National ITS Architecture Logical Architecture – Volume I Description

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Prepared for:

Federal Highway Administration
US Department of Transportation
Washington D.C. 20590

October 2003

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1. Introduction

1.1 Functional Requirements Process Model

The Logical Architecture is based on a Computer Aided Systems Engineering (CASE) model. It models the requirements of the flow of data and control through various functions included in Intelligent Transportation Systems (ITS). Structured Data Flow Diagrams and Specifications, the components of the "Structured Analysis" approach used to define the Logical Architecture, are presented in this volume. These components illustrate the decomposition of the Transportation User Service Requirements (USRs) that define the National ITS Architecture specific strategic requirements to processes and information flows. The Logical Architecture CASE model depicts transportation systems, such as, Traffic Management, Transit Management, and Emergency Management, as well as the "terminators" that bound these systems. The Logical Architecture includes the input (source) terminators and output (sink) terminators of ITS, but not the information imbedded in these terminators, and defines the information flow into, within, and out of the systems. It is the formal representation of the ITS operational concepts that are described in the Theory of Operations Document.

The Logical Architecture is first illustrated as a single function in a high level "System Context Diagram". This diagram shows the inputs (sources) and outputs (sinks), between ITS and external terminators. The Context Diagram is then decomposed into the highest level Data Flow Diagram (DFD) that shows the highest level processes within the ITS Architecture. These processes are then further decomposed into lower and lower level DFDs.

At the lowest level of this decomposition, Process Specifications (P-Specs) are written to define the functions necessary to satisfy the USRs and how the output data flows are constructed from its input data flows. P-Specs are used to represent the sources and sinks of data flows within ITS.

The Logical Architecture is also mapped into a Physical Architecture which assigns the logical processes to physical subsystems. This mapping is documented in the Physical Architecture Document.

1.2 Architecture Strategies and Principles

The following provides a general high-level summary of the various strategies and principles that the Architecture Development Team has followed in developing the National ITS Architecture so as best to achieve the goals of ITS and the USRs.

1. Permit a low entry cost.

   The architecture provides immediate service to all users, regardless of the degree of special instrumentation available to them. This is accomplished by using all the information available from terminators to devise a management strategy. The necessary information is then disseminated to the users through the information channels available to them. Users having access to advanced channels can receive improved service which will provide incentives for deployment of ITS instrumentation. Also this structure will not deny service to those users who do not own the advanced channels. Less advanced service may be provided to the latter users through publicly available channels such as DMS (Dynamic Message Signs), RDS (Radio Data Systems), HAR (Highway Advisory Radio) and conventional media.

   It is generally believed that ITS benefits should be available to large numbers of commercial and private travelers at minimum or no cost. Some examples of how the Architecture Development Team has designed this into the architecture are:

   a. Commercial Vehicle Operations (CVO) with an ID tag. The architecture allows a commercial vehicle to have only an inexpensive electronic ID-tag in order to participate in the basic electronic clearance at roadside stations.

b. Low/no cost traveler information services. Travelers will benefit from better regional travel information broadcast by commercial AM/FM/Cable operators if these operators use the travel information that is available from local traffic management centers and information service providers via ITS media interfaces.

c. Toll-tag services. The National ITS Architecture supports the current deployment of toll-tags.

2. Provide choices in price/performance for travelers to receive user services.

The National ITS Architecture provides not just a single implementation of each user service, but in many cases supports a multiplicity of implementations with varying performance and associated costs to the user.

For example, in the area of route guidance, the architecture supports three distinct modes of operation:

a. Traveler-based route selection, where all route selection processing equipment as well as the navigable database that route selection is based on is included in equipment located with the traveler (either in their vehicle or in their portable computer). This approach provides a high degree of autonomy in both equipment usage and design.

b. Traveler-based route selection coupled to infrastructure-based and provided link/queue-times. In this method, the traveler-based route selection system is augmented by data from the infrastructure about current and possibly estimated future (predicted) link transit times and intersection queue delays. Using this type of data, the traveler will be able to use his equipment to compute better routes since his static navigable road database will be augmented with dynamic information about current and predicted congestion conditions.

c. In-vehicle route guidance coupled to infrastructure based route processing. In this approach the infrastructure (i.e., an ISP) processes the route based upon the traveler route request. The mobile equipment is simplified since it no longer requires a navigable map database, or the processing power to calculate a best route (only the processing power to display the route guidance).

3. Protect traveler privacy.

In the area of privacy the National ITS Architecture takes into account that travelers have many distinct needs and preferences with respect to privacy and the architecture provides the capability for these needs to be met:

a. Traveler Choice. The route selection choices above offer a spectrum of options with respect to privacy for the traveler using ITS. The traveler can select routes totally independently of any infrastructure based entity, or they can choose a higher level of service that requires allowing the infrastructure to provide personalized service which requires sending personalized messages to their specific mobile equipment. An ISP has the option to provide "cash" based accounts for travelers that wish to be completely anonymous, even with infrastructure based service.

b. Architectural Privacy in the Private Domain. The ITS Architecture specifies that when personal or confidential data needs to be stored in the infrastructure (to provide a selected user service), it is stored at an ISP. By limiting personal or confidential information to the records of an ISP, which can be a privately held organization, this information is protected from access by federal or state Freedom of Information Act (FOIA) inquiries.

c. Architectural Information Security. The ITS Architecture allows state-of-the-art processes for message exchange using public key encryption and authentication, assuring that personal or confidential information is protected from unauthorized access.

4. Accommodate increasing levels of system integration.

   The ITS Architecture is designed not only to support the introduction of new technologies, but has been designed to incorporate advances in technology to provide higher levels of system integration and performance. Advanced concepts such as Dynamic Traffic Assignment can be supported by the architecture. Through the coupling of Traffic Control and infrastructure based Route Selection the architecture can, when the technology permits, approach optimum performance.

   By clearly separating the ITS application layer (i.e., the Transportation Layer) and the more commodity communication layer, the National ITS Architecture can rapidly incorporate the frequent advances in communications and computing technology.

5. Assure equity.

   Providing an equitable division of benefits and costs is a key design strategy for the National ITS Architecture Development Team. By splitting the key ITS infrastructure elements between private and public entities, the National ITS Architecture is able to assure equity in expenditures/payments. Public funds are used by public agencies to benefit all travelers equally, and private funds (and fees) are used to supply additional "value add" services to those individuals willing to pay for those services.

6. Promote detailed, open standardization to maximize interoperability and reduce market risk.

   One of the most important requirements of the National ITS Architecture is interoperability -- the ability for the user to obtain user services nationwide with a single set of equipment. To do this the architecture effort must choose limited areas of detailed national standardization to maximize interoperability and market breadth for travelers and manufacturers.

   Certain areas of the architecture should be the focus of only limited standardization where possible to protect existing investments and to allow market forces to come into play.

   The issue of existing investments is particularly important with regard to current public infrastructure investment for TMS (Traffic Management Subsystem) to roadside communications and for TMS and roadside equipment. The architecture's roadside and TMS subsystems have been designed so that current equipment can coexist with most features of the architecture. In addition the architecture has been designed so that messages from one subsystem to another are not dependent on the particular path that they take, media or protocols.

In the area of market forces, some portions of ITS have already been deployed. In some of these areas it is most appropriate to let the market forces drive the standards. Dedicated Short Range Communications (DSRC) interfaces are currently hotly contested in the marketplace. (E.g., in the area of toll/id tags, there are competing "standards" within the industry.) The market and the participants in these markets will most likely determine the applicable communication standards.

7. Leverage the existing and emerging open infrastructures.

   Communications is key to providing ITS user services to a wide range of users. The National ITS Architecture employs a strategy to maximize use of the existing (and planned future) communications infrastructure. This approach has the following benefits:

   a. Minimized capital investment. A national communications infrastructure to support ITS would be costly to deploy if it were only to be used for ITS. The capital formation necessary for this hypothetical ITS only infrastructure could substantially limit or slow the deployment of ITS.

b. Expedited deployment. The ITS Architecture makes use of existing, operational, commercially available wired and wireless data communications services. This does not preclude the continued use of dedicated services where they make sense, such as some public safety, transit, and regional trucking/dispatch services.

c. Elimination of dependence on new spectrum allocations. New spectrum requirements dependent on FCC approval could delay and add considerable risk to the ITS evolutionary deployment.

8. Facilitate profitability for private industry to accelerate early deployment.

New travel information technologies will require capital investments to deploy. The private sector is best prepared to rapidly form capital and efficiently deploy advanced technologies where a profit model can be identified.

The Information Service Provider (ISP) concept in the National ITS Architecture allows for a multiplicity of vendors (public or private) to compete for the traveler's business. Travelers will benefit from a competitive environment of many ISPs that will supply choices of service levels, privacy levels, and cost levels.

a. Enable opportunities for advertising. In addition to ITS services for sale, any ISP will be able to use the interfaces defined by the National ITS Architecture to communicate advertising to their traveling customers. The purpose of this feature is to enable an additional revenue stream to an ISP to subsidize the cost of providing infrastructure based traveler services. The amount that travelers will be willing to pay for ITS services is still unknown. By subsidizing the cost of the services with advertising, the number of travelers who will have access to personalized ITS services will increase.

b. Combine with the sale of other services. Cellular data services are anticipated to be used for supplying a range of information services to mobile users (e.g., e-mail, news services). By combining ITS services and these other commercially viable services, the ITS user community is broadened. The revenue to an ISP providing other services will subsidize the cost of supplying ITS services.

9. Maintain an open architecture, unbiased towards any particular products.

Use of open standards is a priority of the architecture. All subsystems in the architecture will support a range of existing or anticipated product offerings from an unlimited range of hardware or service providers.

Exceptions to this approach were made in the case of DSRC where the markets are currently dominated by a small number of offerings which use proprietary communication interface standards. The Architecture encourages this community to eventually migrate to open standards to the mutual benefit of all participants.

10. Avoid new public agency liabilities.

Liability is managed differently by public and private entities. Private entities have several alternative mechanisms for managing liability (e.g., insurance, legal disclaimers of liability) that are not available or as readily available to public agencies. As a result, public agency officials (e.g., at a TMS) may be reluctant to take on new liability associated services, especially pertaining to vehicle control. Alternative provision of user services by an ISP is an architectural feature arising from this strategy.

One of the areas of public liability that is under study is in the Automated Highway System (AHS) services. The level of infrastructure involvement, and the liabilities associated with this are currently under study in other FHWA efforts. The current architecture implements a form of AHS which minimizes (but does not preclude) the infrastructure component. This is consistent with the view of

AHS as an evolution from the Advanced Vehicle Safety User Services. In this way, new safety liabilities continue to reside primarily with private companies (that manufacture the equipment or offer the services) that are best prepared to manage the new liabilities.

11. Encourage public-private infrastructure cooperation.

    By carefully allocating processes to public and potentially private subsystems, the National ITS Architecture has been designed to encourage mutually beneficial cooperation between public and private institutions through exchange of surveillance and predictive model data.

    Examples of this are:

    a. TMSs providing surveillance data to ISPs which will allow the ISPs to compute better routes for their clients.

    b. The ISPs providing (anonymous) probe data to the TMSs so that their surveillance of non-instrumented roadways is enhanced and thus their ability to manage traffic for all travelers is enhanced.

    c. Similarly, TMSs can access traffic data stored at neighboring TMSs over the data network.

