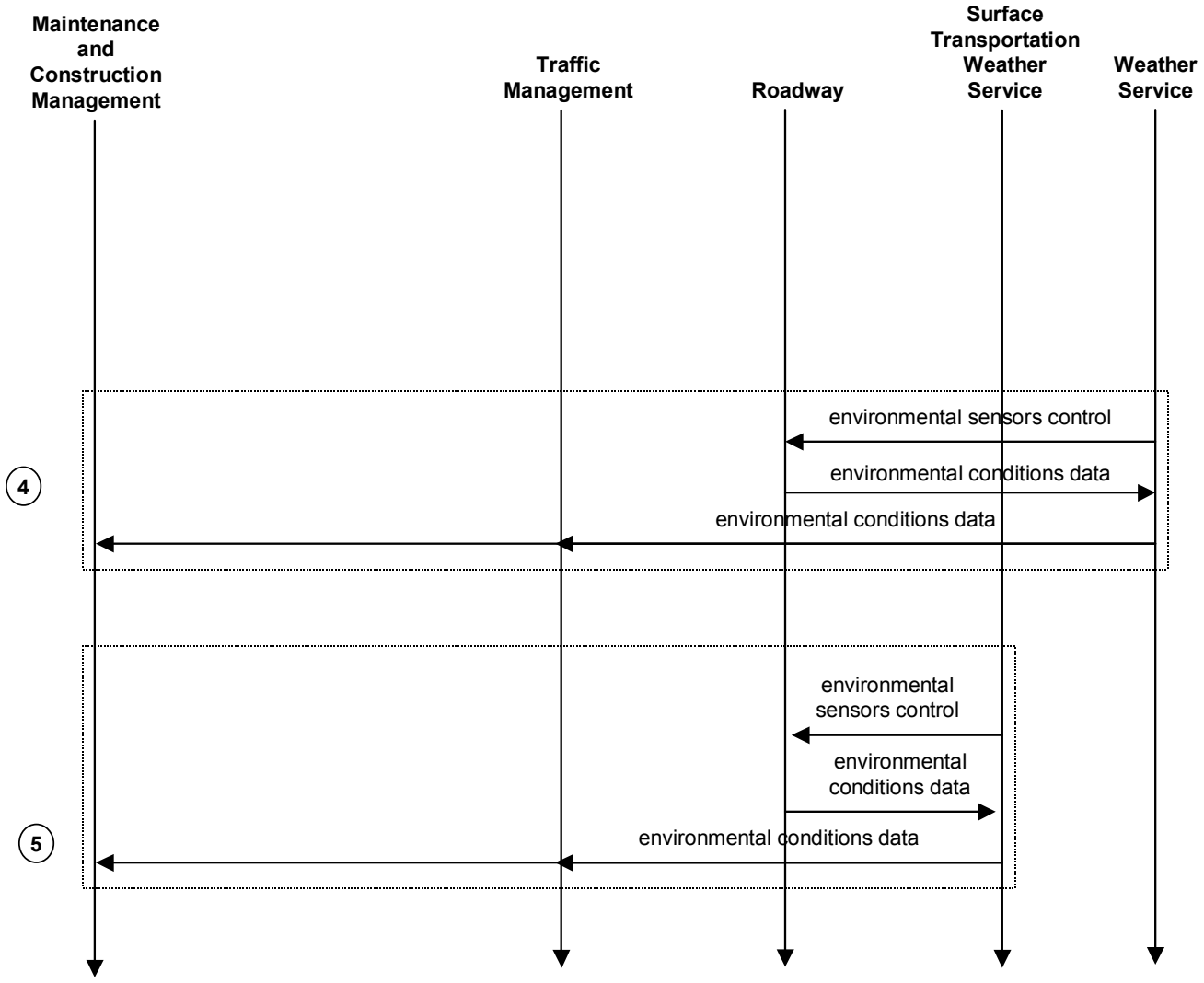
originate with the Maintenance and Construction Field Personnel on-board the vehicle and the sensor data would be presented to them (*maint and const field personnel information presentation*). Note the control by Field Personnel is not explicitly shown in the diagram, but would certainly be an option.

7. This data collection alternative involves control (*environmental sensors control*) and monitoring (*environmental conditions data*) of sensors at the Roadway from the MCVS. The road and weather condition collected from the roadway is forwarded to the MCMS (*environmental probe data*). In addition the *environmental conditions data* collected on board the vehicle could be sent via a wireless link to devices that are part of the Roadway Subsystem for aggregation with other field or vehicle based sensors.
8. Many modern vehicles contain temperature sensors. If we extrapolate this functionality out some years it is very possible for private vehicles to have expanded weather sensor capability (*environmental probe data)*, which they can share with an Information Service Provider (ISP). The ISP could aggregate the probe data from many vehicles and provide this information (*road network probe information*) to either the TMS or MCMS.
9. A vehicle equipped with weather sensor capability, could also share that data (*environmental probe data*) with receivers in the Roadway Subsystem, which can then provide the data (*environmental probe data*) to the TMS.
10. A transit vehicle may also be equipped with weather sensors, providing this data (environmental probe data) to the Transit Management Subsystem, who can use the data as part of transit operations, and send an aggregated view of the data (*road network probe information)* to either the TMS or MCMS.
11. Finally, an emergency vehicle can have a similar capability as described above for the transit vehicle. An emergency vehicle equipped with weather sensors can provide this data (environmental probe data) to the Emergency Management Subsystem, who can use the data as part of its operations, and send an aggregated view of the data (*road network probe information)* to either the TMS or MCMS.

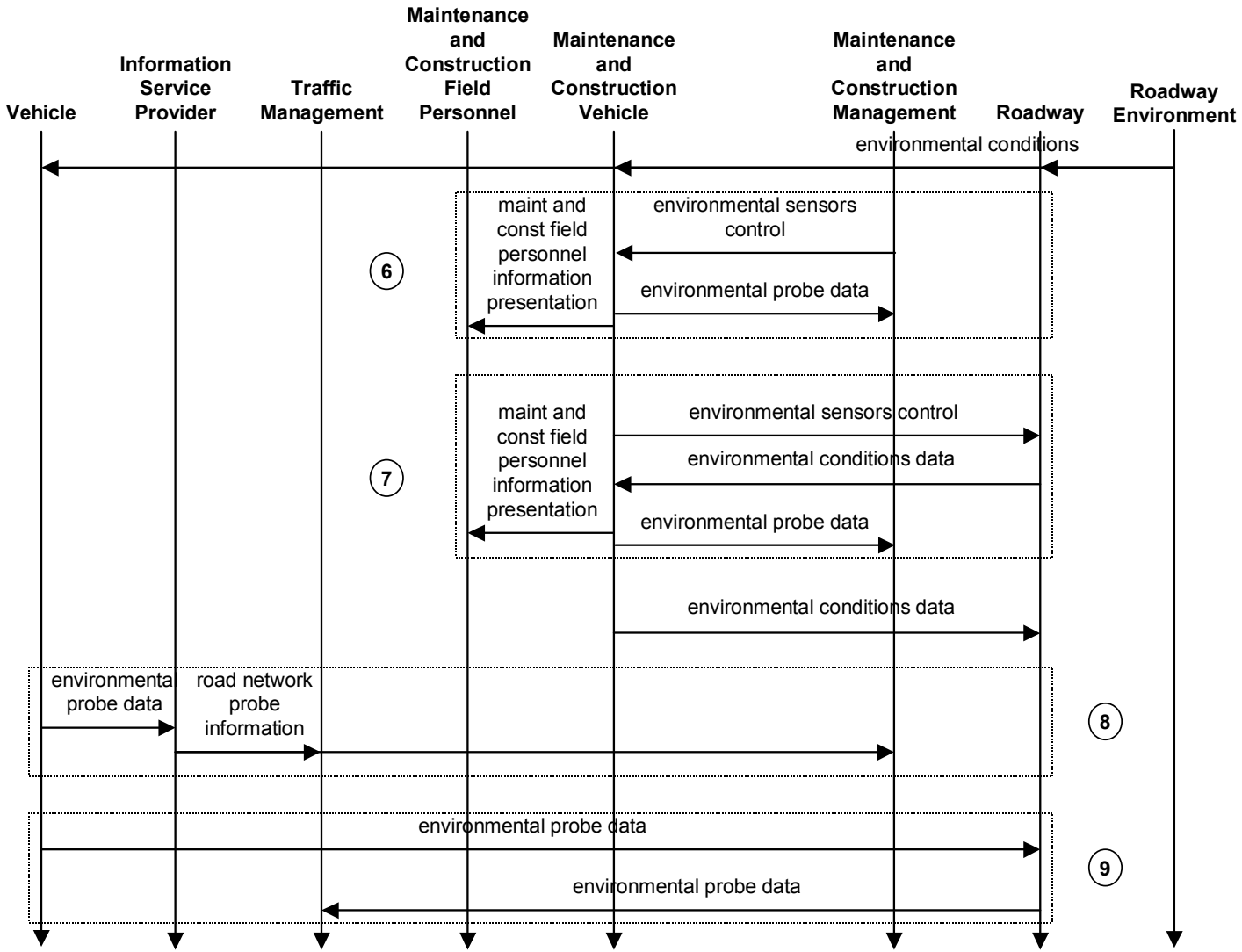
MC03: Road Weather Data Collection (1 of 4)
Data Collection by Centers



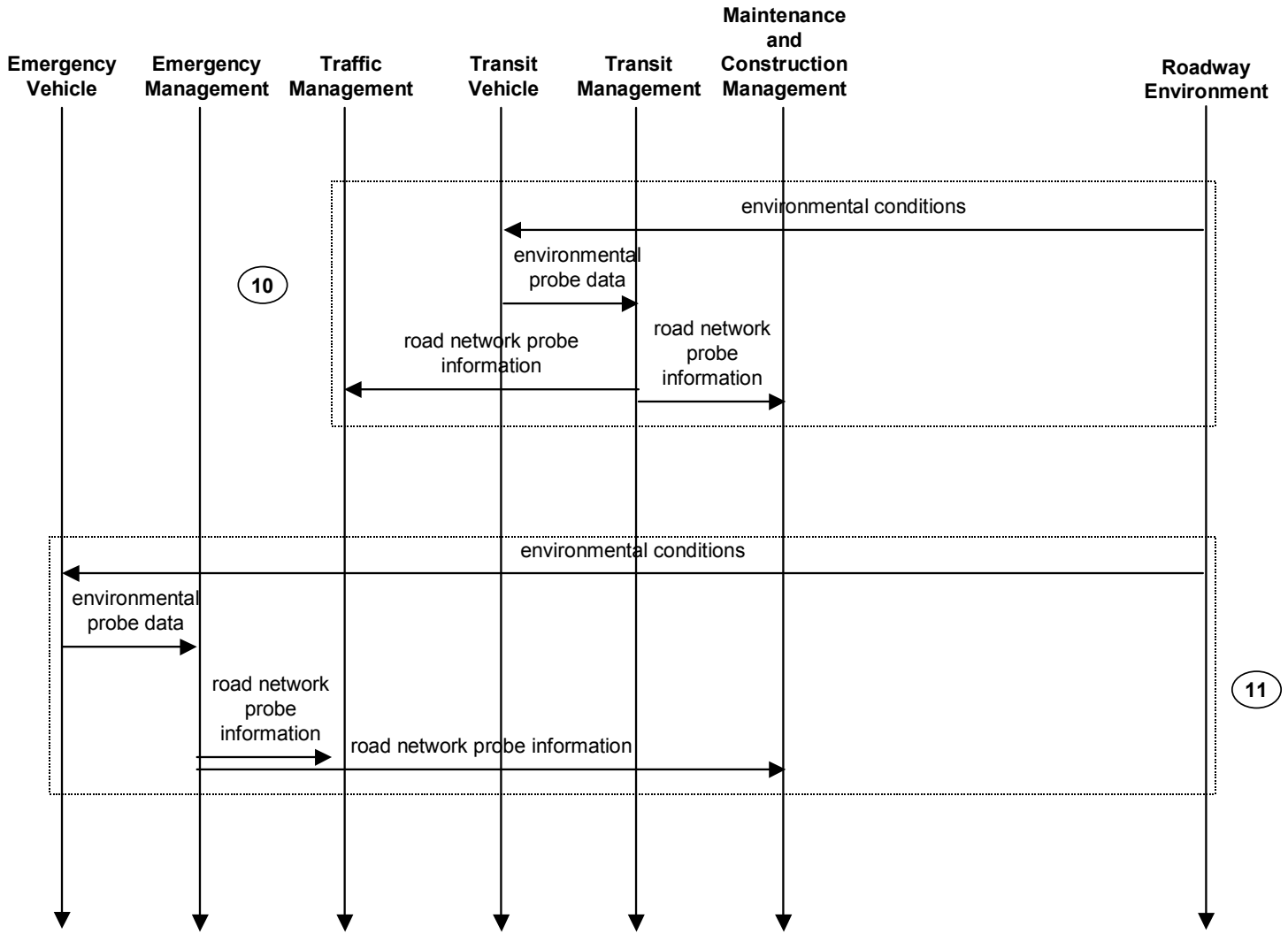
MC03: Road Weather Data Collection (2 of 4)
Data Collection by Weather Entities



MC03: Road Weather Data Collection (3 of 4)
Data Collection from Vehicles (1)



MC03: Road Weather Data Collection (4 of 4)
Data Collection from Vehicles (2)



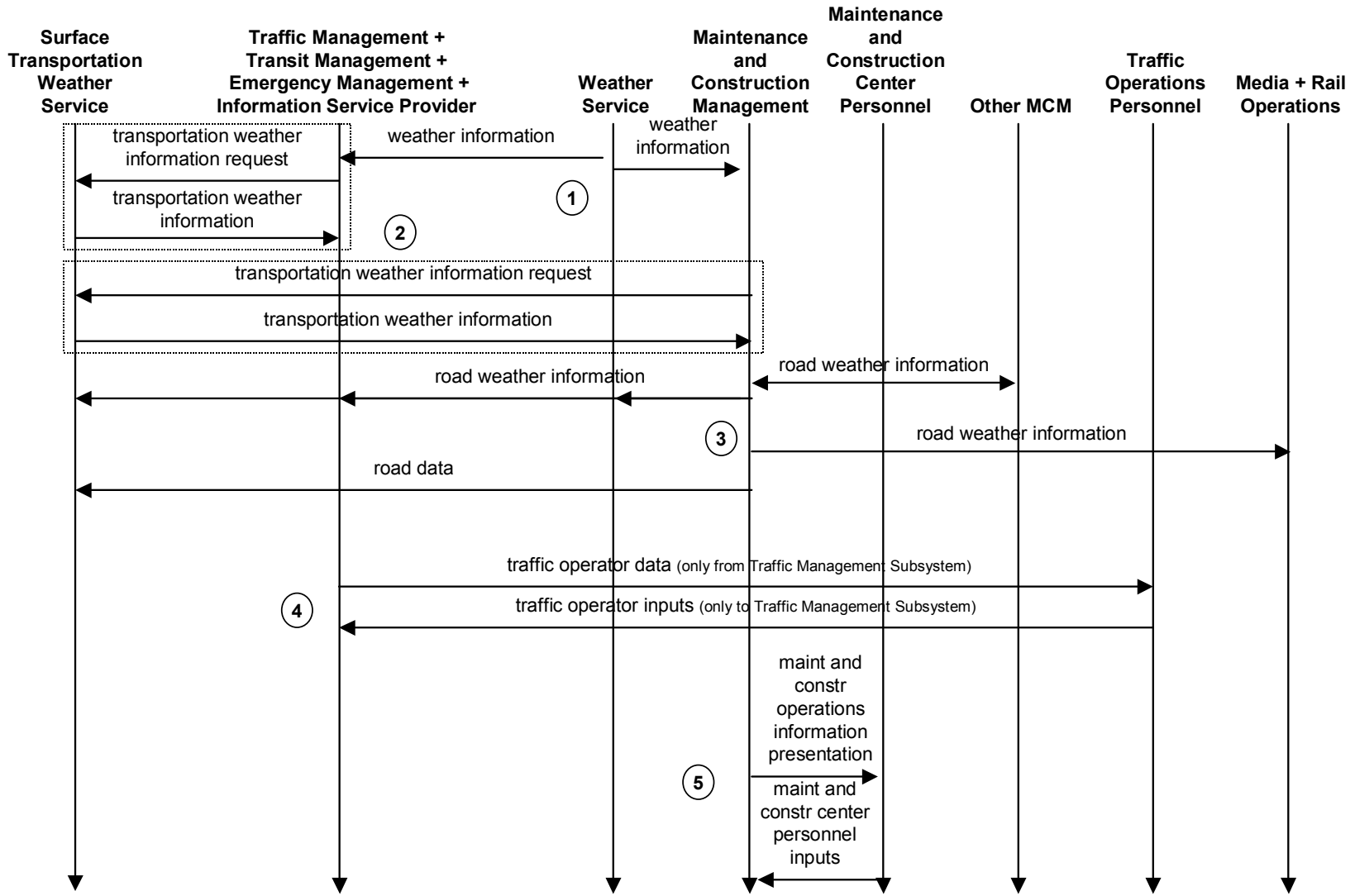
7.4. MC04: Weather Information Processing and Distribution

This market package processes and distributes the environmental information. The information may be generated by the Maintenance and Construction Management Subsystem (MCMS), the Traffic Management Subsystem (TMS), the Weather Service or the Surface Transportation Weather Service. The information is widely distributed to various ITS entities.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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 this *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 market 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. Finally, also on an asynchronous basis, the weather information collected by the MCMS is provided to the Maintenance and Construction Center Personnel (*maint and const operations information presentation*), who exert control over the collection and processing of the data (*maint and const center personnel inputs*).

MC04: Weather Information Processing and Distribution



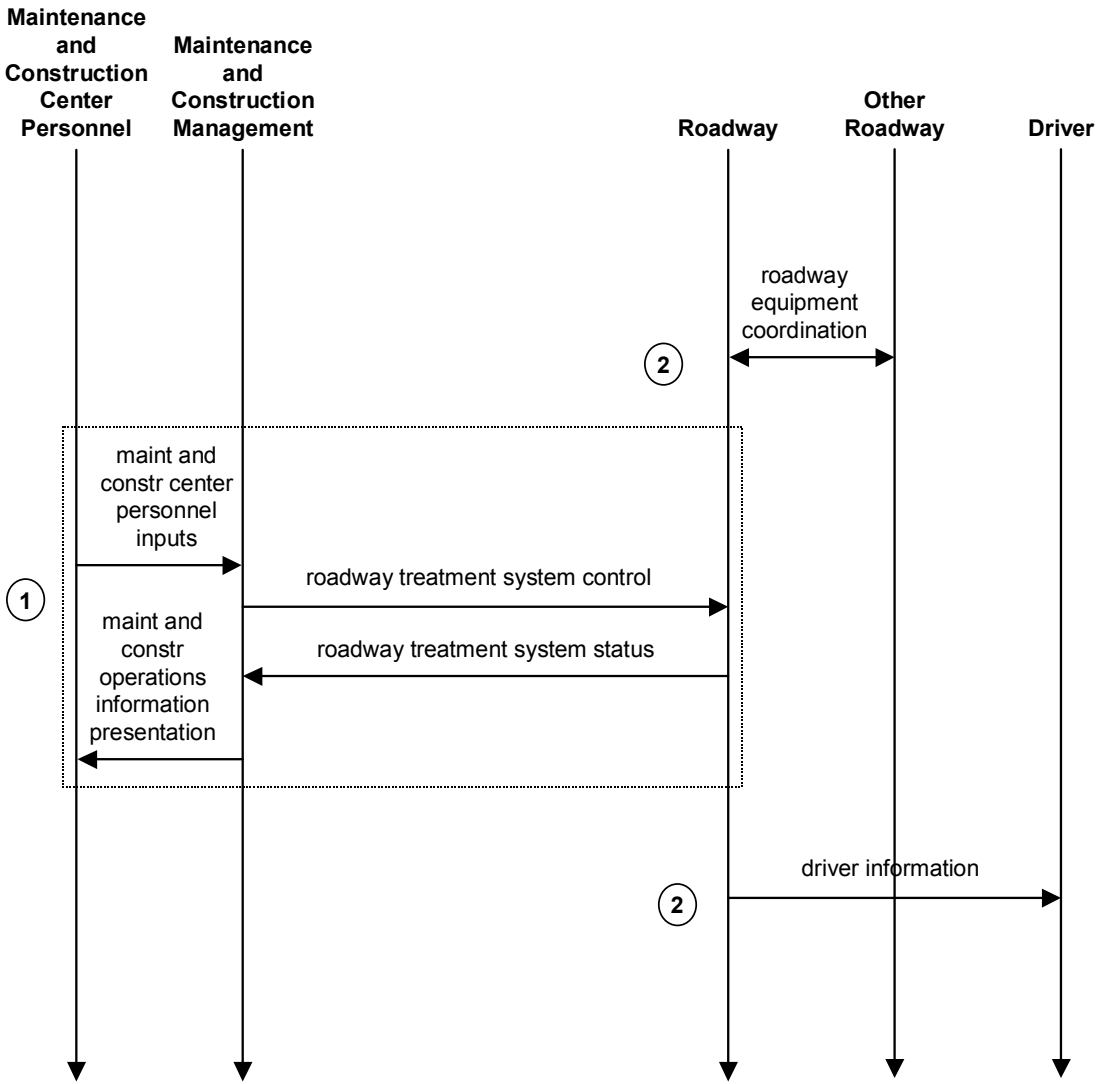
7.5. MC05: Roadway Automated Treatment

This market package automatically treats a roadway section based on environmental or atmospheric conditions. Treatments include fog dispersion, anti-icing chemicals, etc. The market 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 market package. Each numbered item describes the operation of that portion of the market 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 const center personnel input*) and send a control signal to the Roadway Subsystem (*roadway treatment sensor control*). They also monitor the status of the system (*roadway treatment system status* and *maint and const operations information presentation)*.
2. The automated roadway treatment system may also contain environmental sensors, or sensors at the Roadway that provides the environmental data (*roadway equipment coordination* from Other RS 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* from the Roadway Subsystem to the Other RS).

MC05: Roadway Automated Treatment



7.6. MC06: Winter Maintenance

This market package supports winter road maintenance including snowplow 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.

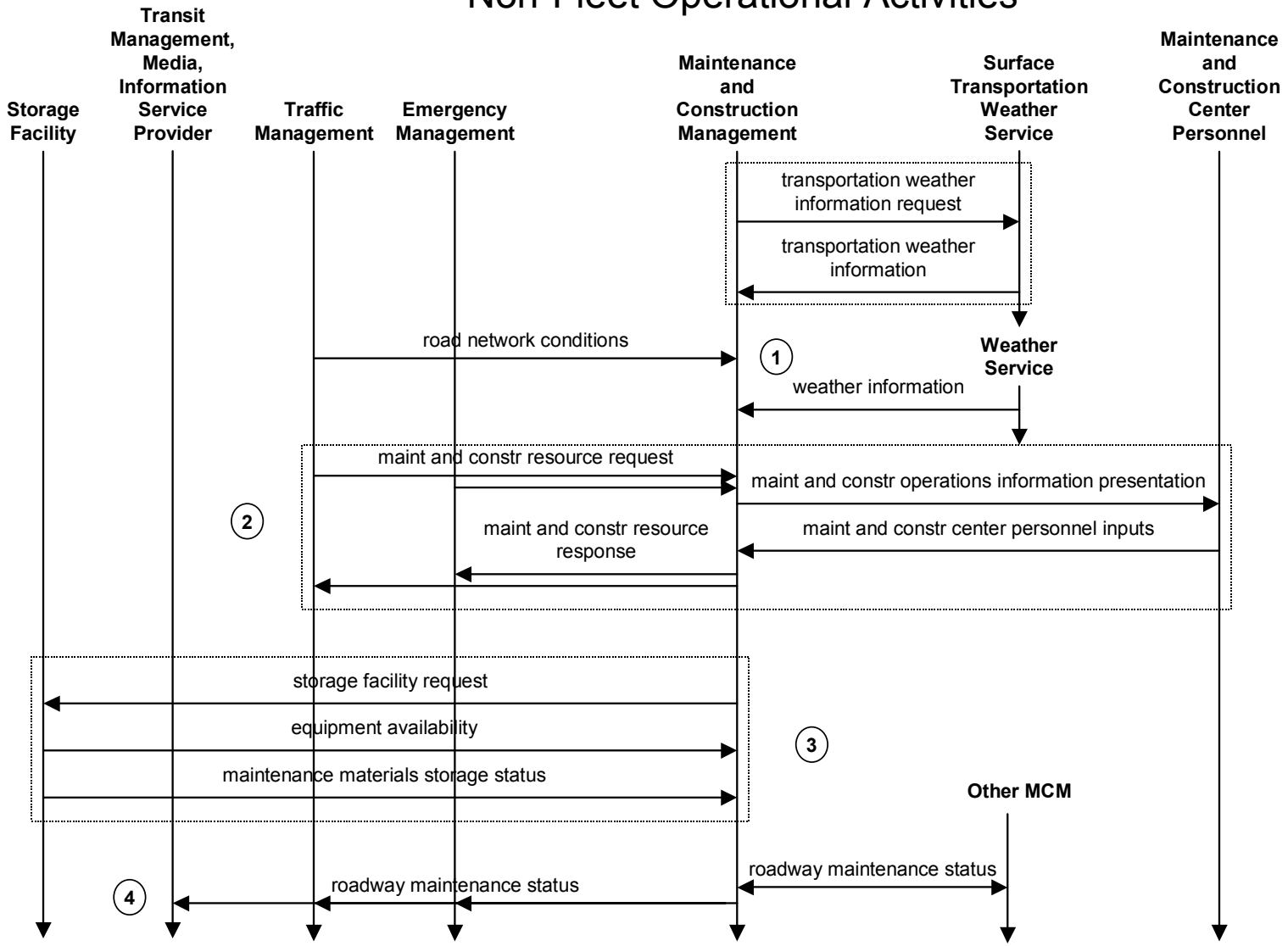
The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagrams.

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/ transportation weather information*), from the Weather Service (*weather information*), and from the Traffic Management Subsystem (*road network conditions,* which can include traffic information and incident information as well as 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 const resource request*) for maintenance resources (possibly in support of incident management). This request is forwarded to the Maintenance and Construction Center Personnel (*maint and const operations information presentation*). The center personnel initiate a response to the request (*maint and const center personnel input)* and that response is returned to the originating center subsystem (*maint and const 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 market 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, Information Service Provider, EM 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 const work performance*) to the Maintenance and Construction Administrative Systems to support contract administration.
6. In addition the MCMS makes requests (*maint and const administrative request*) for administrative information or services. An example of services requested might be the

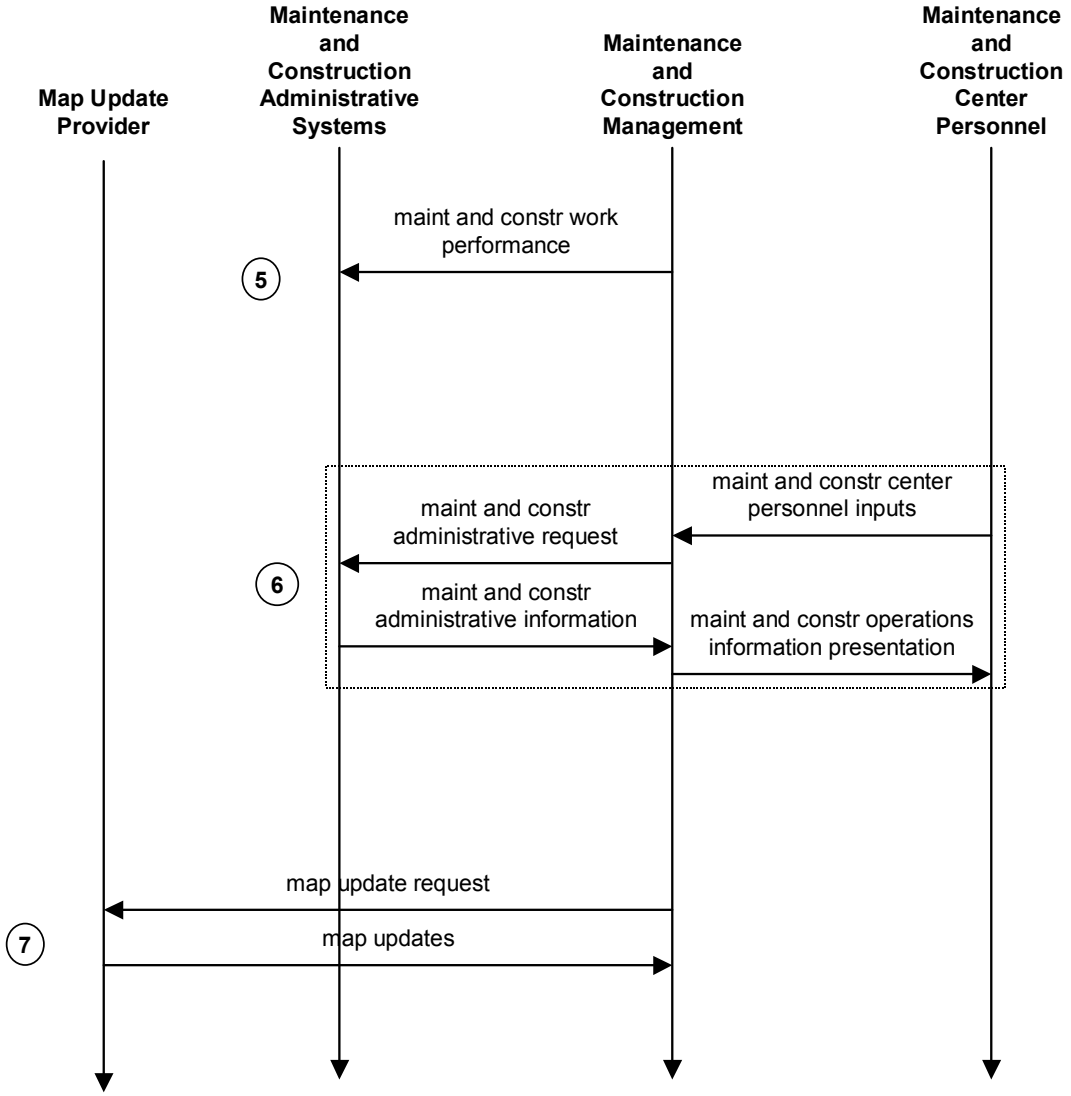
reordering of additional road treatment materials. The Maintenance and Construction Administrative Systems responds with the information or status requested (*maint and const administrative information*).