12. Enhance traveler safety.

    The ITS Architecture Development Team believes that enhancing traveler safety is a key requirement for the architecture. There are many ways in which the National ITS Architecture will enhance safety. Some of these are:

    a. Reduce emergency response time. Early safety analysis has proven that any reduction in time between the occurrence of an accident with injuries and the arrival of medical help has a substantial impact on survivability. In the high-end state architecture, the routes of emergency vehicles will be selected by the infrastructure, and those routes will be communicated to the TMS Traffic Management service package for preemption signal service for the emergency vehicles (with minimal disruption to the rest of the transportation network). In addition, rapid data based deployment of emergency response vehicles via the Emergency Management Subsystem provides help to incidents faster, and enhances traveler safety as a direct consequence.

    b. Augment 9-1-1. The Architecture Development Team has developed an interface between the Emergency Management Subsystem (EM) function and the existing 9-1-1 services. This enables rapid coordination between existing telecommunication public safety interfaces, emergency fleet management, and traffic control.

    c. Reduce congestion. By using available and future demand management tools that the architecture makes available to local public agencies, congestion can be reduced and controlled, thus reducing the number of transitions from free-flow to stop-and-go traffic conditions. These transitions have been identified in preliminary safety analysis as a cause of traffic accidents as well as a source of excess pollution.

    d. Fail-safe infrastructure architecture. The National ITS Architecture has not allocated any new life threatening functions to the infrastructure. Vehicle control (for collision avoidance) remains primarily within the vehicle subsystem (and in the case of platoon operation and AHS related functions, is based on communication directly between adjacent vehicles). In the event of a total infrastructure failure, signals would fall back to local sensor based signal control or fixed time plans, exactly as they do today. Only in the case of intersection collision avoidance are safety critical surveillance processes allocated to the infrastructure.

13. Provide locally determined demand management capabilities for congestion and pollution management.

    For ITS to be desirable in some areas and in some time frames it must be able to address demand management (in addition to supply management). The architecture gives local agencies (and ultimately elected officials) enormous latitude to decide how limited transportation resources are to be allocated.

    The Architecture Development Team has designed the architecture so that any particular form of demand management is optional, and a local decision is required to deploy.

    a. Congestion Pricing. The National ITS Architecture can support DSRC based pricing on any link in the transportation infrastructure. The architecture can support the long term predictive models upon which congestion pricing decisions can be made.

    b. Vehicle Class Preferences. The National ITS Architecture supports DSRCs associated with vehicle classes, and vehicle classes can be verified by roadside sensors. Thus roads can be restricted to specific classes of vehicles by time-of-day or day-of-week and lanes and signals can give preferential service to different classes of vehicles.

       This mechanism would allow the exclusion of classes of vehicles from links or areas (e.g., commercial or public-transport vehicle only areas or vice-verse). This is basically the same mechanism used at the National ITS Architecture Roadside subsystem deployed for toll operation.

    c. Extensions of Ramp Metering and Mainline Metering. Ramp metering and mainline metering, both supported in the National ITS Architecture, have been shown to be effective methods for maintaining free flow of traffic on otherwise congested highways. The National ITS Architecture can be used to extend the "metering" paradigm to all links, and allow the route selection process to suggest alternate routes or trip start times.

1.3 Document Organization

This document is organized to conform to the guidelines provide by the Department of Transportation. The document is comprised of three volumes. This volume, Volume I, describes the Logical Architecture through DFDs and narrative overviews of each high level process. Section 1 is an introduction and contains background information that is intended to allow the reader to understand the Architecture in its context. The second section reviews the functional specification of the logical architecture. That section describes the Context Diagram, describes the purpose and types of Terminators used, and contains narrative descriptions of the DFD diagrams content and purpose. Note that the lowest level functions are described by P-Specs which are found in Volume II. Volume I also includes two appendices: Appendix A, a hierarchical listing of DFDs and process specifications, Appendix B contains a listing of all of the User Service Requirements.

The other two volumes are intended as references for technical users of the Architecture. Volume II of the Logical Architecture Document provides a complete printed set of the Teamwork Structured Analysis model P-Specs for each lowest level specification. Volume III provides the complete Data Dictionary model. It contains the definitions of all the data flows developed in the structured decomposition process. Each data flow is hierarchically composed of other data flows and/or primitive data flows (primitive data flows may not be decomposed further). Since a key requirement of the decomposition is to allocate the User Service Requirements to the Architecture, user requirements have been mapped to the Logical Architecture Process(es) which satisfy each requirement. This is found in the trace tables in the Logical Architecture Database. The Reference Volumes provide primarily technical details and are not necessary for a general understanding of the National ITS Architecture.

1.4 Methodology

1.4.1 Representation of Functionality

The National ITS Architecture is developed using a Structured Analysis methodology. The main source of methodology used in analysis and development of the logical and physical architecture by the National ITS Architecture Development Team has been based on the work of Hatley/Pirbhai.

This method uses Data Flow Diagrams (DFDs) to illustrate the flow of data between the functional elements that make up the architecture. There are three types of functional elements that are used in this approach:

- Terminators: provide the sources and sinks for external information that flows to and from the Architecture. Terminators are represented in boxes and appear on the top level Context Diagram.
- Data stores: internal placeholders for data and may appear on any DFD. They are shown on the Data Flow Diagrams where data repositories are required to support data aggregation or archival services.
- Process Specifications (P-Specs): describe the processes used to transform from input information into desired outputs.

On a DFD, anything other than a store or data flow is shown as a circular object or bubble. A bubble may be a P-Spec or may be further decomposed into a lower level DFD. Bubbles that are decomposed into lower level DFDs are identified by the notation "(dfd)" inside the bubble after the title. If no "(dfd)" is present then the bubble is a P-Spec.

1.4.2 Configuration Control

Strict configuration control throughout the Architecture development process and beyond is an absolute requirement of the Architecture Development Team. This long term strategy is essential to ensure that the Architecture implementation and deployment will be open and support seamless integration and interoperability across geographical locations. It also allows systems deployed by different manufacturers using parts of this documentation as a design guide to interface and work together as intended. This requirement dictates that the DFDs and Data Dictionary Entries (DDEs) shown in this document are automatically accessible to the Team's publishing system directly from the CASE database. In this way, as changes are made to the Architecture model, they can be applied to a new version of the architecture database, the checking tools available in the CASE tool can be applied to assure consistency, and quality documentation can be accurately generated.

2. Functional Specification

This section describes the detailed structure of the information contained in the ITS Logical Architecture. The diagrams referenced in this section are contained in Appendix A of this document. This section explains the use of Terminators in the logical architecture and lists the descriptions for each of the Data Flow Diagrams that make up the logical architecture. The ITS Logical Architecture Context Diagram, shown in Appendix A, provides a precise definition of the ITS Architecture boundary. It is made up of the ITS functional process and the complete set of terminators.

The Functional Specification is expressed in two ways. First, in graphical form as Data Flow Diagrams (DFDs), and second, in more detailed textual form as Process Specifications (P-Specs) and data flow descriptions.

In general, the DFDs provide a convenient "road map" of the structure of the requirements and are shown by the Figures in Appendix A of this document. They consist of lines showing data flows and "bubbles" that represent either a P-Spec, or a lower level DFD. Descriptions are provided for the DFDs starting from the highest level, DFD 0. DFD 0 shows the highest (least detailed) level of functionality needed to meet the User Service Requirements. Each of its nine "bubbles" is itself a DFD which provides a first level decomposition of the high level functionality. The "bubbles" within these nine DFDs are either P-Specs, or will themselves decompose into further lower level DFDs. Each of the descriptions provided in section 2.2 highlights the main features of the DFDs.

The P-specs provide the essence of the requirements in that they describe how data that flows into the Logical Architecture is transformed either for use elsewhere, or for output from the Architecture. The P-specs stand alone in that they completely and rigorously capture the functional requirements of the Architecture. A full textual description of the functionality provided by each P-Spec, including a list of User Service Requirements that they serve, is provided separately in Volume II of the Logical Architecture Document.

The descriptions of the data flows are contained in the Data Dictionary Entries (DDEs), which like the DFDs and P-specs, form a hierarchical structure. In this instance, the hierarchical structure enables one data flow to be comprised of several other data flows, each of which may decompose into other data flows until the primitive or lowest level data flows are reached. Due to their number and overall size, the DDEs describing each data flow, its components (if any), and size, are also provided separately as a second reference volume to this document - see Volume III of the Logical Architecture Document.

2.1 Terminators

Terminators define the boundary of the National ITS Architecture and provide external system interfaces to the processes and functions that support all of the User Service Requirements. The interfaces between terminators and the processes within the National ITS Architecture are defined, but no functional requirements are allocated to terminators. The descriptions of each terminator used in the Architecture may be found in the Physical Architecture Document. These terminators and their descriptions were selected to provide the most rigorous, yet flexible, system boundary acceptable within the constraints of the ITS requirements.

Types of Terminators:

Each of the terminators represents an external entity that communicates data to, or receives data from ITS functional processes. The terminators have been grouped into four types: Human, Systems, Environment, and Other Subsystems.

Human Terminators. These terminators represent the operators and users of ITS systems. The operators of ITS systems include personnel at ITS Center subsystems and Field subsystems as well as Drivers of various fleet vehicles (e.g. Transit Driver). Users of ITS systems include Drivers and Travelers who interact with ITS subsystems.

System Terminators. These represent the non-ITS Center systems (e.g., Media and Financial Institution), Field equipment (e.g. Wayside Equipment), and Vehicle equipment (e.g., an AM radio- which is considered to be part of the Basic Vehicle terminator) with ITS which will interact.

Environment Terminators. These represent the inputs that cause ITS sensors to create outputs. Examples are Traffic (which cause traffic sensors to generate outputs) and Environment (which causes environmental sensors to create outputs).

Other Subsystem Terminators. This is a representation that the architecture development team has adopted to indicate the interactions between multiple, similar subsystems, for example, vehicle-to-vehicle messages and Traffic Management Subsystem (TMS)-to-Traffic Management Subsystem messages. Considering the latter case of a TMS to TMS interface as an example, the logical architecture has a single set of processes describing surveillance, device control, etc. In order to describe the interface that covers the sharing of surveillance information from one TMS to another TMS, the logical architecture has data flows going to and from a process in the Manage Traffic portion of the logical architecture to the Other TM terminator.

The above definitions encompass all of the terminators defined for the architecture. This method of classification helps with understanding the type of information that flows to and from each terminator.

2.2 DFD Descriptions

The following are the descriptions of each of the DFD diagrams. The diagrams themselves can be found in Appendix A.

DFD: Context- Context Diagram

The ITS Logical Architecture Context Diagram provides a precise definition of the ITS Architecture boundary. It is made up of one bubble called "Manage ITS" to represent all of the functional process included in the architecture. The Context Diagram also includes a complete set of terminators that form the boundary of the National ITS Architecture.

Terminators provide external system interfaces to the processes and functions that support all of the User Service Requirements. The interfaces between terminators and the processes within the National ITS Architecture are defined, but no functional requirements are allocated to terminators. The descriptions of each terminator used in the Architecture may be found in the Physical Architecture Document. These terminators and their descriptions were selected to provide the most rigorous, yet flexible, system boundary acceptable within the constraints of the ITS requirements.

DFD: 0 Manage ITS

Data Flow Diagram 0 called "Manage ITS" shows the nine functional process trees that encompass all the functionality of the National ITS Architecture. The processes within these nine bubbles make up the functional decomposition of the Logical Architecture and are designed to satisfy all of the functional requirements of the 33 User Services (as defined in the User Service Requirements (USRs)). The processes have been created using a modular approach to enable partial or full deployment of functions depending on technological developments, and the needs of the implementers and stakeholders (jurisdictional authorities and private organizations). The modular approach also allows the inclusion of other later architecture developments without needing major changes.