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 const 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 const material information*) is the remaining quantity and current application rate of materials on the vehicle. In addition the maintenance and construction vehicle can have a location capability (*vehicle location* sent from the Vehicle Subsystem (VS) to the MCVS) and advanced safety system features such as lane following (*safety system status* 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 const vehicle condition presentation*) and to the MCMS (*maint and const 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 const vehicle status coordination*). The information is passed to the Maintenance and Construction Field Personnel (*maint and const 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 const field personnel inputs*). The vehicle's operational status is sent to the MCMS (*maint and const vehicle operational data*). Information can also be passed from the MCVS back to the Other MCV (*maint and const vehicle status coordination).*
10. One of the key fleet activities of the MCMS is to dispatch the fleet vehicles. This *maint and const 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 const 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 const field personnel inputs*). This information is forwarded to the MCMS (*maint and const dispatch status*).

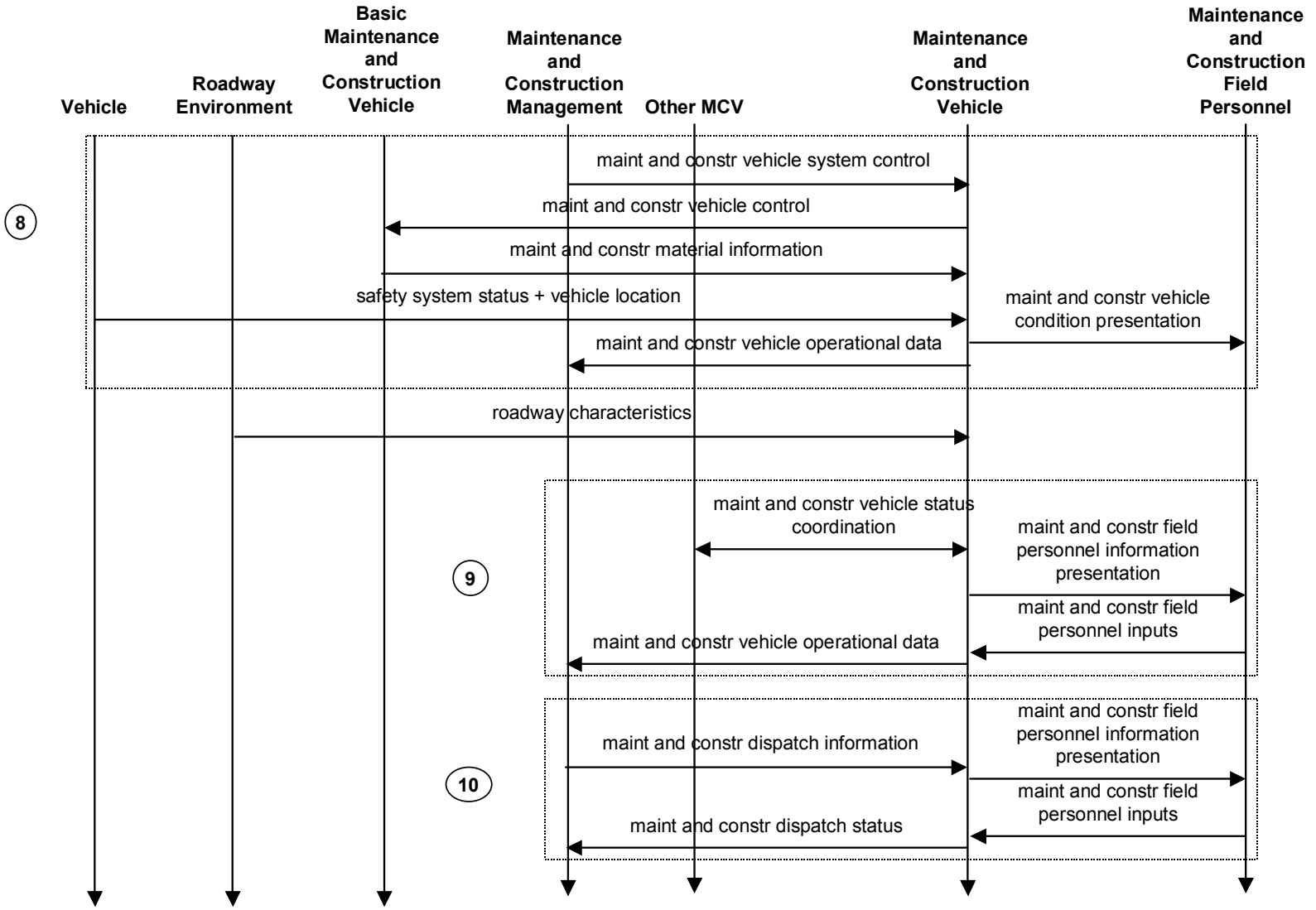
MC06: Winter Maintenance (1 of 3)
Non-Fleet Operational Activities



MC06: Winter Maintenance (2 of 3) Administrative Activities



MC06: Winter Maintenance (3 of 3)
Fleet Activities



7.7. MC07: Roadway Maintenance and Construction

This market package supports 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.).

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

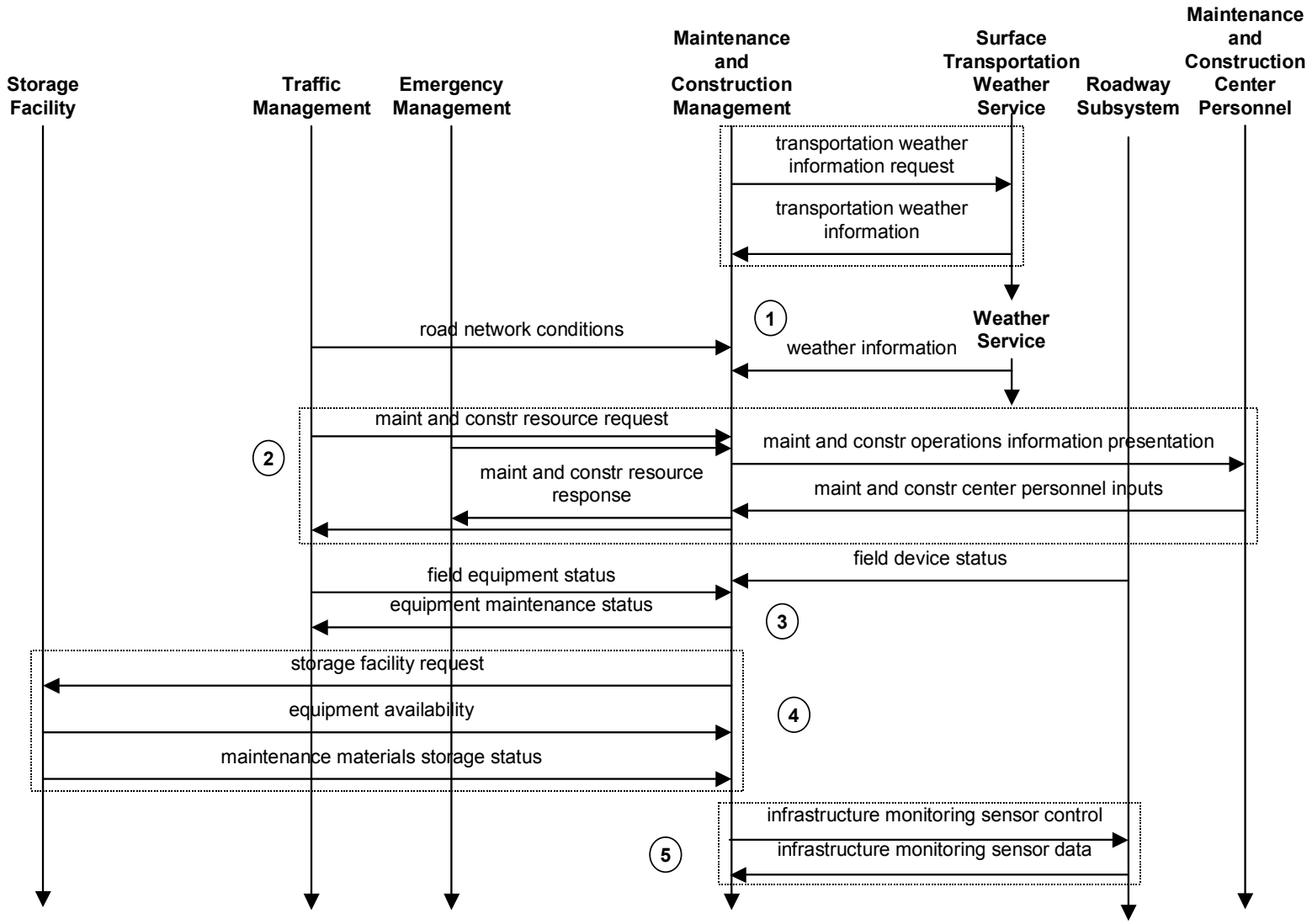
1. In order to support its operational activities, the Maintenance and Construction Management Subsystem (MCMS) inputs information regarding weather and the state of the road network. The information comes from the Surface Transportation Weather Service (via the request/ response pair of architecture flows *transportation weather information request/ transportation weather information*), from the Weather Service (*weather information*), and from the Traffic Management Subsystem (*road network conditions,* which can include traffic information and incident information as well as 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 makes a request (*maint and const resource request*) for maintenance resources (possibly in support of incident management). This request is forwarded to the Maintenance and Construction Center Personnel (*maint and const operations information presentation*). The center personnel initiate a response to the request (*maint and const center personnel input)* and that response is returned to the originating center subsystem (*maint and const 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.
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, or the fault information could be sent from the TMS (*field equipment status*). Following the maintenance actions the *equipment maintenance status* is sent from the MCMS to the TMS.
4. The MCMS 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 market package the status of available materials might include sand (for treatment of spills) or herbicide (for spraying of the vegetation along the roadside).
5. 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.

6. 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 also sends *asset restrictions* to the MCMS, which could include height, width, or weight restrictions to various assets. 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 maintenance or construction activities or infrastructure monitoring (*asset status update*). This same flow can also contain results of infrastructure monitoring carried out by the maintenance organization. Another administrative function the MCMS supports is to provide overall work performance information (*maint and const work performance*) to the Maintenance and Construction Administrative Systems (MCAS) to support contract administration.
7. The MCMS makes requests (*maint and const administrative request*) for administrative information or services. An example of services requested might be the reordering of additional road treatment materials. The MCAS responds with the information or status requested (*maint and const administrative information*).
8. As part of its maintenance operations, 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*).
9. 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 const 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 const material information*) is the remaining quantity and current application rate of materials on the vehicle. In addition the maintenance and construction vehicle can have a location capability (*vehicle location* sent from the Vehicle Subsystem (VS) to the MCVS) and advanced safety system features such as lane following (*safety system status* sent from the VS to the MCVS). 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 const vehicle condition presentation*) and to the MCMS (*maint and const vehicle operational data*) where it is eventually presented to the Maintenance and Construction Center Personnel.
10. Another maintenance activity that can be carried on by the MCVS is control (*infrastructure monitoring sensor control*) and monitoring (*infrastructure monitoring sensor data*) of infrastructure sensors located at the Roadway Subsystem. The control flow is initiated by an action from the Maintenance and Construction Field Personnel, which is not explicitly shown

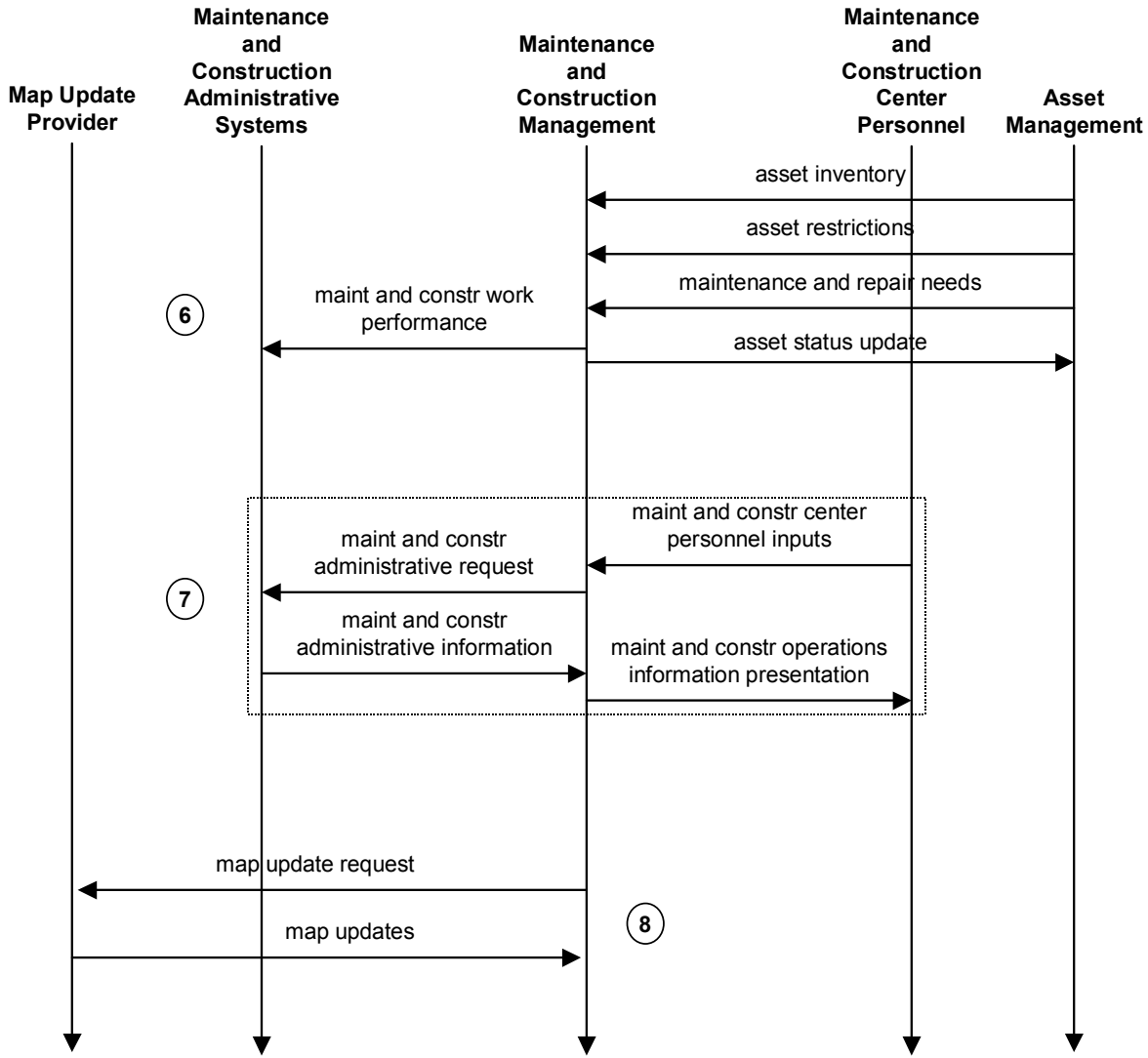
in the figure. The infrastructure data is then presented to the Field Personnel (*maint and const field personnel information presentation*) and passed along to the MCMS (*infrastructure conditions data*). An alternative mode of operation for this function is for the infrastructure sensor to be on the MCVS, in which case these two architecture flows of the previous sentence would contain data collected directly on the MCVS.

11. One of the key fleet activities of the MCMS is to dispatch the fleet vehicles. This *maint and const dispatch information*, which can include routing, is sent to the MCVS, and presented to the Maintenance and Construction Field Personnel (*maint and const 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 const field personnel inputs*). This information is forwarded to the MCMS (*maint and const dispatch status*).

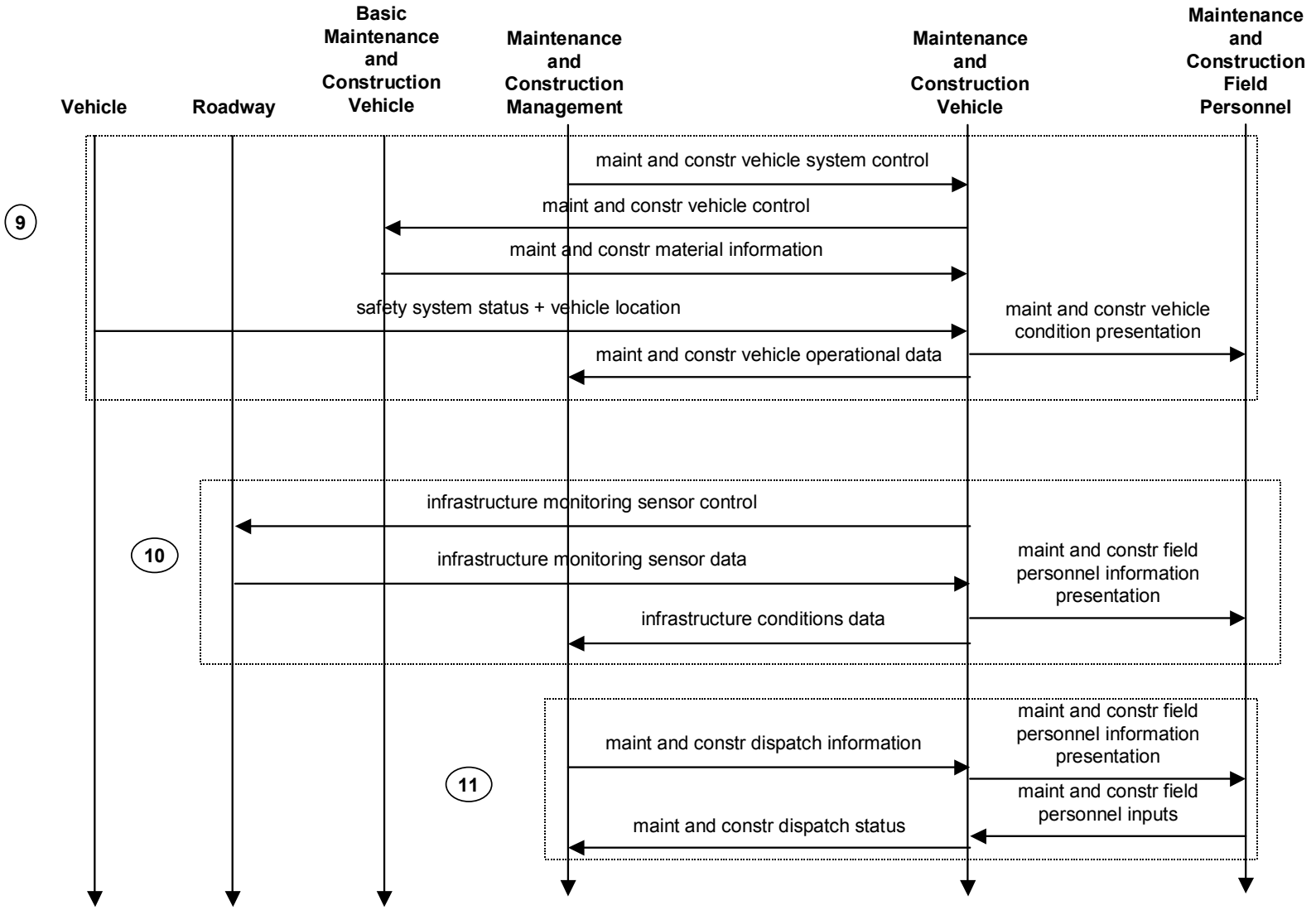
MC07: Roadway Maintenance and Construction (1 of 3)
Non-Fleet Operational Activities



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

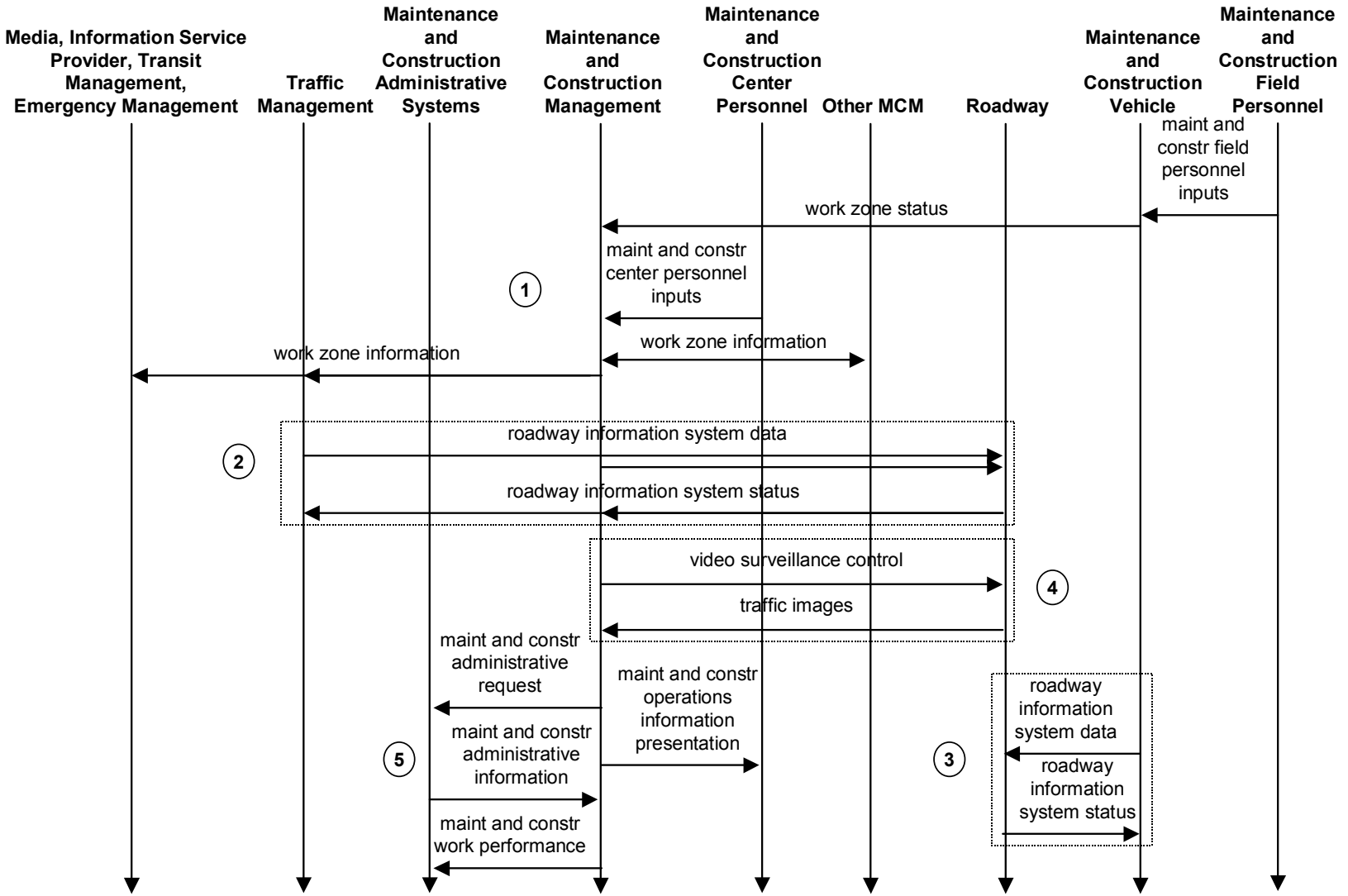
This market package directs activity in work zones, controlling traffic through portable dynamic message signs (DMS) and informing other groups of activity (e.g., ISP, TMS, other maintenance and construction centers) for better coordination management. The market package also includes providing information to motorists regarding work zone delays.

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

1. 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 const file 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 const 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)
2. 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. Additionally, the MCMS monitors the roadway information device to ensure its correct operation (roadway information system status).
3. The roadway information devices may also be controlled (roadway system information data) and monitored (roadway system information status) by the Field Personnel inside the MCVS.
4. 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.
5. Based upon inputs from the field, the MCMS may place a request to the Maintenance and Construction Administrative Systems (maint and const 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 const administrative information). This information is presented to the

Maintenance and Construction Center Personnel (maint and const operations information presentation). An additional administrative function the MCMS supports is to provide overall work performance information (maint and const work performance) to the Maintenance and Construction Administrative Systems (MCAS) for contract administration.

MC08: Work Zone Management



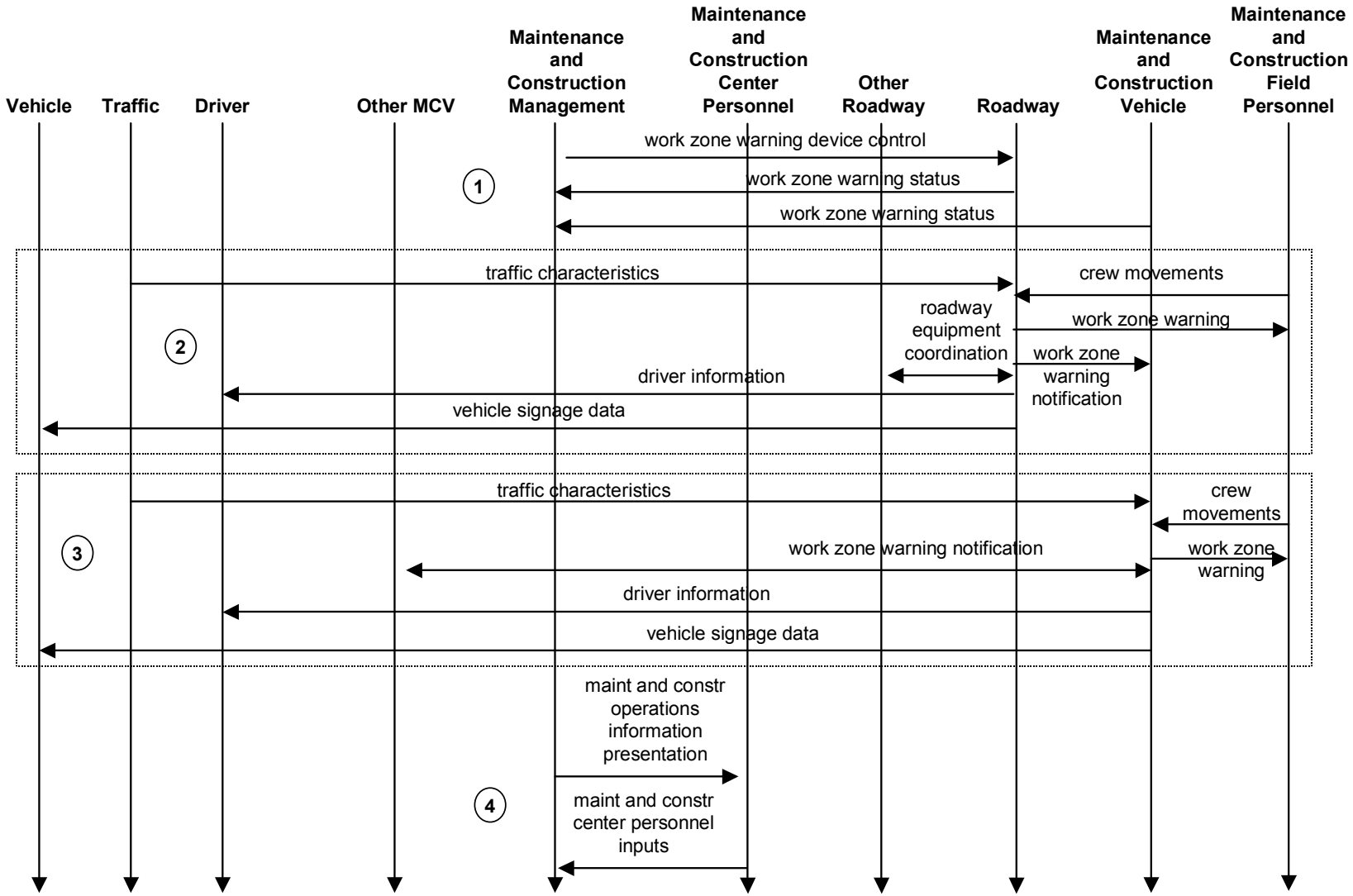
7.9. MC09: Work Zone Safety Monitoring

This market 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 following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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 const center personnel inputs)* and can get an indication of work zone intrusions that have occurred and what alerts were provided (*maint and const operations information presentation*).