The processes subordinate to this DFD are themselves DFDs:

1) Manage Traffic
2) Manage Commercial Vehicles
3) Provide Vehicle Monitoring and Control
4) Manage Transit
5) Manage Emergency Services
6) Provide Driver and Traveler Services
7) Provide Electronic Payment Services
8) Manage Archived Data
9) Manage Maintenance and Construction

DFD: 1 Manage Traffic

This DFD shows the processes that provide the Manage Traffic function. This function is responsible for providing facilities to manage traffic flowing in the area it serves so that the most efficient use is made of the surface street and freeway network. The User Services Requirements included in this functional tree are:

1.1 Pre Trip Travel Information
1.2 En-Route Driver Information
1.5 Traveler Services Information
1.6 Traffic Control
1.7 Incident Management
1.8 Travel Demand Management
1.9 Emission Testing and Mitigation
1.10 Highway Rail Intersections
3.1 Electronic Payment Services
5.3 Disaster Response and Evacuation
7.1 Archived Data Function
8.1 Maintenance and Construction Operations

The key points about the function are as follows:

- Collection of traffic data and traffic management provided for the surface street and freeway network;
- Collected data can be used by other ITS functions, operations personnel and the media;
- Incident management available based on pre-defined responses;
- Demand management available based on pre-defined policies and operational data;
- Pollution monitoring available both on a wide area and individual vehicle basis;
- Highway rail intersection is monitored and controlled;
- Intersection collision avoidance data provided to vehicles;
- Data can be exchanged with similar functions serving other geographic or jurisdictional areas.

There are six processes in this DFD all of which are themselves DFDs. They divide the overall functionality of the DFD between themselves in the following ways.

a) Provide Traffic Surveillance (DFD 1.1)
b) Provide Device Control (DFD 1.2)
c) Manage Incidents (DFD 1.3)
d) Manage Travel Demand (DFD 1.4)
e) Manage Emissions (DFD 1.5)
f) Manage Highway Rail Intersections (DFD 1.6)

Each of the traffic control, manage incidents and manage emissions facilities could be implemented independently without any of the others. In this form the traffic control process would be able to provide some improvement to the overall traffic flow within the surface street and freeway network, whereas the incident management and manage emissions facilities would do little more than provide data recording services. There would be little or no point in implementing the manage travel demand facility without any of the other facilities that provide the data on which the demand forecasting is based.

DFD:1.1 Provide Traffic Surveillance

This DFD shows the processes that make up the Provide Traffic Surveillance facility within the Manage Traffic function. These processes collect and store traffic data collected by sensors for use in traffic management, and by the media and other ITS functions. They are also responsible for using the data to generate a predictive model of network operation and for the exchange of data with Manage Traffic functions serving other areas.

The key points about the facility are as follows:

- Data collected about the passage of vehicles and pedestrians through the surface street and freeway network;
- Collected data is stored as either current data (five minutes old) or long term (historic) data;
- Collected data used by the Provide Device Control facility to control vehicles and pedestrians;
- Predictive model produced using long term data and data from other traffic management centers;
- Predictive model data used by the Manage Travel Demand and Route Selection facilities;
- Many ITS functions use the current, long term and predictive data stores as a source of traffic data;
- Traffic operations personnel can display current, long term and predicted data;
- Output sent to the media;
- Smart probe data collected from vehicles and provided both for storage and for output;
- Collected data and incident data is exchanged with other traffic management centers.

There are seven processes in this DFD and three are separate DFDs:

a) Process Sensor Data (DFD 1.1.1)
b) Process and Store Traffic Data (DFD 1.1.2)
c) Generate Predictive Traffic Model (1.1.3)
d) Display and Output Traffic Data (DFD 1.1.4)
e) Exchange data with Other Traffic Centers (1.1.5)
f) Collect Vehicle Probe Data (1.1.6)
g) Collect Vehicle Smart Probe Data (1.1.7)

All data about vehicles and pedestrians passing through the surface street and freeway network is collected by processes (a) and (f). It is then sent to processes in (b) which distribute it to other facilities and load it into the current and long term data stores. The data in these stores plus weather and incident data is used by process (c) to produce a predictive model of future traffic conditions. The results of this process and the data stored by processes in (b) are available for display by the traffic operations personnel and the media through the processes in (d). The long term data is also exchanged with other traffic centers, the data from which is also used as input to the predictive model by process (c).

Although all of these processes, except (a), (f) and (g), depend on others in the group for data, they will each operate continuously and independently. This enables traffic data to be processed, stored and accumulated in a timely fashion. Process (a) could be deployed on its own with some of the control processes in the Roadside Control facility - see DFD 1.2.7, to provide a roadside based traffic control facility with no links to any central system for coordination, fault reporting, etc.

Processes in (a) also controls the video cameras used for traffic surveillance. This enables them to be set up to collect traffic data from different "views", where a "view" is a particular video image of part of the surface street and freeway network. The "view" being provided by a camera may be changed by either the traffic operations personnel or automatically as part of a traffic control strategy through a process in the Provide Device Control facility - see DFD 1.2. This enables the same camera to be used to gather different traffic data at different times of the day, days of the week, etc. One example is the data needed to monitor traffic flows in the morning and evening peak traffic periods may need to be obtained from different "views".

DFD:1.1.1 Process Sensor Data

This DFD shows the processes that make up the Process Sensor Data facility within the Manage Traffic function. These processes analyze, collect, store, and distribute sensor data to other facilities.

The key points about the facility are as follows:

- Processed sensor data to other processes within the Manage Traffic function;
- Sensors are monitored to detect and report any sensor faults;
- Collected sensor data is stored within a sensor data store.

There are six processes in this DFD:

a) Process Traffic Sensor Data (1.1.1.1)
b) Collect and Process Sensor Fault Data (1.1.1.2)
c) Process Environmental Sensor Data (1.1.1.3)
d) Manage Data Collection and Monitoring (1.1.1.4)
e) Provide Sensor Interface to Other Roadway Devices (1.1.1.5)
f) Collect Infrastructure Sensor Data (1.1.1.6)

The collected data is received by process (b). The actual sensor data from the roadside is received by processes (a), (b), and (c). Data from the sensors are collected and sent to the Manage Archive function in process (c). Status and control of sensors between roadside devices is distributed by process (e). The Maintenance and Construction facility and Maintenance and Construction Vehicle obtains infrastructure conditions from process (f). All sensor status and faults from process (a) and (c)-(e) are detected and stored by process (b) then sent to the Manage Maintenance and Construction facility to correct the fault. Infrastructure sensor data in process (f) is sent directly to DFD 9.2.3 in the Manage Maintenance facility. These processes distribute the sensor data to other facilities in the Manage Traffic function.

DFD:1.1.2 Process and Store Traffic Data

This DFD shows the processes that make up the Process Traffic Data for Storage facility within the Manage Traffic function. These processes analyze collected data, distribute it to other facilities in the function and store the data, together with that provided by other facilities.

The key points about the facility are as follows:

- Processed sensor data to other processes within the Manage Traffic function;
- High occupancy vehicle (HOV) lane operation monitored and violators reported;
- Data from on-board vehicle tags processed to determine journey times;
- Vehicle smart probe data processed to determine roadway hazards ready for storage and output.

There are seven processes in this DFD:

a) Process Traffic Data for Storage (1.1.2.1)
b) Process Traffic Data (1.1.2.2)
c) Update Data Source Static Data (1.1.2.3)
d) Monitor HOV lane use (1.1.2.4)
e) Process Probe Data (1.1.2.5)
f) Process Collected Vehicle Smart Probe Data (1.1.2.6)
g) Monitor Reversible Lanes (1.1.2.7)

The collected data is received by process (b). This distributes it to other facilities in the Manage Traffic function using the data in the store of static data to decide which processes should actually receive the data. The data is also sent by process (a) to process 1.1.5 for loading into the current and long term data stores. This process also receives and loads into the stores indicator control and response data, implemented strategies, freeway ramp and parking lot data received from the Provide Device Control facility. Process (d) provides its link journey time data direct to process (a) again for loading into the stores. Process (e) and (f) analyze data from vehicle smart probes. Both of the processes then sends the data for storage to the Provide Roadside Control Facilities facility - see DFD 1.2.7, for output to passing vehicles. Data in process (g) is collected to monitor and detect possible incidents on reversible lanes and sends information to the Traffic Data Analysis for Incidents facility in DFD 1.3.1.

Overwriting of the data stored in the current data store will remove the data for the previous five minute period. The exception to this is the video image data, which is overwritten as soon as it is received. The data in the long term data store will not be overwritten as new data is accumulated and, it will be possible to display the data so far accumulated in the current hour. The life of this data will depend on the size of the data store in each implementation and the availability of store archiving and back-up facilities.

Although all of these processes depend on others in the group for data, they will each operate continuously and independently so that traffic data can be processed, stored and accumulated in a timely fashion. The last two processes may be omitted from specific implementations if no HOV lanes are present, or there is no roadside equipment to interrogate on-board vehicle tags for data.

DFD:1.1.4 Display and Output Traffic Data

This DFD shows the processes that make up the Display and Output Traffic Data facility within the Manage Traffic function. These processes provide the interfaces through which stored traffic data can be provided to other ITS functions and the media.

The key points about the facility are as follows:

- Access to current, historic and predictive model data provided for traffic operations personnel and for archiving;
- Media can access data under the control of traffic operations personnel;
- Other ITS functions and Manage Traffic facilities provided with access to the data on request;
- Output can be presented against the background of digitized map data.

There are seven processes in this DFD:

a) Retrieve Traffic Data (1.1.4.1)
b) Provide Traffic Operations Personnel Traffic Data Interface (1.1.4.2)
c) Provide Direct Media Traffic Data Interface (1.1.4.3)
d) Update Traffic Display Map Data (1.1.4.4)
e) Provide Media System Traffic Data Interface (1.1.4.5)
f) Provide Traffic Data Retrieval Interface (1.1.4.6)
g) Manage Traffic Archive Data (1.1.4.7)

Process (a) is responsible for retrieving the requested data from the stores of current, long term (historic)

and predictive model data. It receives requests from either process (b), which provides the traffic operations personnel interface, or from process (f). This process acts as the interface between processes (c) and (a). It enables the traffic operations personnel to control the access that the media and other ITS functions have to the stored data. It also controls the output of data to process (e) which is the output interface to the media systems, e.g. highway advisory radio (HAR), dynamic message signs (DMS), or flashing lights that direct drivers to tune their radios to a particular frequency to receive traffic information. The data collected in process (a) is then sent to process (g) for archiving.

The process (b), (c) and (e) depend on the process (a) and (f) for data and can only function as a group. It is possible for the outputs provided by the processes (b) and (c) to appear without the digitized map data produced by the fourth process. For process (b) an example might be video image data provided by traffic surveillance cameras.

DFD:1.2 Provide Device Control

This DFD shows the processes that make up the Provide Device Control facility within the Manage Traffic function. These processes provide the mechanism through which traffic management strategies can be implemented on the road and highway network served by the function.