MC9: Work Zone Safety Monitoring



7.10. MC10: Maintenance and Construction Activity Coordination

This market package supports the dissemination of maintenance and construction activity to centers which 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 market package. Each numbered item describes the operation of that portion of the market 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 as well as special restrictions such as spring weight restrictions and temporary bridge weight restrictions. These 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 to large or oversized vehicle limits.

2. One of the key functions of the MCMS is to plan maintenance and construction activity. These *maint and const 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

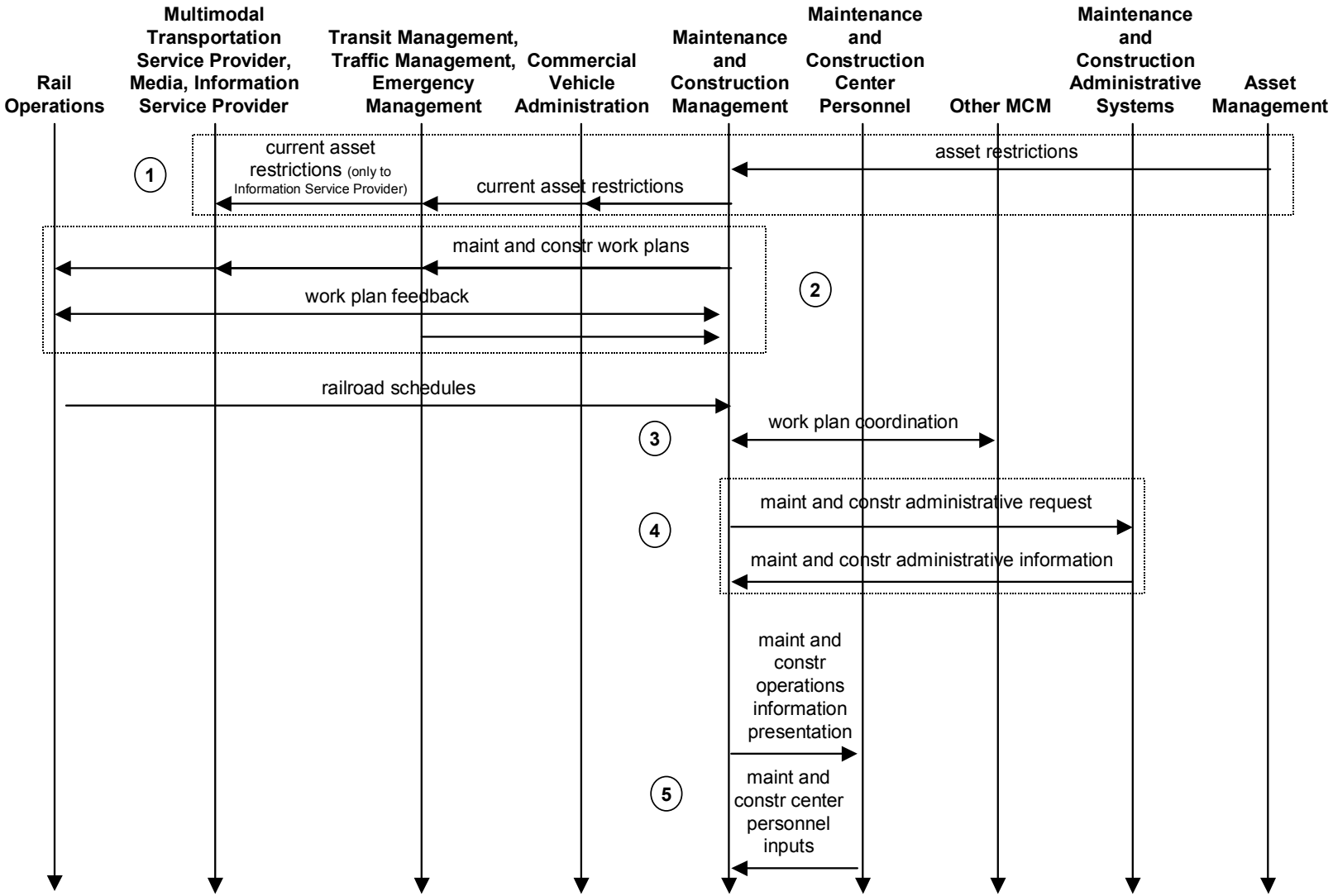
   It is expected that the following entities will provide *work plan feedback* to the MCMS:

   - 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 coordination (*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 const administrative request*), which would respond with information such as equipment and consumables resupply 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 const 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 const 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 const operations information presentation*).

MC10: Maintenance and Construction Activity Coordination



8. Archived Data Management

This section provides the Theory of Operations for the Archive Data Management Market Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each market package section) to identify these market packages is AD—Archived Data.

To understand the relationship of the three Archive Data Management Market 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 market 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 Market Packages.

8.1. AD1: ITS Data Mart

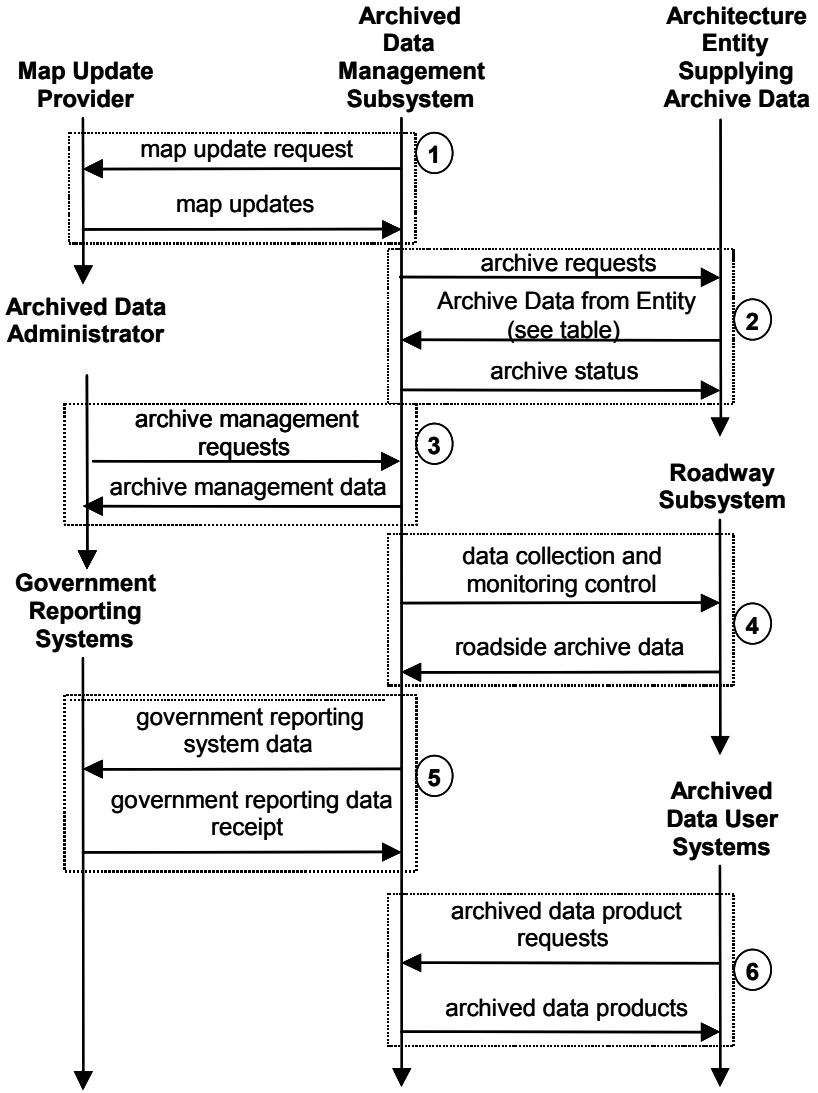
This Market Package collects and archives operational data from one source. The particular source can be selected from a variety of ITS subsystems or terminators. The institutional deployment of such a market package usually will be when an instance of one of these subsystems or terminators is deployed and wishes to archive its own operational data, and then make that archived data available to external users or government reporting systems. It is analogous to a library whose collection is acquired from a single publisher.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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) with subscription updates from a Map Update Provider.
2. The ADMS can request or subscribe to operational data from one of the subsystems or terminators in the table in the AD1 diagram that follows. On receipt of submitted operational data, the ADMS can confirm to the source that the data was received.
3. An Archive Data Administrator can set operational parameters on the archive. 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.

4. A special interface is available to allow the archive to control and collect monitoring data directly from Roadway subsystem monitoring equipment. This is in support of operations to collect data that will be used for federal HPMS (Highway Performance Monitoring System) reporting requirements.
5. A special interface is also provided for standard government reports (again, such as, but not limited to, HPMS reports).
6. An interface is provided for archive users, to specify and then receive archived data products.

AD1: ITS Data Mart



Architecture Entity Supplying Archive Data	Archive Data Sent to Archived Data Management System
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
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 information

8.2. AD2: ITS Data Warehouse

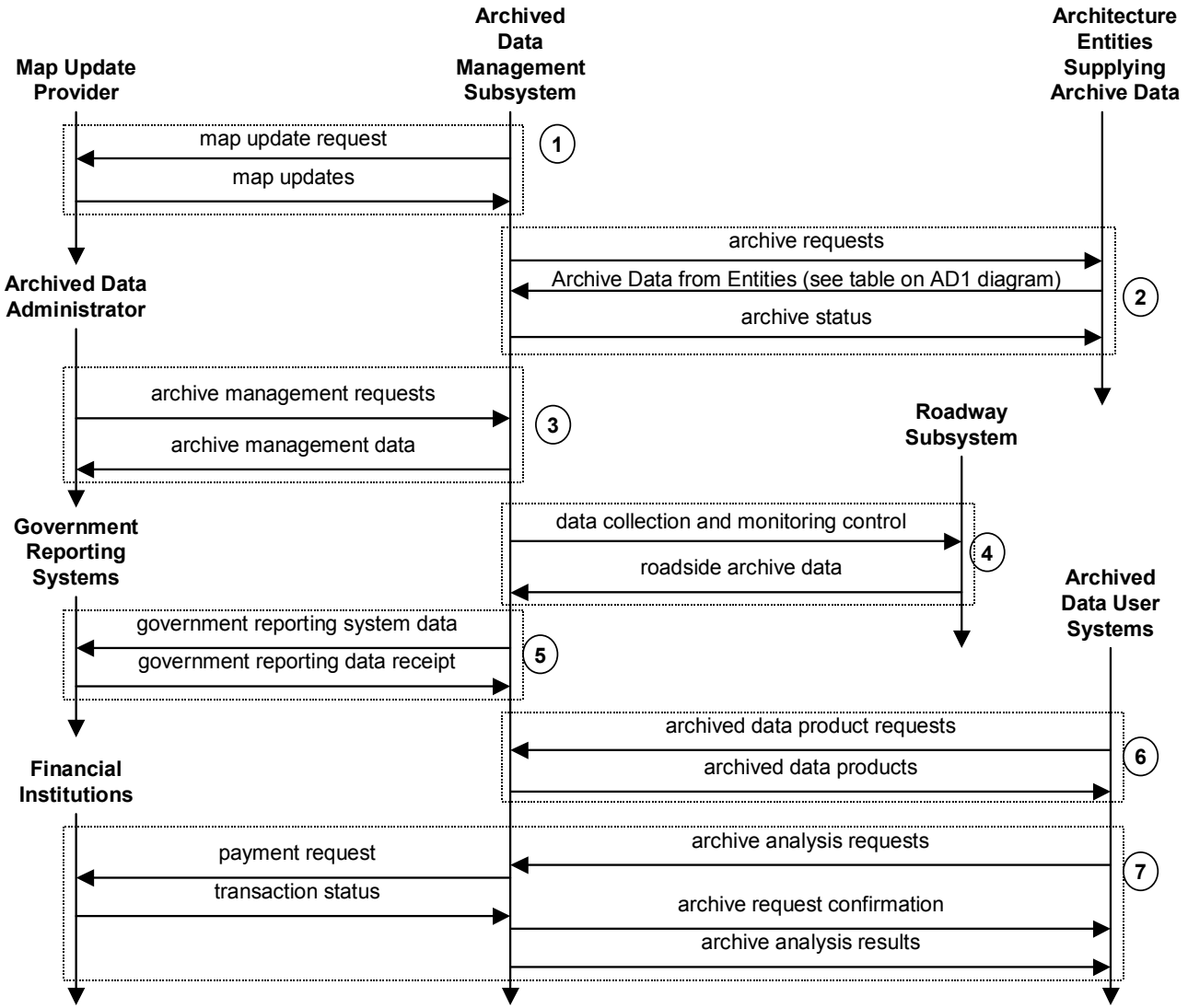
This Market Package collects and archives operational data from multiple sources. The sources can be selected from a variety of ITS subsystems or terminators. The institutional deployment of such a market package usually will be an agency such as an MPO (Metropolitan Planning Agency) or State Agency that wishes to archive operational data across a region, and then make that archived data available to external users or government reporting systems. It is analogous to a library whose collection is acquired from multiple publishers. This Market Package includes all the interfaces of the AD1 Market Package, and in addition an extended interface for the Archive Data User Systems that allows customized archive data analysis and reports to be generated, with the option of payment to the archive for these services.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. Each numbered item describes the operation of that portion of the market 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) with subscription updates from a Map Update Provider.
2. The ADMS can request or subscribe to operational data from one of the subsystems or terminators in the table in the AD1 diagram that follows. On receipt of submitted operational data, the ADMS can confirm to the source that the data was received.
3. An Archive Data Administrator can set operational parameters on the archive. 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.
4. A special interface is available to allow the archive to control and collect monitoring data directly from Roadway subsystem monitoring equipment. This is in support of operations to collect data that will be used for federal HPMS (Highway Performance Monitoring System) reporting requirements.
5. A special interface is also provided for standard government reports (again, such as, but not limited to, HPMS reports).
6. An interface is provided for archive users, to specify and then receive archived data products.

The Archive Data User Systems may request customized or predefined archive data analysis and reports to be generated, with the option of payment to the archive (using a separate Financial Institution interface for payment reconciliation) for these services. 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).

AD2: ITS Data Warehouse



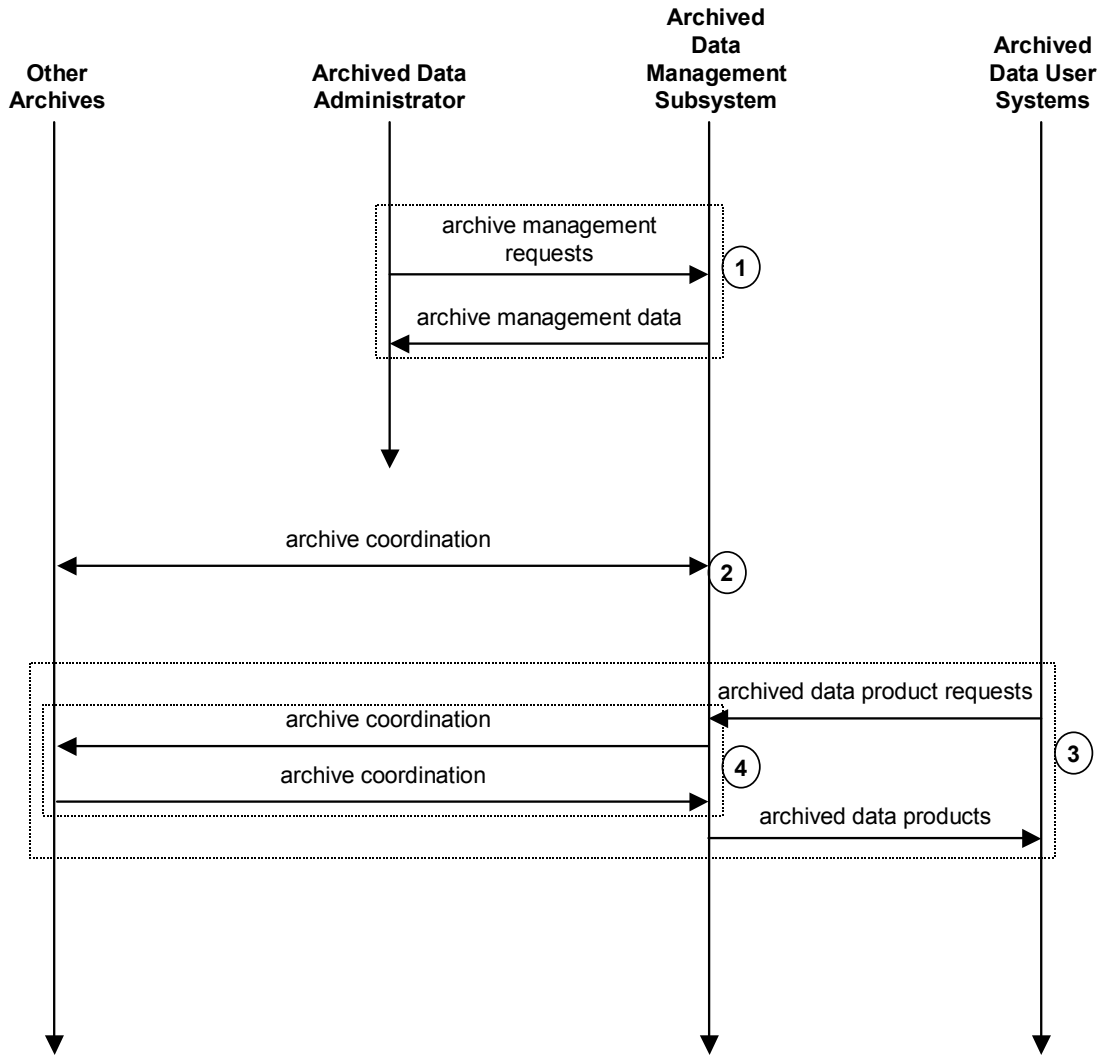
8.3. AD3: ITS Virtual Warehouse

This Market Package collects and archives operational data from other Archive Data Warehouses. The institutional deployment of such a market package usually will be an academic institution or State Agency that wishes to archive or use operational data across a wide region, and then make that archived data available to external users or government reporting systems. It is analogous to a library whose collection is acquired from other libraries. The benefit of such an archive is that it can offer, "one stop shopping" for archive data users.

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

1. An Archive Data Administrator can set operational parameters on the archive. 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.
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 specify and then receive archived data products.
4. If necessary to be responsive to an Archive Data User System, the archive may request and get information from one or more Other Archives.

AD3: ITS Virtual Data Warehouse



9. Advanced Vehicle Safety

This section provides the Theory of Operations for the Advanced Vehicle Safety Market Packages. The acronym used in National ITS Architecture tables (and seen below in the title of each market package section) to identify these market packages is AVSS—Advanced Vehicle Safety Systems. For all but one of these Market Packages, there are really no machine-to-machine interfaces outside of the vehicle. (That is not true for the last market 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

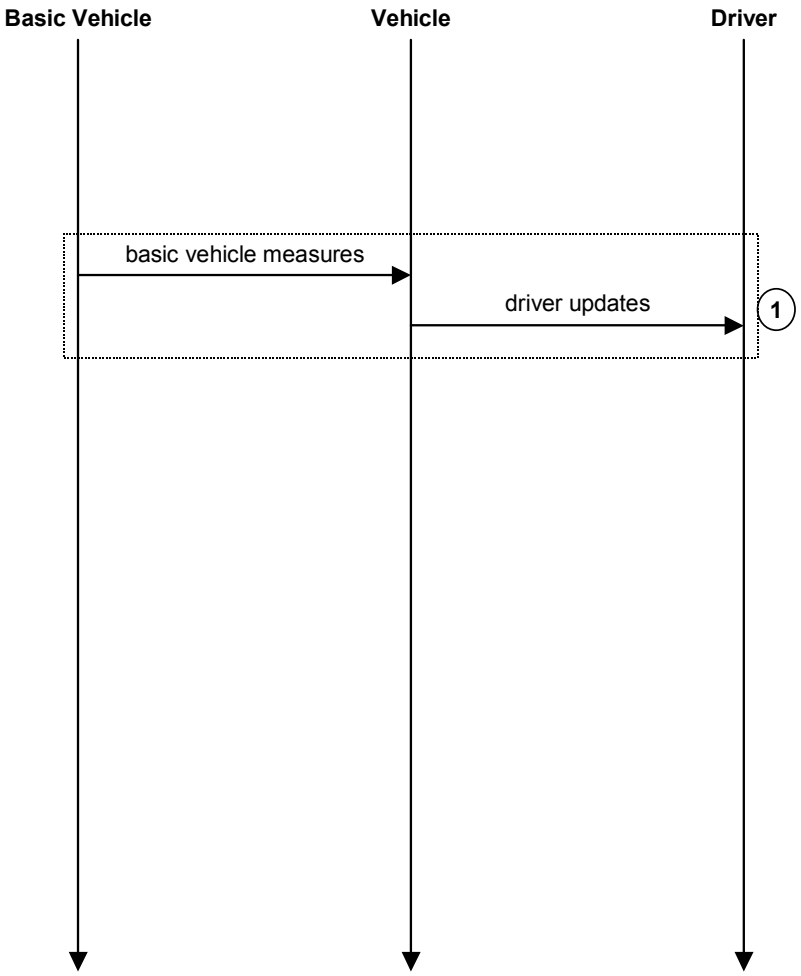
This market package will diagnose critical components of the vehicle and warn the driver of potential dangers. On-board sensors will determine the vehicle's condition and performance, determine on-board safety data and display information.

In this and subsequent market packages in this area, the "Basic Vehicle" represents the non-ITS part of the vehicle, and the Vehicle subsystem, represents the ITS part.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. The numbered item describes the operation of the market package elements 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. The Vehicle subsystem analyzes this data and presents updates and alarms to the Driver.

AVSS01: Vehicle Safety Monitoring



9.2. AVSS02: Driver Safety Monitoring

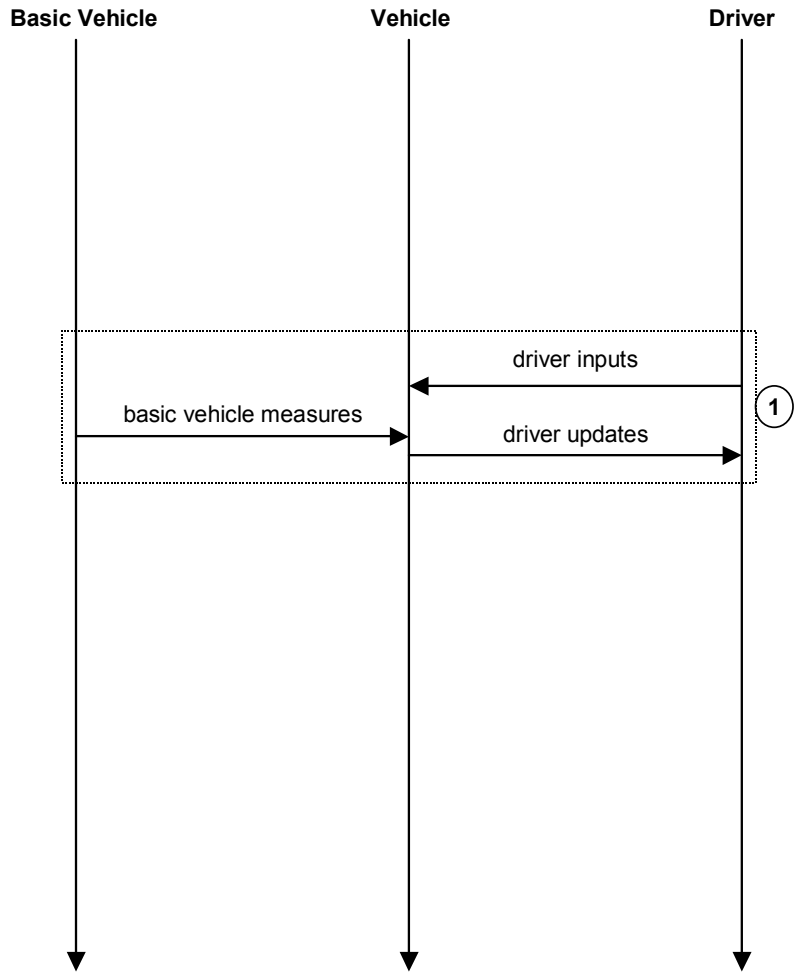
This market package will determine the driver's condition, and warn the driver of potential dangers. On-board sensors will determine the driver's condition and performance, determine on-board safety data and display information.

This market package is similar to AVSS01, except that inputs from the driver are also included.

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

1. The vehicle receives input from the Driver (e.g. throttle, brake and steering) as well as inputs for example motion detectors, eye movement detectors, and breath analyzer. 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. The Vehicle subsystem analyzes this data and presents updates and alarms to the Driver.

AVSS02: Driver Safety Monitoring



9.3. AVSS03: Longitudinal Safety Warning

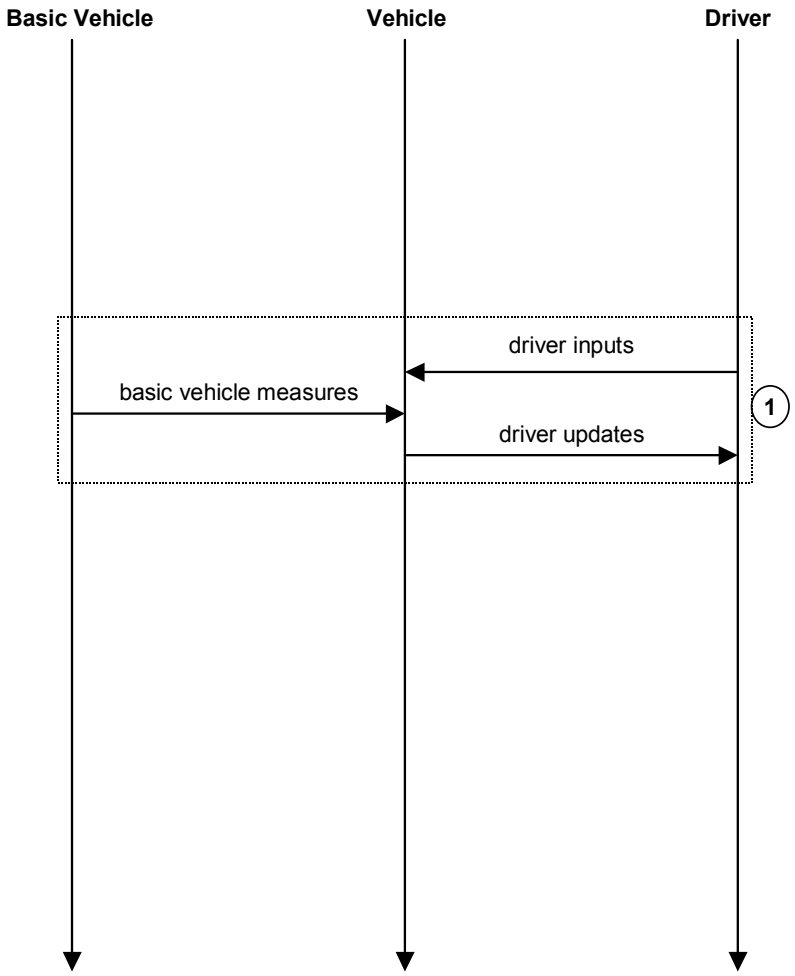
This market package allows for longitudinal warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas in front of and behind the vehicle and present warnings to the driver about potential hazards.