The key points about this facility are as follows:

- Traffic management provided through coordination of roadside equipment (indicators);
- Traffic management strategy depends on current traffic conditions and default strategy;
- Traffic management strategy can be overridden by Manage Incident and Manage Demand facilities;
- Traffic management strategy can also be overridden by traffic operations personnel;
- Indicators can be intersection, ramp or pedestrian controllers, or dynamic message signs (DMS);
- Coordination of controller outputs can be based on a range of algorithms using real time data;
- Controllers can operate using local data with no coordination;
- Override strategies available to give emergency, high occupancy (HOV), and transit vehicle priority;
- DMS can be used to guide drivers away from congestion and inform them of major incidents and alerts;
- HAR can also be used to guide drivers away from congestion and inform them of major incidents and alerts;
- DMS can also be used to guide drivers towards parking lots with spaces currently available;
- Output of data to in-vehicle signage equipment provided through roadside units;
- Output of smart probe data collected from vehicles provided through roadside units;
- Incorrect operation of indicators reported as faults to the construction and maintenance organization.

There are two processes and six DFDs in this DFD:

a) Select Strategy (1.2.1)
b) Determine Road and Freeway State (DFD 1.2.2)
c) Determine Ramp State (1.2.3)
d) Output Control Data (DFD 1.2.4)
e) Manage Parking Lot State (DFD 1.2.5)
f) Maintain Static Data for TMC (DFD 1.2.6)
g) Provide Roadside Control Facilities (DFD 1.2.7)
h) Collect and Process Indicator Fault Data (DFD 1.2.8)

Although some of these processes depend on others in the group for data, they will each operate continuously and independently so that traffic control can be implemented in a timely fashion. Note that the processes in (g) receive data from the process (a) in the Provide Traffic Surveillance facility - see DFD 1.1, so that they can continue to function using local data if control data is not received from the processes in (d).

DFD:1.2.2 Determine Road and Freeway State

This DFD shows the processes that make up the Determine Road and Freeway State facility within the Manage Traffic function. These processes implement selected traffic management strategies for the road and highway network served by the function.

The key points about the facility are as follows:

- Adaptive, fixed time and local control strategies supported for indicators on roads;
- Sequencing control strategies supported for indicators on freeways;
- Strategies may be implemented on one, some or all indicators on roads and freeways;
- Coordination provided between freeway, road and ramp control processes.

There are two processes in this DFD:

a) Determine Indicator State for Freeway Management (1.2.2.1)
b) Determine Indicator State for Road Management (1.2.2.2)

These processes can be implemented singly, or as a pair where traffic management of a mixed system is required. In either case, the coordination flows will be present to provide linkages to the other process controlling the other roadway type.

DFD:1.2.4 Output Control Data

This DFD shows the processes that make up the Output Control Data facility within the Manage Traffic function.

The key points about the facility are as follows:

- Non-compliance with control commands by indicators reported as faults;
- Data for in-vehicle signage output to roadside equipment automatically;
- Data for managing and controlling barrier systems automatically.

There are five processes in this DFD:

a) Output Control Data for Roads (1.2.4.1)
b) Output Control Data for Freeways (1.2.4.2)
c) Output In-vehicle Signage Data (1.2.4.3)
d) Output Roadway Information Data (1.2.4.4)
e) Manage Barrier Systems (1.2.4.5)

These processes can be implemented separately, or grouped by processes supporting freeways and those supporting roads. In the latter case there will be a broadcast output process in each of the pairs, with only one input flow. It would also be possible to implement all processes as one group for a mixed freeway and road management system.

DFD:1.2.5 Manage Parking Lot State

This DFD shows the processes that make up the Manage Parking Lot State facility within the Manage Traffic function. These processes determine and manage the state of parking lots in the area served by the function.

The key points about the facility are as follows:

- Parking lot state can be determined from inputs provided by a variety of sources;
- The precise input configuration can be set up to suit individual parking lots;
- Parking lot data output using signs is used to guide vehicles to lots with spaces;
- Parking lot data stored for use by traffic operations personnel and the media;
- Parking lot data also used by the Mange Demand facility.

There are five processes in this DFD:

a) Provide Parking Lot Static Data (1.2.5.1)
b) Coordinate Other Parking Data (1.2.5.2)
c) Provide Parking Lot Operator Interface (1.2.5.3)
d) Determine Dynamic Parking Lot State (1.2.5.4)
e) Manage Parking Archive Data (1.2.5.5)

These processes can be implemented in a variety of sub-sets. The two common processes are (a) which provides parking lot static data and (d) which determines the dynamic parking lot state, some or all of the others need not be present in any individual implementation. A typical implementation would have process (a) and/or (d), plus one out of processes (b) or (c).

DFD:1.2.6 Maintain Static Data for TMC

This DFD shows the processes that make up the Maintain Traffic and Sensor Static Data facility within the Manage Traffic function. These processes provide static data for use by facilities within the function.

The key points about the facility are as follows:

- Static data maintained by Traffic Operations Personnel;
- Current static data can be retrieved and sent to the Manage Archived Data function.

There are two processes in this DFD:

a) Maintain Traffic and Sensor Static Data (1.2.6.1)
b) Provide Static Data Store Output Interface (1.2.6.2)

The two processes in this facility must be implemented as a pair. This is because process (b) is driven to provide its outputs by process (a) and relies on that process to provide the data in the store. Process (a) may also receive a request for a copy of the current static data from the Manage Archived Data function. In this case it requests the current data from the processes that serve the stores in the Provide traffic Surveillance and Manage Incidents facilities - see DFDs 1.1 and 1.3, and combines the data that they provide with that in its own store. This combined set of data is then sent to the Manage Archived Data function.

DFD:1.2.7 Provide Roadside Control Facilities

This DFD shows the processes that make up the Provide Roadside Control Facilities facility within the Manage Traffic function. These processes distribute the data implementing traffic management strategies to roadside equipment served by the function.

The key points about the facility are as follows:

- Control data translated into output that will be easily and readily understood by drivers and travelers;
- Indicator faults reported when their operation does not match that specified in their control data;
- Indicators can operate with local sensor data possible if required, or no control data is provided;
- Local priority can be given to transit and emergency vehicles;
- In-vehicle signage data and smart probe data output to passing vehicles;
- Data provided to warn vehicles of potential intersection collisions;
- Data provided by probes on vehicles to monitor roadside conditions;
- Allows the exchange of controls and commands between roadside devices;
- Control data to activate barrier systems to manage entry to roadways;

There are ten processes in this DFD:

a) Process Indicator Output Data for Roads (1.2.7.1)
b) Monitor Roadside Equipment Operation for Faults (1.2.7.2)
c) Manage Indicator Preemptions (1.2.7.3)
d) Process In-vehicle Signage Data (1.2.7.4)
e) Process Indicator Output Data for Freeways (1.2.7.5)
f) Provide Intersection Collision Avoidance Data (1.2.7.6)
g) Process Vehicle Smart Probe Data for Output (1.2.7.7)
h) Provide Device Interface to Other Roadway Devices (1.2.7.8)
i) Process Roadway Information Data (1.2.7.9)
j) Control Barrier Systems (1.2.7.10)

Although the processes in this facility form a cohesive group, only process (i) is essential for the output of indications to drivers and travelers. This process receives data from the output control data process in the Provide Device Control facility - see DFD 1.2. Process (b) provides the facility to monitor the operation of processes (a) and (e) unless this is temporarily suspended by process (c), as well as the operation of processes (d) and (g). Process (d) will enable vehicles to receive a copy of the data that is being output by indicators plus information about incidents, alerts, and traffic conditions, that are local to the process itself. Process (j) will control the activation of barrier systems, used to manage entry to roadways upon receiving configuration and control commands from another process – see DFD 1.2.4.

All processes apart from (a), (b), and (e) may be regarded as options and need only included when the facility that they provide is required by a particular implementation. Processes (a), (e), (h), or (j) could be provided in conjunction with process (a) in the Provide Traffic Surveillance facility - see DFD 1.1, as a local roadside traffic control unit. This would use locally detected traffic and pedestrian data to determine its control outputs and not be able to provide the benefits of coordination obtained from links other traffic management equipment.

DFD:1.2.8 Collect and Process Indicator Fault Data

This DFD shows the processes that make up the Collect and Process Indicator Fault Data facility within the Manage Traffic function. These processes manage faults detected in roadside equipment served by the function.

The key points about the facility are as follows:

- Faults reported to and cleared by, the construction and maintenance organization;
- Fault reporting and clearance monitored by traffic operations personnel;
- Traffic operations personnel can modify fault data and enter faults not detected automatically.

There are four processes in this DFD:

a) Collect Indicator Fault Data (1.2.8.1)
b) Maintain Indicator Fault Data Store (1.2.8.2)
c) Provide Device Fault Interface for C and M (1.2.8.3)
d) Provide Traffic Operations Personnel Indicator Fault Interface (1.2.8.4)

Fault data is collected by process (a) which passes the data to process (b) for logging in the list of current indicator faults. The data is then sent from process (b) to process (c) for output to the construction and maintenance organization. Process (b) also updates the Select Strategy process (see process (a) in DFD 1.2.2) with the fault state, so that the faulty indicator(s) are not included in any strategy selection, and if necessary some strategies may be revised to take account of indicator faults. Fault clearance data is received from the construction and maintenance organization by process (c) and sent to process (b). This updates the current indicator faults list and outputs the new (cleared) fault status to the Select Strategy process.

The four processes in this facility form a cohesive group, although only the first three are essential to the processing of indicator fault data. The operator interface process can be omitted if the reporting and clearance of indicator faults is to be left as an automatic process.

DFD:1.3 Manage Incidents

This DFD shows the processes that make up the Manage Incidents facility within the Manage Traffic function. These processes manage the classification of incidents and implement responses when they actually occur.

The key points about the facility are as follows:

- Incident inputs available from many sources, e.g. emergency services, event promoters, etc.;
- Data from traffic sensors analyzed for indications of possible incidents;
- Traffic operations personnel can update incident data with other inputs, e.g. telephone reports;
- Incident inputs from construction and maintenance organization must be confirmed;
- When an incident occurs predefined mitigation strategy is automatically implemented;
- Predefined incident strategies can be set up in advance by the traffic operations personnel;
- Incident status provided as input to the predictive traffic model and to vehicle route selection criteria;
- Information on incidents is available to the media.
- Provide disaster response and evacuation support in the form of coordination with other traffic management centers, traffic operations personnel and emergency management.

There are seven processes in this DFD and three are DFDs themselves:

a) Traffic Data Analysis for Incidents (DFD 1.3.1)
b) Review and Manage Incident Data (DFD 1.3.2)
c) Respond to Current Incidents (1.3.3)
d) Provide Operator Interfaces for Incidents (DFD 1.3.4)
e) Manage Incident Response Planning (1.3.5)
f) Traffic Disaster Response Control (1.3.6)
g) Traffic Evacuation Control (1.3.7)

The processes in this DFD and its constituent DFDs divide incidents up into three types comprising, possible, predicted and current data. Those in the possible category need further analysis work to establish their status as actual incidents. They may then be either planned events, which are those that have yet to happen, or current incidents, disasters, evacuations, or other emergencies, which are those that are in the process of occurring. Examples of planned events are special events, sports events and maintenance and construction activities, while current incidents can be any event when it actually occurs, traffic accidents, terrorist activity, natural disasters, and incidents caused by the effects of the weather.

Facilities are provided to enable the traffic operations personnel to oversee the management of incidents through the processes in (d). Thus planned events notified by event promoters and the construction and maintenance organization through processes in (b) are subject to confirmation by the traffic operations personnel. This enables these types of incident to be scheduled away from peak travel times. Traffic operations personnel can also amend incident data, and are responsible for the setting up of the defined responses that are implemented when an incident becomes current.