This market package is similar to AVSS02, except that inputs from the vehicle explicitly include sensors regarding speed, throttle, and sensor data regarding the position of objects in the line of travel of the vehicle.

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

1. The vehicle receives input from the Driver (e.g. throttle and brake). 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 as well as sensor data regarding objects that may be in front of or behind the vehicle. The Vehicle subsystem analyzes this data and presents updates and alarms to the Driver regarding potential collision with objects, people or vehicles ahead or behind of the vehicle.

AVSS03: Longitudinal Safety Warning



9.4. AVSS04: Lateral Safety Warning

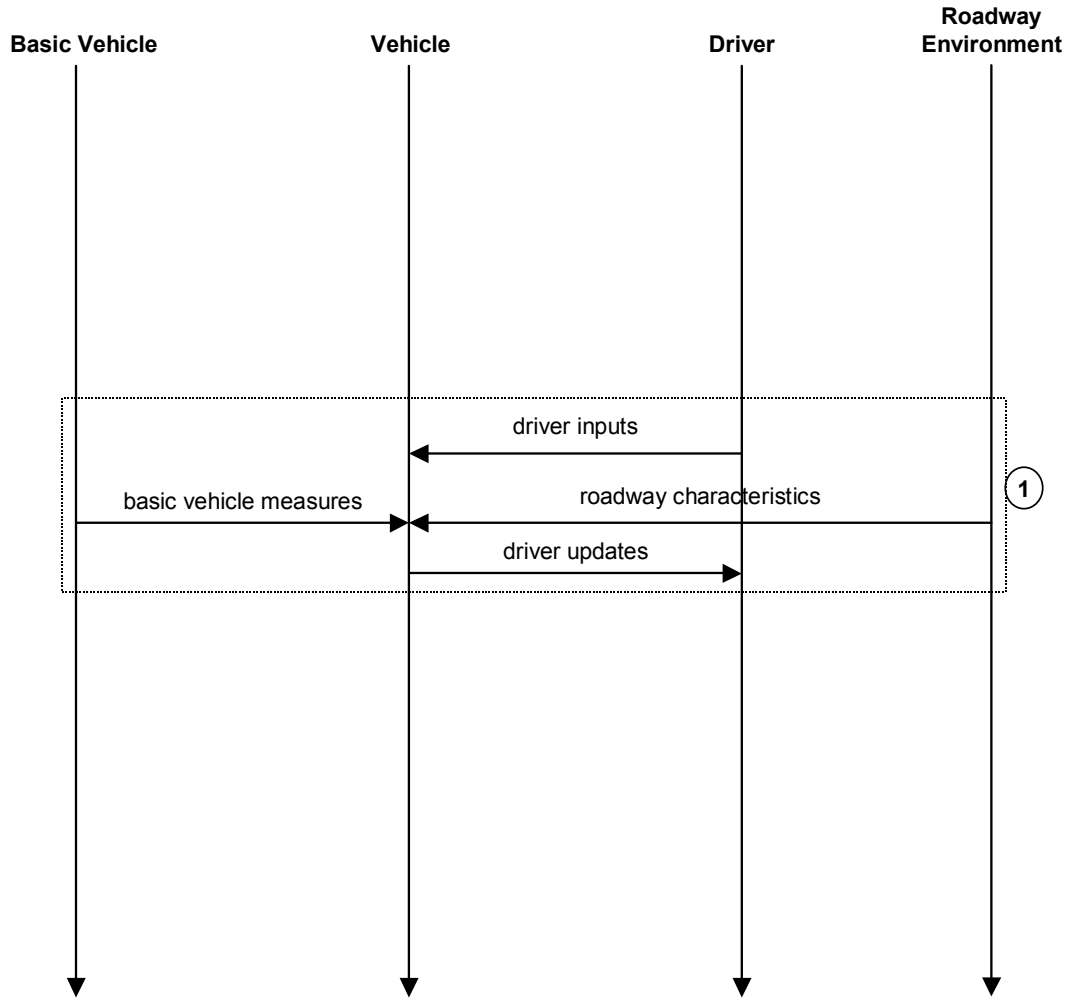
This market package allows for lateral warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas to the sides of the vehicle and present warnings to the driver about potential hazards.

This market package is similar to AVSS02, except that inputs from the vehicle explicitly include sensors regarding steering, speed, throttle, and sensor data regarding the position of objects in the line of travel of the vehicle and with respect to the lane the vehicle is traveling in (lane holding and lane departure).

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

1. The vehicle receives input from the Driver (e.g. steering). 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 as well as sensor data about lane position. The Vehicle subsystem analyzes this data and presents updates and alarms to the Driver regarding potential lane departure conditions.

AVSS04: Lateral Safety Warning



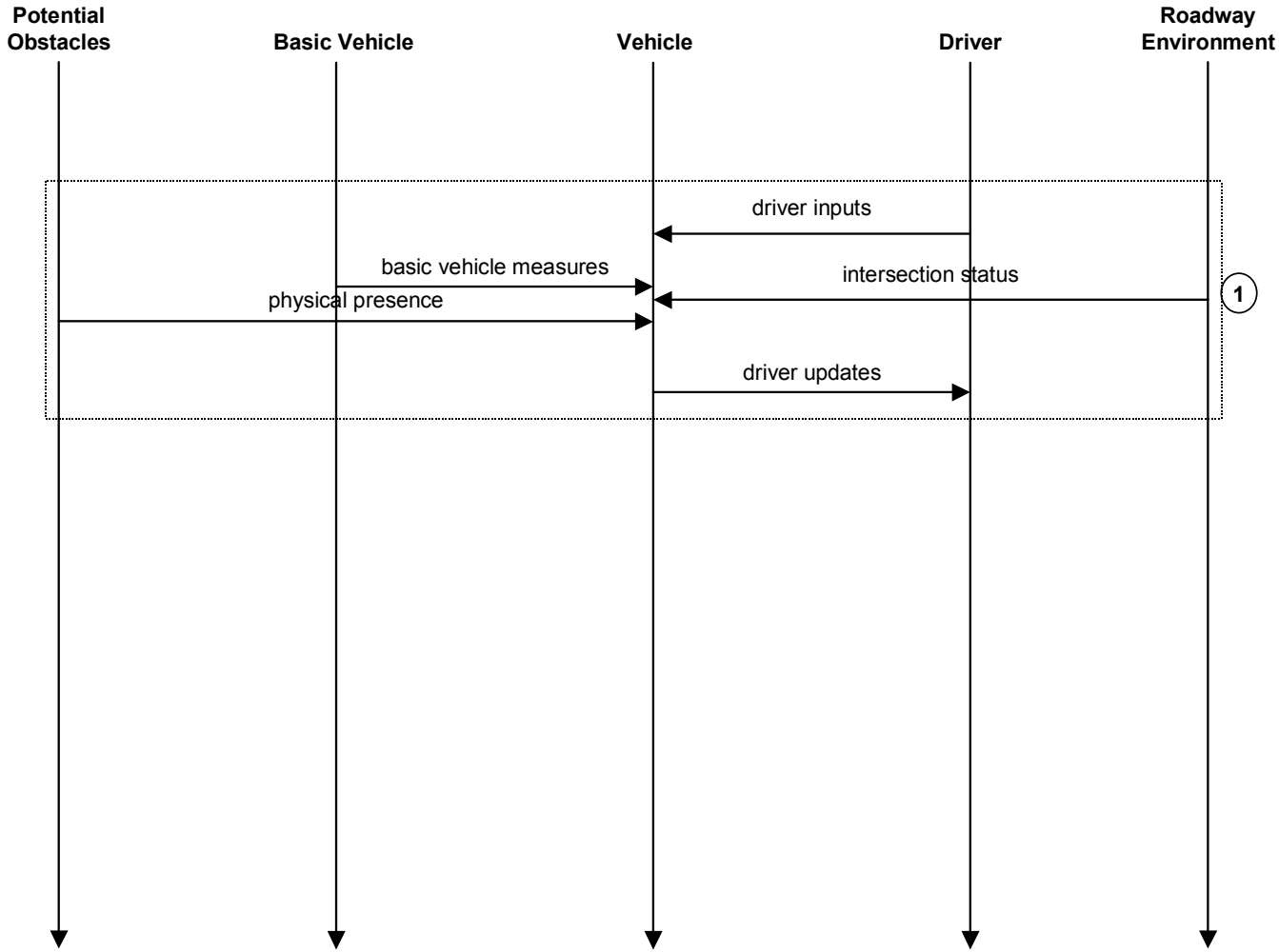
9.5. AVSS05: Intersection Safety Warning

This market package will determine the probability of a collision in an equipped intersection (either highway-highway or highway-rail) and provide timely warnings to drivers in response to hazardous conditions. Monitors in the roadway infrastructure assess vehicle locations and speeds near an intersection. Using this information, a warning is determined and communicated to the approaching vehicle using a short range communications system. Information can be provided to the driver through the market package ATIS9--In-Vehicle Signing.

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

1. This market package combines longitudinal and lateral safety warning features with sensor input regarding the Roadway environment and Potential Obstacles to provide intersection collision warnings to the driver.

AVSS05: Intersection Safety Warning



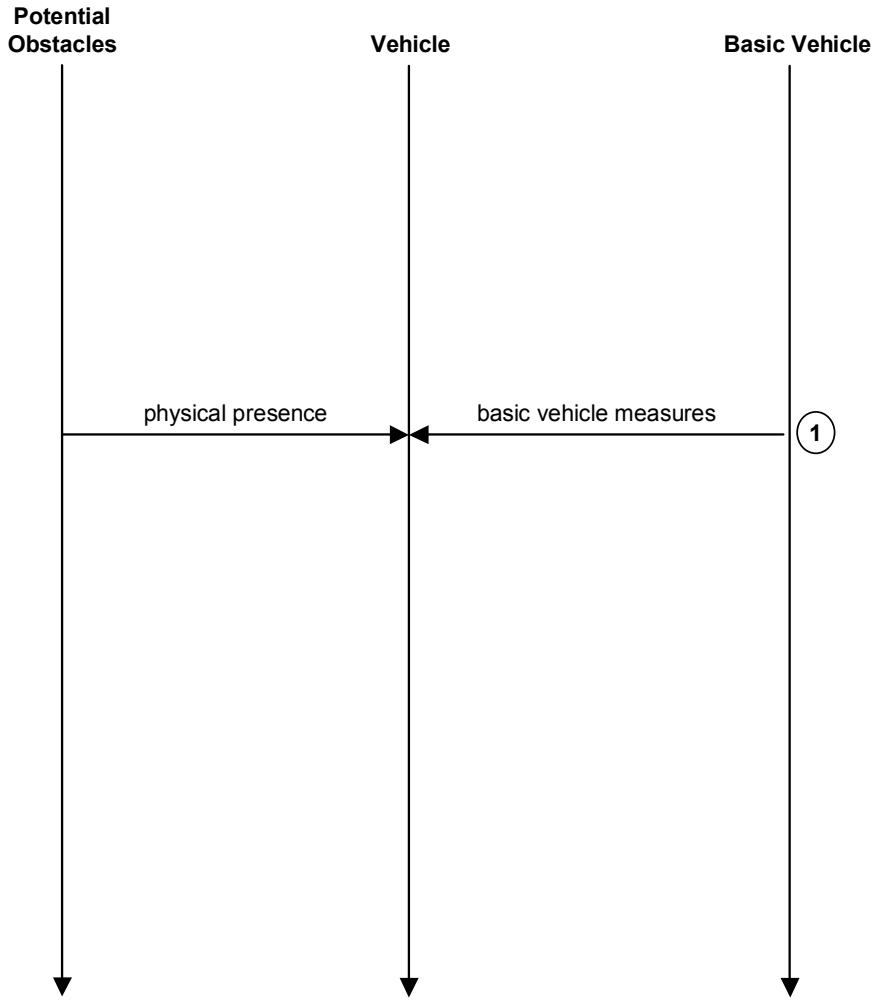
9.6. AVSS06: Pre-Crash Restraint Deployment

This market package provides in-vehicle sensors 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 have the mechanism to deploy a pre-crash safety system.

The following discusses how the National ITS Architecture provides the transportation service described by this market package. The numbered item describes the operation of the market package elements 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.

AVSS06: Pre-Crash Restraint Deployment



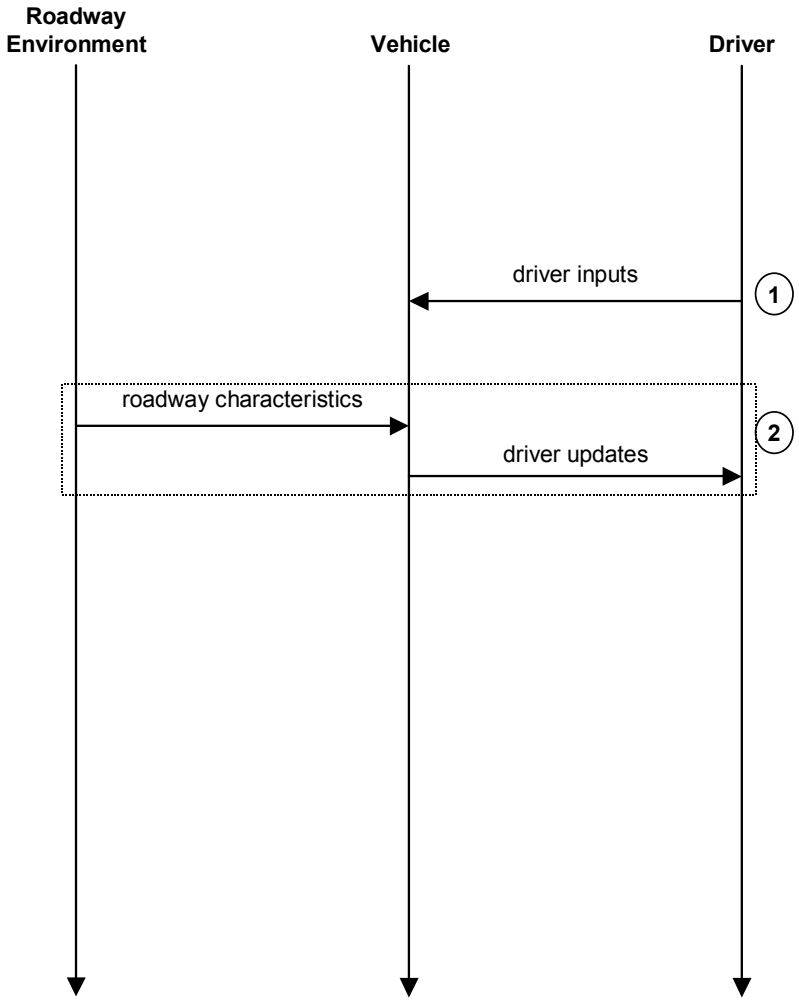
9.7. AVSS07: Driver Visibility Improvement

This market 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 market package. Each numbered item describes the operation of that portion of the market 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
2. The vehicle senses characteristics of the roadway and environment and presents this as an enhanced image to the driver.