The defined responses used for current incidents can be based on policy data provided by the jurisdictional authorities, or on the responses to previous incidents of the same type. The process (e) analyzes previous responses to incidents and creates a store of possible responses, which could be added to the library of pre-defined responses. In the event of a disaster, evacuation, or other major emergency processes (f and g) access the pre-defined responses library and act to assist in coordination efforts between traffic management, other traffic management centers, the traffic operations personnel, and emergency management. If a defined response is not available for a particular type of current incident, the traffic operations personnel will be notified and expected to provide one, before any further action is taken.

Although the processes in this DFD and its constituents feed each other data they will operate continuously and independently in order that incidents are detected and acted upon in a timely manner. As a minimum, the current incidents processes in (b) and the process in (c) are needed to provide a very basic incident management system, with no automatic detection, or differentiation between current incidents and planned events.

DFD:1.3.1 Traffic Data Analysis for Incidents

This DFD shows the processes that make up the Traffic Data Analysis for Incidents facility within the Manage Traffic function. These processes analyze traffic data to look for indications of possible incidents.

The key points about the facility are as follows:

- Video image and other sensor data analyzed for indications of possible incidents;
- Location of possible incidents fixed by location of data source.

There are three processes in this DFD:

a) Analyze Traffic Data for Incidents (1.3.1.1)
b) Maintain Static Data for Incident Management (1.3.1.2)
c) Process Traffic Images (1.3.1.3)

Process (a) provides data about possible incidents. It takes data from traffic sensors provided by processes in the Provide Traffic Surveillance facility - see DFD 1.1.1 plus video image data provided by process (c), and analyzes it for anomalies that may indicate the presence of a possible incident. When a possible incident is detected, the process sends the data to the Review and Manage Incidents facility - see DFD 1.3.2. Process (c) acts as the video image processor. It can also change the video image being used for incident analysis and provide the actual video images at the request of the traffic operations personnel through processes in the Provide Operator Interface for Incidents facility - see DFD 1.3.4.

The three processes should be implemented as a group of three. However there may be some implementations without process (c) which provides analysis of video images.

DFD:1.3.2 Review and Manage Incident Data

This DFD shows the processes that make up the Review and Manage Incident Data facility within the Manage Traffic function. These processes manage the classification of incidents into the categories of possible, current, and planned events.

The key points about the facility are as follows:

- Possible incidents data reviewed for transfer to predicted category if confidence level high enough;
- Planned events data reviewed for transfer to current category when start time occurs;
- Traffic operations personnel can review and amend incident data;
- Current incidents automatically cleared when duration has expired.
- Traffic detours and routes are developed and managed.

There are six processes in this DFD:

a) Store Possible Incident Data (1.3.2.1)
b) Review and Classify Possible Incidents (1.3.2.2)
c) Review and Classify Planned Events (1.3.2.3)
d) Provide Planned Events Store Interface (1.3.2.4)
e) Provide Current Incidents Store Interface (1.3.2.5)
f) Manage Traffic Routing (1.3.2.6)

Data on possible incidents in provided to process (a), which analyses it and if it has enough confidence that the incident is genuine, will upgrade its status to that of a planned event. The data is then passed to process (b) which again analyses it to determine whether the incident is current or is a planned event. Those in the former category are loaded into the store of planned events which process (c) will review periodically. Data about incidents that become current are sent to process (e) and on to process (c) in the Manage Incidents facility - see DFD 1.3, for response implementation. Process (d) acts as the interface to

the store of planned events and also accepted data about such incidents in geographic areas served by other Manage Traffic functions. Process (f) develops and provides traffic detours and routes as appropriate for incidents.

Although these processes feed each other data they will operate continuously and independently in order that incidents are detected and acted upon in a timely manner. They should be implemented as a group since incident data is designed to exchange data from one process to another as its status changes.

DFD:1.3.4 Provide Operator Interfaces for Incidents

This DFD shows the processes that make up the Provide Operator Interfaces for Incidents facility within the Manage Traffic function. These processes provide the interfaces for traffic operations personnel to manage incidents, and the media to gain access to incident information.

The key points about the facility are as follows:

- Incident data output to traffic operations personnel and media using digitized map display;
- Traffic operations personnel can provide incident data and set up defined incident responses;
- Warning of incidents can be output through the media.

There are five processes in this DFD:

a) Retrieve Incident Data (1.3.4.1)
b) Provide Traffic Operations Personnel Incident Data Interface (1.3.4.2)
c) Provide Media Incident Data Interface (1.3.4.3)
d) Update Incident Display Map Data (1.3.4.4)
e) Manage Resources for Incidents (1.3.4.5)

The interfaces for the traffic operations personnel and the media are provided through processes (b) and (c). Both use process (a) as the mechanism for obtaining data about possible incidents planned events, and current incidents. Process (b) also enables the traffic operations personnel to have access to data in other parts of the Manage Incidents facility such as that for defined incident responses - see DFD 1.3, to control the use and set up of these responses, and to see the video images being used for incident analysis obtained by the Traffic Data Analysis for Incidents facility - see DFD 1.3.1. As well as enabling incident data to be displayed, process (c) enables the media to report incidents. These reports will be based on data received by the media from those of their customers who are travelers.

One of the features of the structure of the processes in this DFD is that it enables the media to have direct access to the lists of both current incidents and planned events using processes (a) and (c). However this access will be controlled through data in the store of defined responses and can be set up by the traffic operations personnel. This enables the personnel to set up the type and extent of incident information to which the media can have direct access, so that those incidents of a “sensitive” nature can be deleted as far as direct media access is concerned. The same mechanism is used to control the output of incident warnings as well as request assistance from the Maintenance and Construction organization through process (e).

DFD:1.4 Manage Travel Demand

This DFD shows the processes that make up the Manage Travel Demand facility within the Manage Traffic function. These processes enable travel demand to be predicted and managed to make the most efficient use of the road, highway and other parts of the transportation network served by the function.

The key points about the facility are as follows:

- Demand forecasts are based on current operational data and policy data;
- Current operational data provided by Manage Traffic and other ITS functions;
- Policy data is set up by the traffic operations personnel, who also run the forecast process;
- Demand forecast results are implemented by requesting action by ITS functions.

There are five processes in this DFD:

a) Provide Traffic Operations Personnel Demand Interface (1.4.1)
b) Collect Demand Forecast Data (1.4.2)
c) Update Demand Display Map Data (1.4.3)
d) Implement Demand Management Policy (1.4.4)
e) Calculate Forecast Demand (1.4.5)

The traffic operations personnel through process (a) control the operation of the demand forecasting facility. This enables operational data to be gathered by process (b) and loaded into the store of demand input data. This data will originate from sources such as the current use of the road network, transit services and other modes, weather predictions, the predictive model of traffic conditions, the status of the current transit services and their schedules, current charges for tolls, parking lots and public transit fares, plus current pollution levels. Policy data, which is the other input to the demand forecasting carried out by process (e) is provided directly by the traffic operations personnel.

Preparation of a demand forecast by process (e) is initiated by the traffic operations personnel, who can review the results and request their implementation by process (d). This process will report the results of its implementation back to the traffic operations personnel. All output to the personnel can be shown against a background of digitized map data provided through process (c).

The processes themselves do not need to know anything about the structure of responsibility in the geographic area they control. For example it will be possible for process in (b) to receive data from several Provide Traffic Surveillance facilities each of which serves a different part of the total geographic area served by the Manage Traffic function.

The processes are structured in the manner shown above to allow for easy replacement and updating, particularly as new demand management algorithms are developed.

DFD:1.5 Manage Emissions

This DFD shows the processes that make up the Manage Emissions facility within the Manage Traffic function. These processes monitor atmospheric pollution levels and provide details of those that are above pre-set limits to other facilities.

The key points about the facility are as follows:

- Current pollution levels monitored both on an area basis and from individual vehicles;
- Area pollution levels above permitted levels reported as incidents to the Manage Incidents facility;
- Driver and law enforcement agency(ies) notified of vehicle pollution levels above permitted levels;
- Provide Traffic Surveillance facility sent pollution data for loading into current and long term stores;
- Pollution data also provided to Manage Archived Data function.

There are nine processes in this DFD:

a) Provide Emissions Operations Personnel Pollution Data Interface (1.5.1)
b) Process Pollution Data (1.5.2)
c) Update Pollution Display Map Data (1.5.3)
d) Manage Pollution State Data Store (1.5.4)
e) Process Vehicle Pollution Data (1.5.5)
f) Detect Roadside Pollution Levels (1.5.6)
g) Manage Pollution Data Log (1.5.7)
h) Manage Pollution Reference Data Store (1.5.8)
i) Manage Pollution Archive Data (1.5.9)

Pollution levels are detected at the roadside by process (f), in the wider geographic area by process (b) and from vehicles by process (e). The data from these three processes is supplied to process (d) which maintains and stores the data for access by the traffic operations personnel through process (a). Process (d) also supplies a copy of the stored pollution data on request to the Manage Demand facility - see DFD 1.4. The wide area and vehicle pollution data is also supplied to process (g) for loading into the log of pollution data. A copy of this is periodically sent to the Manage Archived Data function - see DFD 8.

The need for are pollution levels to be reported as incidents by process (b), or vehicle drivers and the law enforcement agency notified of high pollution by process (e), depends on the pollution reference data. This is contained in a store managed by process (h). It can be monitored and updated by the traffic operations personnel through process (a). The output of data by process (a) may be against a background of a digitized map supplied by process (c). Although these processes are shown as a coherent group, they can be implemented in part if needed. For example, the monitoring of either area or vehicle pollution can be omitted. Data about the ownership of polluting vehicles is obtained from the relevant Department of Motor Vehicles by the process responsible for law enforcement - see DFD 5.4.

DFD:1.6 Manage Highway Rail Intersections

This DFD shows the processes that make up the Highway Rail Intersection facility within the Manage Traffic function. The process in this DFD contains the principal functions that provide User Service 30, Highway Rail Intersection management.

The key points about the facility are as follows:

- Management of the HRI is accomplished by direct interfaces to railroad operations,
- Wayside equipment interface provides real-time information about approaching trains,
- Provides a two way interactive exchange of traffic data between ITS and a railroad operator.
- Provides inputs to ITS traffic demand management,
- Receives traffic surveillance data from sensors
- Provides real-time crossing status
- Controls devices at the grade crossing and nearby intersections by passing device control requests
- Provides status of device controls to the Manage HRI Traffic process.

- Provides grade crossing status and information to detect and manage incidents around grade crossings.
- Reports incident information that may be important to trains and grade crossing operation
- Reports HRI status to the Manage Travel Demand process so that HRI operations can be factored into demand management algorithms and decisions.

There are five processes in this DFD, all of which are DFD themselves:

a) Manage HRI Traffic Volume (DFD 1.6.1)
b) Interact with Rail Operations (DFD 1.6.2)
c) Manage HRI Rail Traffic (DFD 1.6.3)
d) Interact with Traffic Management (DFD 1.6.4)
e) Monitor HRI Status (DFD 1.6.5)

All of the data about traffic at an HRI is collected and managed by processes within DFD (a) and (c). The processes in (d) interact with other ITS Traffic Management functions to obtain surveillance data and control strategies used by the processes in (e).

DFD:1.6.1 Manage HRI Traffic Volume

This DFD shows the processes that are responsible for managing traffic volume at an HRI and in the immediate vicinity.

The key points about the facility are as follows:

- Monitors local sensor data obtained from traffic surveillance;
- Detects hazardous conditions or potential hazards at an HRI;
- Detects real-time HRI blockages or collisions;
- Provides advanced warnings where warranted.

There are seven processes in this DFD and four are DFDs themselves:

a) Detect Roadway Events (1.6.1.1)
b) Activate HRI Device Controls (DFD 1.6.1.2)
c) Perform Equipment Self-Test (1.6.1.3)
d) Provide Advisories and Alerts (DFD 1.6.1.4)
e) Detect HRI Hazards (1.6.1.5)
f) Provide Advance Warnings (DFD 1.6.1.6)
g) Execute Local Control Strategy (DFD 1.6.1.7)

The collected data is by process (a). Process (a) is responsible for detecting any roadway events and then determining and reporting the current state of traffic. Processes (a), (e), and (f) depend on processes in (d) and (g). Processes in (d) are responsible for providing advisories and alerts as well as the conditions at the HRI. The processes in (g) are responsible for managing and executing control strategies at the HRI.

DFD:1.6.1.2 Activate HRI Device Controls

This DFD controls different types of devices for translating traffic management strategies into the appropriate sequences of traffic device control requests.

The key points about the facility are as follows:

- Interprets HRI control messages,
- Activates HRI control devices.

There are six processes in this DFD:

a) Control HRI Traffic Signals (1.6.1.2.1)
b) Control HRI Warnings and Barriers (1.6.1.2.2)
c) Provide SSR Device Controls (1.6.1.2.3)
d) Provide HSR Device Controls (1.6.1.2.4)
e) Manage Device Control (1.6.1.2.5)
f) Maintain Device State (1.6.1.2.6)

The collected data is received by process (a). Process (a) distributes the data to all other processes within the DFD. Processes (e) and (f) distribute the data to other facilities in the Manage Traffic function.

DFD:1.6.1.4 Provide Advisories and Alerts

This DFD generates and reports on conditions at the HRI.

The key points about the facility are as follows:

- Generates the message to advise and protect all persons approaching and crossing railroad crossings,
- Reports real-time HRI traffic volume advisories as they approach an HRI.

There are four processes in this DFD:

a) Generate Alerts and Advisories (1.6.1.4.1)
b) Provide Closure Parameters (1.6.1.4.2)
c) Report Alerts and Advisories (1.6.1.4.3)
d) Report HRI Status on Approach (1.6.1.4.4)

The collected data is received by processes all processes to determine the need to generate an alert, to provide closure, and to report HRI status. Process (a) and (c) depend on processes (b) and (d). Processes (c) and (d) distribute data to other facilities in the Manage Traffic function.

DFD:1.6.1.6 Provide Advance Warnings

This DFD is responsible for predicting likely conditions at the HRI and providing advance warnings where warranted.

The key points about the facility are as follows:

- Detect HRI closure,
- Detect vehicle/train collisions.

There are two processes in this DFD:

a) Close HRI on Detection (1.6.1.6.1)
b) Detect Imminent Vehicle/Train Collision (1.6.1.6.2)

All data is received by process (a) and also sent to other facilities within the Manage Traffic function. Process (b) reports any vehicle/train collisions and reports the collision to process (a).

DFD:1.6.1.7 Execute Local Control Strategy

This DFD is responsible for maintaining the local traffic control parameters and for selecting the appropriate strategy, based on roadway events and detected hazards.

The key points about the facility are as follows:

- Responsible for controlling traffic volume at passive grade crossings,
- Responsible for closing the HRI to traffic.

There are two processes in this DFD:

a) Control Traffic Volume at Active HRI (1.6.1.7.1)
b) Close HRI on Command (1.6.1.7.3)

The collected data is received and sent to other Manage Traffic functions by process (a). Processes (a) and depend on process (b). Data is collected from process (a) and passes HRI closure messages to process (b).

DFD:1.6.2 Interact with Rail Operations

This DFD is responsible for interacting with railroad owned and operated operations management facilities.

The key points about the facility are as follows:

- Exchanges data with rail operations,
- Provides and maintains a current store of rail operations data.

There are three processes in this DFD:

a) Exchange Data with Rail Operations (1.6.2.1)
b) Manage Alerts and Advisories (1.6.2.2)
c) Manage Rail Traffic Control Data (1.6.2.3)

The collected data is received by process (a) which is dependent on processes (b) and (c). Process (s) is responsible for exchanging data with rail operations. The data collected in process (a) is also distributed to other Manage Traffic function.

DFD:1.6.3 Manage HRI Rail Traffic

This DFD is responsible for performing real-time equipment checks and reporting the status of the equipment associated with an active grade crossing.

The key points about the facility are as follows:

- Responsible for generating advisories/ alerts,
- Responsible for protecting all traffic approaching and crossing grade crossings.

There are three processes in this DFD:

a) Interact with Wayside Systems (1.6.3.1)
b) Advise and Protect Train Crews (1.6.3.2)
c) Provide ATS Alerts (1.6.3.3)

The collected data is received by process (b). Process (a) interacts with the wayside equipment system and reports the status to process (c). Data collected in process (b) is distributed to process (a) to report HRI data. All of the processes distribute data to other Manage Traffic functions.

DFD:1.6.4 Interact with Traffic Volume Management

This DFD generates and reports on conditions at the HRI.

The key points about the facility are as follows:

- Coordinate and manage HRI closures,
- Exchange data with other traffic management processes.

There are two processes in this DFD:

a) Manage HRI Closures (1.6.4.1)
b) Exchange Data with Traffic Management (1.6.4.2)

The collected data is received by process (b). Process (a) is responsible for managing HRI closures and receiving HRI real time traffic data. Data is distributed to other processes within the Manage Traffic function by process (b).

DFD:1.6.5 Monitor HRI Status

This DFD contains the processes associated with monitoring the overall operation of the HRI, maintaining a consistent "health status" and reporting to both Traffic Management and Rail Operations.

The key points about the facility are as follows:

- Initiates reports of health status of HRI to Traffic Management and Rail Operations,
- Manages a data log of HRI operations.

There are three processes in this DFD:

a) Provide Interactive Interface (1.6.5.1)
b) Determine HRI Status (1.6.5.2)
c) Maintain HRI Closure Data (1.6.5.3)

The collected data is received by process (b) which depend on both processes (a) and (c). Process (b) determines the status of a HRI and reports the status to processes (a) and (c).

DFD: 2 Manage Commercial Vehicles

The processes in this DFD make up the Manage Commercial Vehicles function. This function is responsible for providing facilities for the management of commercial vehicle operations, with their primary concern being the efficient management of Commercial Vehicles, e.g., electronic credentials, tax filing, safety checking, and the movement of freight. Although the movement of vehicles is confined to the surface transportation system, interfaces are provided to enable freight to be moved by this and any other means, e.g., specialist carriers using air or sea transport. The functional processes contained in this DFD satisfy the User Service Requirements from the following User Services:

4.1 Commercial Vehicle Electronic Clearance
4.2 Automated Roadside Safety Inspection
4.3 On-Board Safety Monitoring
4.4 Commercial Vehicle Administrative Processes
4.5 Hazardous Material Incident Response
4.6 Freight Mobility

The key points about this function are as follows:

- Facilities provided for commercial vehicle managers and drivers who are their own managers;
- Trip planning and electronic credential and tax filing provided for managers and owner drivers;
- Managers and owner drivers may pre-clear vehicles through roadside check station facilities;
- Roadside facilities can check vehicles for pre-clearance, safety and international border clearance;
- CVO inspectors can override pass/pull-in decisions at roadside facilities;
- Details of actions at roadside facilities recorded on vehicle's on-board tag;
- Vehicle collects data about its operation and stores it on-board;
- Manager can access on-board vehicle data and exchange messages with driver;
- Commercial vehicle and freight equipment security capabilities such as monitoring vehicle location for route deviations, detecting breach or tamper events, and monitoring commercial vehicle, driver and freight equipment identities to determine assignment mismatches;

There are seven processes subordinate to this DFD, all of which are themselves DFDs:

a) Manage Commercial Vehicle Fleet Operations (DFD 2.1).
b) Manage Commercial Vehicle Driver Operations (DFD 2.2).
c) Provide Commercial Vehicle Roadside Facilities (DFD 2.3).
d) Provide Commercial Vehicle Data Collection (DFD 2.4).
e) Administer Commercial Vehicles (DFD 2.5).
f) Provide Commercial Vehicle On-board Data (DFD 2.6).
g) Provide Freight Operations (2.7).

DFD:2.1 Manage Commercial Vehicle Fleet Operations

The processes in this DFD make up the Manage Commercial Vehicle Fleet Operations facility within the manage Commercial Vehicles function. These processes enable commercial fleet managers to plan commercial vehicle routes taking into account the needs of this type of vehicle, as well as the electronic credential and tax filing needed to use the route. The manager is provided with facilities to use the route data to set up a set of delivery instructions for the driver. Information can also be exchanged between the manager and the driver, and the manager can up-load and review a copy of the data that has been collected on-board the vehicle.

The key points about the facility are as follows:

- Managers may plan trips using either static route selection, or request a dynamic route selection;
- Managers do credential and tax filing to pre-clear vehicles at roadside check station facilities;
- Managers store routes for access by drivers with cargo drop-off/pick-up details added;
- Managers can access on-board vehicle data and exchange general data with the driver;
- Managers can detect and respond to commercial vehicle security incidents.

There are six processes in this DFD, one of which itself is a DFD:

a) Manage Commercial Vehicle Fleet (2.1.1).
b) Provide Commercial Vehicle Fleet Manager Interface (2.1.2).
c) Provide Fleet Manager Commercial Vehicle Communications (2.1.3).
d) Provide Commercial Vehicle Driver Routing Interface (2.1.4).
e) Manage Driver Instruction Store (2.1.5).
f) Manage Commercial Vehicle Incidents (2.1.6).

DFD:2.1.1 Manage Commercial Vehicle Fleet

The processes in this DFD make up the Manage Commercial Vehicle Fleet facility within the manage Commercial Vehicles function. These processes enable commercial vehicle fleet managers to plan commercial vehicle routes taking into account the needs of this type of vehicle, as well as the electronic credential and tax filing needed to use the route. They provide additional capabilities to normal fleet management functions to enhance commercial vehicle security.

The key points about the facility are as follows:

- Managers may plan trips using either static route selection, or request a dynamic route selection;
- Static route selection is based on surface street and freeway network geometry;
- Dynamic route selection based on current and future traffic conditions;
- Managers do credential and tax filing to pre-clear vehicles at roadside check station facilities;
- Commercial vehicle routes are monitored to detect potential route deviations;
- Commercial vehicle drivers and freight equipment identities are monitored to detect potential assignment mismatches.

There are seven processes in this DFD:

a) Manage Commercial Fleet Electronic Credentials and Tax Filing (2.1.1.1).
b) Manage Commercial Vehicle Routes (2.1.1.2).
c) Provide Commercial Fleet Static Route (2.1.1.3).
d) Provide HAZMAT Incident Support (2.1.1.4).
e) Manage Commercial Vehicle Fleet Map Data (2.1.1.5).
f) Monitor Commercial Vehicle Route (2.1.1.6).
g) Monitor Assignment Identities (2.1.1.7).