AVSS07: Driver Visibility Improvement



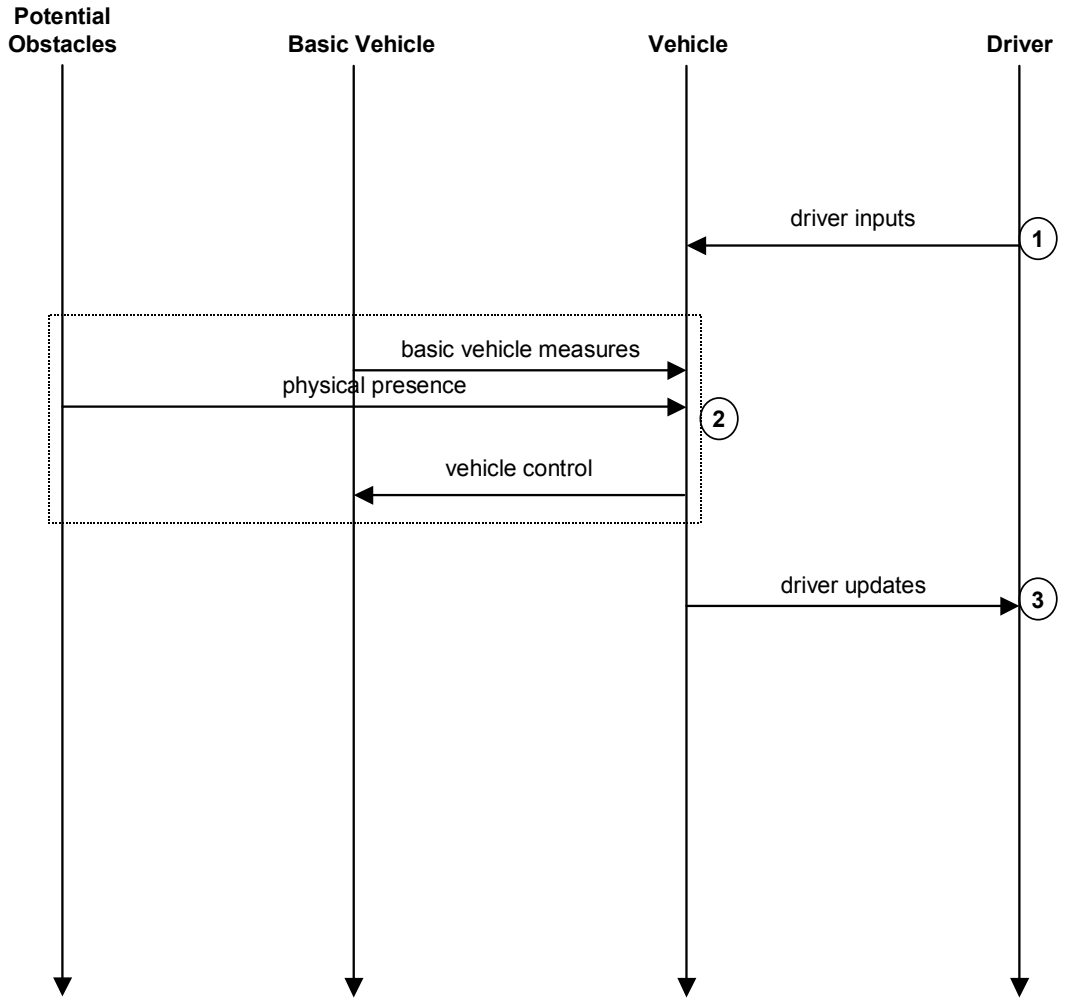
9.8. AVSS08: Advanced Vehicle Longitudinal Control

This market 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. The driver can activate the system as well as provide steering and other vehicle control inputs to the vehicle.
2. The vehicle receives basic vehicle measures (speed, surface traction) as well as physical presence of potential obstacles. If a collision seems possible, the vehicle may take evasive action (e.g. change in throttle position, change in transmission gearing, braking).
3. Driver is updated on longitudinal collision and control conditions.

AVSS08: Advanced Vehicle Longitudinal Control



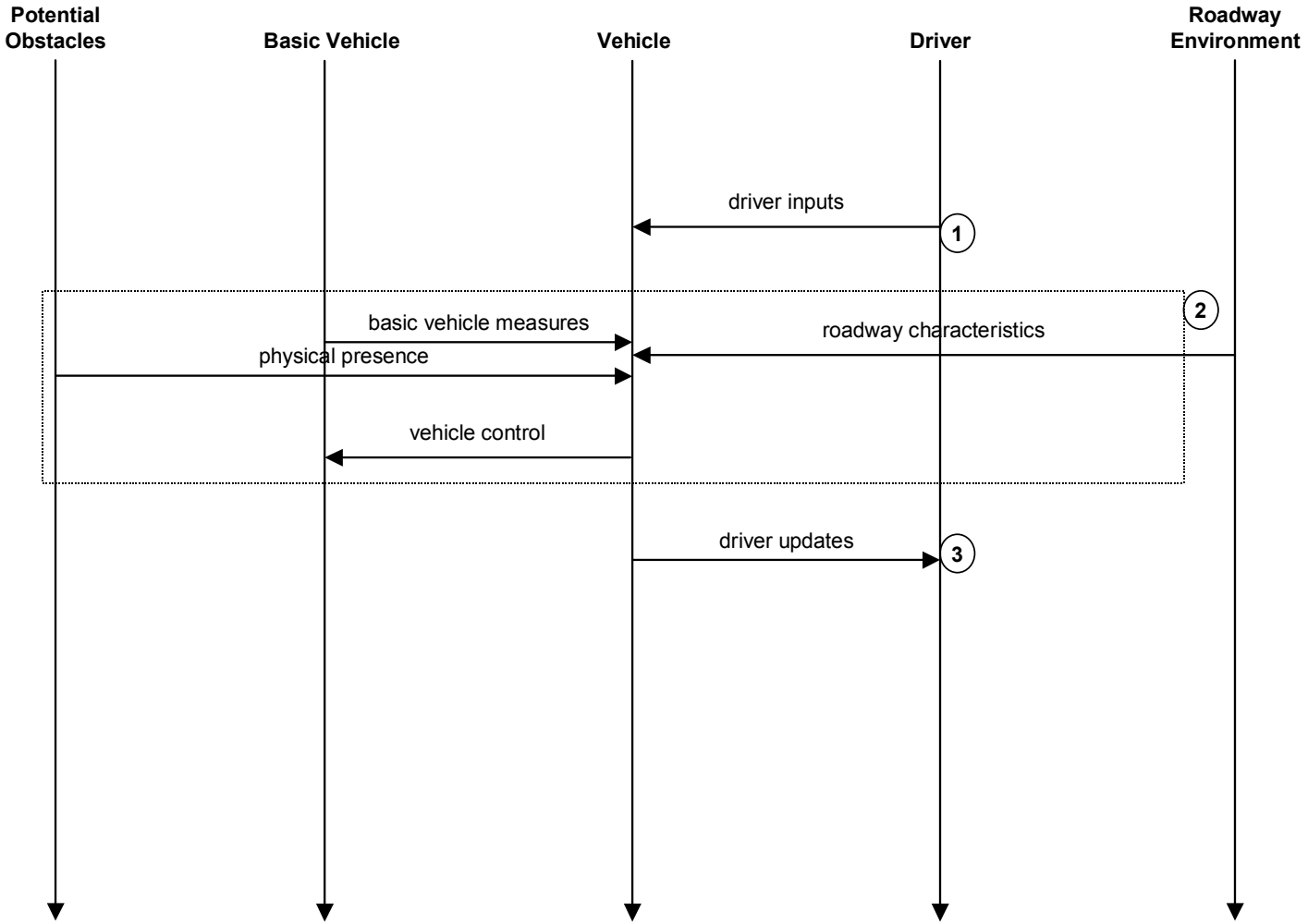
9.9. AVSS09: Advanced Vehicle Lateral Control

This market 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 market package. Each numbered item describes the operation of that portion of the market package identified with the corresponding number on the transaction set diagram.

1. The driver can activate the system as well as provide steering and other vehicle control inputs to the vehicle.
2. The vehicle receives basic vehicle measures (speed, surface traction), physical presence of potential obstacles and Roadway Environment 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).
3. Driver is updated on lateral collision and control conditions.

AVSS09: Advanced Vehicle Lateral Control



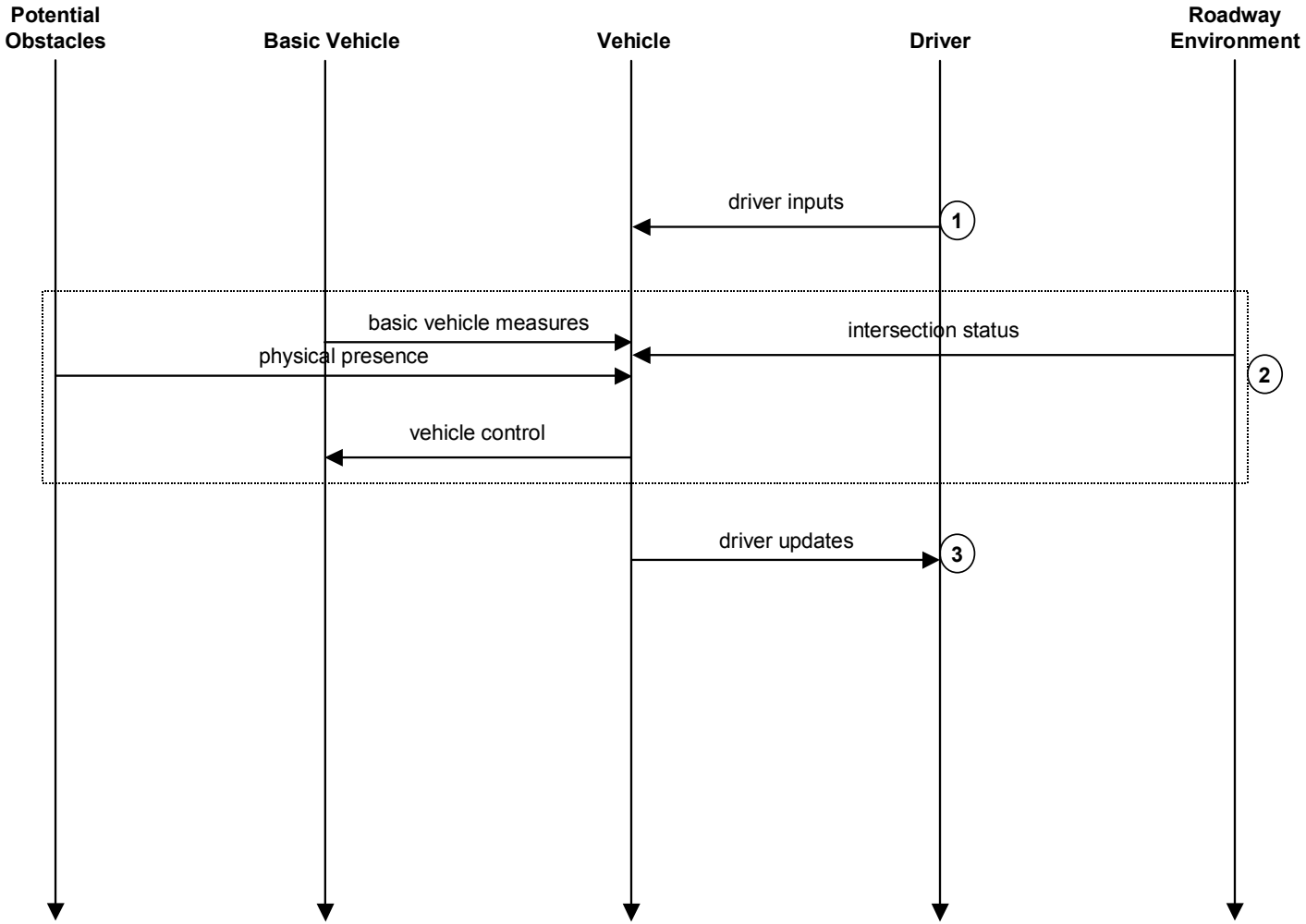
9.10. AVSS10: Intersection Collision Avoidance

This market package combines advanced vehicle lateral and longitudinal control features with sensor input regarding the Roadway environment and Potential Obstacles to provide intersection collision avoidance maneuvers in addition to driver updates.

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

1. The driver can activate the system as well as provide steering and other vehicle control inputs to the vehicle.
2. The vehicle receives basic vehicle measures (speed, surface traction), physical presence of potential obstacles and intersection status input (e.g. lane marker position, turning movement constraints). If a collision seems possible or if the vehicle seems to be departing from the correct turning movements, the vehicle may take evasive action (e.g. adjust steering position, change in throttle position, change in transmission gearing, braking).
3. Driver is updated on intersection collision avoidance conditions.

AVSS10: Intersection Collision Avoidance



9.11. AVSS11: Automated Highway System

This market package enables "hands-off" operation of the vehicle on the automated portion of the highway system. Implementation requires lateral lane holding, vehicle speed and steering control, and Automated Highway System check-in and checkout. This market package currently supports a balance in intelligence allocation between infrastructure and the vehicle pending selection of a single operational concept by the AHS consortium.

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

1. The Roadway subsystem provides status of the AHS system to the Traffic Management subsystem, and the Traffic Management subsystem provides AHS control information to the Roadway subsystem.
2. The Vehicle subsystem collects information from the Driver (e.g. control inputs), and non-ITS system status measures from the Basic Vehicle
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. 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 AHS control data to the individual vehicles. This could be information about when and where to merge into or depart the AHS lane.
6. The Vehicle subsystem can send vehicle control information to the basic vehicle (e.g. steering, braking, and throttle position).
7. The Driver receives status updates about the AHS system and Vehicle condition.
8. The vehicle can notify the roadway about its condition.

AVSS11: Automated Highway System