DFD:2.2 Manage Commercial Vehicle Driver Operations

This DFD shows the processes that make up the Manage Commercial Vehicle Driver Operations facility within the Manage Commercial Vehicles function. These processes enable commercial vehicle drivers who manage their own vehicles, to plan commercial vehicle routes taking into account the needs of this type of vehicle, as well as the electronic credential and tax filing needed to use the route. The driver is provided with facilities to up-load and review a copy of the data that has been collected on-board the vehicle.

The key points about the facility are as follows:

- Facilities provided for commercial vehicle owner/drivers who do their own management;
- Facilities are available from a driver's personal portable device (ppd);
- Drivers may plan trips using either static route selection, or request a dynamic route selection;
- Static route selection is based on surface street and freeway network geometry;
- Dynamic route selection based on current and future traffic conditions;
- Drivers do credential and tax filing to pre-clear vehicles at roadside check station facilities;
- Drivers can access on-board vehicle data.

There are four processes in this DFD:

a) Manage CV Electronic Credential and Tax Filing Interface (2.2.1).
b) Provide Vehicle Static Route (2.2.2).
c) Provide CV Driver Electronic Credential and Tax Filing Interface (2.2.3).
d) Provide Commercial Vehicle Driver Communications (2.2.4).

DFD:2.3 Provide Commercial Vehicle Roadside Facilities

The processes in this DFD are responsible for the Provide Commercial Vehicle Roadside Facilities facility within the Manage Commercial Vehicles function. These processes enable roadside check station facilities to selectively pull-in approaching vehicles. They provide the capability for commercial vehicles to be pre-cleared through screening and international border crossing checks and to carry-out safety and security checks.

The key points about the facility are as follows:

- Credential, international border and safety clearance provided at roadside check stations;
- Credential clearance given if vehicle of the same physical characteristics as that pre-cleared;
- Cargo lock tag checked for tampering at international border crossing facilities;
- Commercial vehicles and freight equipment checked for breach or tampering at roadside facilities;
- Safety clearance given if vehicle passes specified criteria and no poor safety history found;
- Pass/pull-in request sent to driver by roadside sign(s) and in-vehicle display unit;
- Pass/pull-in decisions subject to override by CVO inspector at the roadside facility;
- Roadside facility may be configured for any of the credential, border crossing or safety checking.

There are eight processes in this DFD, two of which are themselves DFDs:

a) Produce Commercial Vehicle Driver Message at Roadside (2.3.1).
b) Provide Commercial Vehicle Clearance Screening (DFD 2.3.2).
c) Provide Roadside Commercial Vehicle Safety (DFD 2.3.3).
d) Detect and Classify Commercial Vehicles and Freight Equipment (2.3.4).
e) Provide Commercial Vehicle Roadside Operator Interface (2.3.5).
f) Provide Commercial Vehicle Reports (2.3.6).
g) Produce Commercial Vehicle Driver Message on Vehicle (2.3.7).
h) Provide Commercial Vehicle Border Screening (2.3.8).

DFD:2.3.2 Provide Commercial Vehicle Clearance Screening

The processes in this DFD make up the Provide Commercial Vehicle Clearance Screening facility within the Manage Commercial Vehicles function. These processes enable roadside facilities to pull-in approaching vehicles whose credentials have not been pre-cleared.

The key points about the facility are as follows:

- Pre-clearance of a commercial vehicle based on its identity plus size and weight is provided;

- Vehicles containing security sensitive HAZMAT material are checked against trip credentials;
- All pass/pull-in decisions may be overridden by the CVO inspector override and are logged.

There are two processes in this DFD:

a) Administer Commercial Vehicle Credentials Database (2.3.2.1).
b) Process Screening Transactions (2.3.2.2).

DFD:2.3.3 Provide Roadside Commercial Vehicle Safety

The five processes in this DFD are responsible for the Provide Roadside Commercial Vehicle Safety facility within the Manage Commercial Vehicles function. These processes enable roadside facilities to pull-in approaching vehicles with a poor safety history and to carry out roadside inspections.

The key points about the facility are as follows:

- Vehicles are pulled in if they, their owners or drivers have had previous safety problems;
- Roadside safety inspection may be carried out by CVO inspector using hand held terminal;
- All pass/pull-in decisions may be overridden by the CVO inspector and are logged.

There are five processes in this DFD:

a) Provide Commercial Vehicle Checkstation Communications (2.3.3.1).
b) Provide Commercial Vehicle Inspector Hand Held Terminal Interface (2.3.3.2).
c) Administer Commercial Vehicle Roadside Safety Database (2.3.3.3).
d) Carry-out Commercial Vehicle Roadside Safety Screening (2.3.3.4).
e) Carry-out Commercial Vehicle Roadside Inspection (2.3.3.5).

DFD:2.4 Provide Commercial Vehicle Data Collection

The processes in this DFD are responsible for the Provide Commercial Vehicle Data Collection facility within the Manage Commercial Vehicles function. These processes are responsible for collecting data from on-board sensors and from the driver. The data is kept in an in-vehicle data store which can be transmitted to the roadside check facility to enable safety checks and roadside inspections. The contents of the store can also be sent to the commercial vehicle driver and fleet manager.

The key points about the facility are as follows:

- Automatic collection and processing of vehicle operational, safety, security and driver data;
- Commercial vehicle driver is able to enter data on cargo details, fuel consumed, etc.;
- Commercial vehicle location is compared to planned route, deviations are indicated to driver;
- Commercial vehicle driver is authenticated and unauthorized individuals are identified;
- Recorded data sent to the roadside check station facility or commercial vehicle manager on request;
- Commercial vehicle driver and vehicle manager can exchange general messages as textual data.

There are nine processes in this DFD:

a) Communicate Commercial Vehicle On-board Data to Roadside (2.4.1).
b) Collect On-board Commercial Vehicle Sensor Data (2.4.2).
c) Analyze Commercial Vehicle On-board Data (2.4.3).
d) Provide Commercial Vehicle Driver Interface (2.4.4).
e) Communicate Commercial Vehicle On-board Data to Vehicle Manager (2.4.5).
f) Provide Commercial Vehicle On-board Data Store Interface (2.4.6).
g) Manage CV On-board Data (2.4.7).
h) Correlate Commercial Vehicle Route (2.4.8).
i) Authenticate Commercial Vehicle Driver (2.4.9).

DFD:2.5 Administer Commercial Vehicles

The processes in this DFD are responsible for the Administer Commercial Vehicles facility within the Manage Commercial Vehicles function. These processes enable commercial vehicle pre-clearance to be managed and data from roadside check station facilities to be analyzed. These processes provide the electronic credential and tax filing functions that interface to the commercial vehicle manager and commercial vehicle driver acting as a fleet manager.

The key points about the facility are as follows:

- Provides a central facility for the processing of electronic credential and tax filing;
- Pre-clearance obtained for the selected route through roadside check facilities, including international borders;
- Roadside check station facility logs analyzed daily for safety problems and storage;
- Transportation and declaration information analyzed for border clearance assessments;
- Stored roadside facility logs available for output to the commercial vehicle manager;
- Collect and manage border clearance data used by the check station.

There are ten processes in this DFD, and one is itself a DFD:

a) Manage Commercial Vehicle Trips and Clearances (2.5.1).
b) Obtain Electronic Credential and Tax Filing Payment (2.5.2).
c) Manage Border Clearances (DFD 2.5.3).
d) Communicate with Other Commercial Vehicle Administration System (2.5.4).
e) Manage Commercial Vehicle Credentials and Enrollment (2.5.5).
f) Output Commercial Vehicle Enrollment Data to Roadside Facilities (2.5.6).
g) Process Commercial Vehicle Violations (2.5.7).
h) Process Data Received from Roadside Facilities (2.5.8).
i) Manage Commercial Vehicle Archive Data (2.5.9).
j) Manage CV Database Store (2.5.10).

DFD:2.5.3 Manage Border Clearances

The processes in this DFD are responsible for the Manage Border Clearances facility within the Manage Commercial Vehicles function. These processes enable commercial vehicles to communicate with Trade Regulatory Agencies and allow data from Trade Regulatory Agencies and roadside check station facilities to be analyzed in support of international border clearance activities.

The key points about the facility are as follows:

- Provides a means for communicating with Trade Regulatory Agencies;
- Analyze information obtained for border clearance through roadside check facilities.

There are two processes in this DFD:

a) Communicate With Trade Regulatory Agencies (2.5.3.1).
b) Analyze Border Clearance Data (2.5.3.2).

DFD:2.6 Provide Commercial Vehicle On-board Data

The processes in this DFD are responsible for the Provide Commercial Vehicle On-board Data facility within the Manage Commercial Vehicles function. These processes enable data to be loaded into commercial vehicle tags by the vehicle manager, driver, or roadside facilities passed by the vehicle. This data will enable it to be recognized at each roadside check facility and can be used by the facility for pre-clearance and safety checks. For clearance at international border crossings, the contents of the lock tag can also be sent to the roadside facility.

The key points about the facility are as follows:

- Enables the vehicle tag to be loaded with the data by the commercial vehicle manager or driver;
- Tag data is output on request to each roadside facility approached by the vehicle;
- Tag data is updated by the roadside facility with the results of the pass/pull-in decision.

There are five processes in this DFD:

a) Provide Commercial Vehicle Manager Tag Data Interface (2.6.1).
b) Transmit Commercial Vehicle Tag Data (2.6.2).
c) Provide Commercial Vehicle Driver Tag Data Interface (2.6.3).
d) Provide Lock Tag Data Interface (2.6.4).
e) Manage Commercial Vehicle Tag Data Store (2.6.5).

DFD:2.7 Provide Freight Operations

The processes in this DFD are responsible for the Provide Freight Operations facility within the Manage Commercial Vehicles function. These processes enable freight managers to process freight transportation bookings. As part of the booking process, trip plans are coordinated with commercial vehicle fleet managers. The freight equipment is monitored for security related incidents.

The key points about this facility are as follows:

- Freight transportation bookings are processed by the freight manager;
- Freight managers coordinate with commercial vehicle fleet managers to plan trips in response to a freight transportation booking;
- Freight managers schedule freight equipment maintenance;
- Freight equipment locations are monitored and deviations from intended route are flagged;
- Freight equipment is monitored for breach or tamper events;
- Freight managers determine a response plan to a freight security incident.

There are seven processes in the DFD:

a) Manage Freight Incidents (2.7.1).
b) Monitor Freight Equipment Route (2.7.2).
c) Manage Freight Equipment Fleet (2.7.3).
d) Manage Freight Equipment Maintenance (2.7.4).
e) Process Freight Integrity Data (2.7.5).
f) Provide Freight Manager Interface (2.7.6).
g) Provide Shipper Booking Interface (2.7.7).

DFD: 3 Provide Vehicle Monitoring and Control

This DFD shows the processes that make up the Provide Vehicle Monitoring and Control function. This function is responsible for providing facilities for the automatic control of vehicles, either in basic form, or as required for operation in platoons or on Automatic Highway System (AHS) lanes. The functional processes contained in this DFD satisfy the User Service Requirements from the following User Services:

1.6 Traffic Control
5.1 Emergency Notification and Personal Security
6.1 Longitudinal Collision Avoidance
6.2 Lateral Collision Avoidance
6.3 Intersection Collision Avoidance
6.4 Vision Enhancement for Crash Avoidance
6.5 Safety Readiness
6.6 Pre-Crash Restraint Deployment
6.7 Automated Vehicle Operation
8.1 Maintenance and Construction Operations

The key points about the function are as follows:

- Emergency services automatically notified when the vehicle is involved in a collision;
- Cargo information is provided to emergency services if any is present on the vehicle;
- Vehicle control provided at various levels of automation from basic to full AHS level;
- Automatic vehicle control canceled by driver action or failure of built in self test processes.

There are four processes in this DFD, three of which are DFDs themselves:

1) Monitor Vehicle Status (DFD 3.1)
2) Provide Automatic Vehicle Operation (DFD 3.2)
3) Provide Automatic Emergency Notification (DFD 3.3)
4) Enhance Driver's Vision (3.4)

Although links are provided between the processes, they can operate independently. All of the processes use the Provide Information Services facility - see DFD 6.2, to interface with the driver for the input of commands and the output of information. Another part of the Provide Driver and Traveler function (see DFD 6) is used to provide the vehicle's location for the automatic notification of emergency situations.

DFD:3.1 Monitor Vehicle Status

The three processes in this DFD provide the Monitor Vehicle Status facility within the Provide Vehicle Monitoring and Control function. The processes in this facility monitor vehicle operation, driver performance and data provided from the roadway on which the vehicle is operating. This data is used to generate messages for output to the driver and may also provide input to the vehicle control facilities for automatic action.

The key points about the facility are as follows:

- Potentially unsafe vehicle conditions detected by on-board vehicle sensors;
- Driver's condition continuously analyzed and warning data provided if found unsafe;
- Unsafe vehicle and driver conditions notified to the driver through safety and warning messages;
- Crash and collision avoidance data automatically provided if unsafe condition likely;
- In the event of a potential collision, crash restraint deployment action is also initiated.

There are three processes in this DFD:

a) Produce Collision and Crash Avoidance Data (3.1.1)
b) Carry-out Safety Analysis (3.1.2)
c) Process Vehicle On-board Data (3.1.3)

The above processes provide an early form of vehicle control that is limited to on-board vehicle safety analysis and crash avoidance functions. The analysis of data collected on-board the vehicle or from its surroundings is carried out by process (c). Safety analysis of the data from process (c) is carried out by process (b) and potential collision analysis by process (a). The safety and position warnings that they generate will be output to the Provide Information Services facility - see DFD 6.2. These two processes will also output data to the Provide Vehicle Control facility - see DFD 3.2.3, for action, if the vehicle is so equipped. These processes can be applied to all types of vehicle with the exception of the safety analysis in process (b), which need not be applied commercial vehicles as they have their own on-board safety analysis systems.

DFD:3.2 Provide Automatic Vehicle Operation

This DFD shows the seven processes that make up the Provide Automatic Vehicle Operation facility within the Provide Vehicle Monitoring and Control function. The processes in this facility provide automatic vehicle operation, either for a single vehicle, or as part of a platoon, and may use AHS lanes.

The key points about the facility are as follows:

- Automatic vehicle control functions provided for speed, lane position and platoon following;
- Driver activation of vehicle controls will cancel automatic vehicle control;
- Failure of built in self test function for critical processes will also cancel automatic vehicle control;
- AHS operating parameters may be changed to improve lane utilization efficiency;
- AHS facilities provided in separate processes for implementation when the technology matures.

There is one DFD and eight processes in this DFD:

a) Provide Driver Interface (3.2.1)
b) Provide AHS Control (3.2.2)
c) Provide Vehicle Control (DFD 3.2.3)
d) Process Sensor Data for AHS input (3.2.4)
e) Check Vehicle for AHS eligibility (3.2.5)
f) Manage AHS Check-in and Check-out (3.2.6)
g) Manage AHS Operations (3.2.7)
h) Provide Automated Lane Changing (3.2.8)

Process (a) provides the means by which these processes can communicate with the driver interface provided in the Provide Information Services facility - see DFD 6.2. This is also the mechanism by which information about the status of automatic vehicle control is output to the driver. The AHS check-in and check-out facility is provided by processes (e) through (h). They are provided with AHS operational data by the Manage Demand facility - see DFD 1.4, through process (g). This process also provides AHS operational data to the Manage Traffic function which forwards the data to the Manage Archived Data function - see DFD 8.

The processes in this DFD can be divided up into two groups, those concerned with basic automatic vehicle control (processes (a) and (c)) and those concerned with the AHS facilities (processes (b), plus (d) through (h)). This is to enable the latter to be deployed after the processes in the former group and allows for the later development of a mature AHS technology.

DFD:3.2.3 Provide Vehicle Control

This DFD shows the processes that make up the Provide Vehicle Control facility within the Provide Vehicle Monitoring and Control function. The processes in this facility provide automatic vehicle control including the interface to the platoon in which it may be running.

The key points about the facility are as follows:

- Simple speed, headway and lane position control functions are provided;
- The more complicated platoon following function is provided as a separate facility;
- Incorrect vehicle control command response feedback will cause automatic control to be disabled;
- Vehicle control disabled if driver activation of the controls detected;
- Any failure of built in self test in control processes will also disable vehicle control.

There are six processes and one DFD in this DFD:

a) Provide Command Interface (3.2.3.1)
b) Manage Platoon Following (3.2.3.2)
c) Process data for Vehicle Actuators (3.2.3.3)
d) Provide Servo Control (DFD 3.2.3.4)
e) Process Vehicle Sensor Data (3.2.3.5)
f) Communicate with other Platoon Vehicles (3.2.3.6)

The basic vehicle control facilities are provided through processes (c) and (d), with inputs being provided from on-board vehicle sensors through process (e) and the driver through process (a). Output of the control status to the driver is provided through process (a). Optionally the exchange of data with other vehicles to enable their operation as part of a platoon can be provided through processes (b) and (f). These two processes can be implemented at a later date from the others, enabling basic vehicle control to be introduced ahead of the more advanced facilities for platooning vehicles.

DFD:3.2.3.4 Provide Servo Controls

This DFD shows the processes that are in the Provide Servo Controls facility within the Provide Vehicle Monitoring and Control function. The processes in this facility provide automatic control of the basic vehicle functions such as speed and position.

The key points about the facility are as follows:

- Separate processes provided for control of throttle, brake and steering;
- One or more of these processes may be implemented on a vehicle;
- Driver use of the vehicle controls immediately cancels automatic control operation;
- All processes have built in self test functions canceling automatic control when a failure is detected.

There are five processes in this DFD:

a) Provide Speed Servo Control (3.2.3.4.1)
b) Provide Headway Servo Control (3.2.3.4.2)
c) Provide Lane Servo Control (3.2.3.4.3)
d) Provide Change Lane Servo Control (3.2.3.4.4)
e) Provide Vehicle Control Data Interface (3.2.3.4.5)

The five processes have been organized so they can be implemented separately and not necessarily at the same time. Processes (a) through (d) provide particular control functions, while process (d) provides interfaces for communications with other processes and with the store of vehicle control data. This store is provided as part of the vehicle's control system; and is pre-loaded with data during its manufacture. It may be changed centrally from the Manage Demand facility - see DFD 1.4. This enables the way in which AHS lane operation is carried out to be adjusted to suit demand management strategies. Any such changes will be lost and the store returned to its original settings when the vehicle is switched off. This is to prevent the data being changed by unauthorized means which could be prejudicial to automatic vehicle operation.

DFD:3.3 Provide Automatic Emergency Notification

This DFD shows the processes that provide the Provide Automatic Emergency Notification facility within the Provide Vehicle Monitoring and Control function. The processes in this facility enable the vehicle to automatically inform the Manage Emergency Services function of its involvement in an incident.

The key points about the facility are as follows:

- Automatic emergency notification provided in the event of an accident regardless of driver condition;
- Vehicle location and identity provided automatically.

There are two processes in this DFD:

a) Provide Communications Function (3.3.1)
b) Build Automatic Collision Notification Message (3.3.2)

These processes are designed to enable notification of an accident or other kind of emergency involving any combination of the driver, the vehicle, to be sent as soon as possible to the Manage Emergency Services function - see DFD 5. The data from the vehicle will be generated automatically by process (a), plus process (b) if the vehicle is carrying any cargo. This enables the data to reach the emergency services though process (a) even if the driver is unable to initiate the action. Although the processes depend on others in the facility for data, they will each operate continuously and independently so that the data can processed, stored and accumulated as fast as possible bearing in mind the urgency with which their work has to be done.

DFD: 4 Manage Transit

This functional process performs the management functions that apply to fixed routed transit services, plus the provision of the flexibly routed transit service (demand responsive transit). Information is provided to the Transit Vehicle Operator and Traveler directly through this function, but information for the traveler trip planning and guidance is provided through the Provide Driver and Traveler Services function. Interaction with the Manage Traffic function is provided to support priority at signalized intersections and freeway ramps, and also to reflect the overall coordination between transit and traffic management services (including provision for transit vehicle location data to be passed to traffic management and maintenance and construction as probe information. Interaction is also provided with the Provide Electronic Payment Services function to enable the advanced payment of transit fares and other services, and with the Maintenance and Construction function to coordinate scheduled maintenance and construction work activities including anticipated closures and impact to the roadway that will affect transit routes or schedules. Interaction is also provided with Emergency Management to support security functions and incident management in the public transportation network.

The User Services Requirements that are included in this functional process are:

2.1 Public Transportation Management
2.2 En-Route Transit Information
2.3 Personalized Public Transit
2.4 Public Travel Security

The processes in this DFD comprise the Manage Transit function. This function is responsible for the management of transit operations within some or all of the areas served by ITS.

The key points about the function are as follows:

- monitoring of transit services operation uses data collected on-board transit vehicles;
- strategies available for returning late running transit vehicles to normal operation;
- transit services planned using current operational data and input from various other sources;
- demand responsive transit provides personalized transport for travelers on request;
- security coordination and monitoring provides links to the Manage Emergency Services function, which includes Disaster and Evacuation Management;
- transit vehicle operator activities can be assigned using past performance and other factors;
- transit vehicle maintenance can be scheduled and work assigned to technicians;
- transit fares can be collected either on-board the vehicle or at the roadside;
- transit service information and data from approaching transit vehicles is available at the roadside.

The processes subordinate to this DFD are themselves DFDs:

(a) Operate Transit Vehicles and Facilities (4.1)
(b) Plan and Schedule Transit Services (4.2)
(c) Schedule Transit Vehicle Maintenance (4.3)
(d) Support Transit Security and Coordination (4.4)
(e) Generate Transit Vehicle Operator Schedules (4.5)
(f) Collect Transit Fares in the Vehicle (4.6)
(g) Provide Traveler Roadside Facilities (4.7)

The key processes in this function are those provided by the facilities in (a) and (b), since they both provide data to other parts of the Manage Transit function, and in the case of process (b) to other ITS functions. Implementation of the processes in (c) through (g) without these two facilities will limit the effectiveness of their operation. However stand-alone implementation of some or all of the processes in (c) through (g) is possible if particular implementations do not require the full functionality. It is also not necessary to include the transit fare collection facilities provided by processes in both (f) and (g) in the same implementation.

Although many of the processes and some of the variables they use refer to a “transit vehicle”, the definition of what this actually means is flexible. Thus the processes can be applied to a fleet of Light Rail Vehicles (LRVs) or Light Rail Trams (LRTs), or taxis used for demand responsive transit services, as well as a fleet of buses used in the roadway.

The term “transit system operator” is frequently used within the descriptions of the facilities in this function. It is intended to represent an employee of the functional entity that is providing transit services. This employee is expected to oversee the operation of the transit services and to provide inputs to aid its operation, as required by the various facilities. The "transit system operator" as used in the National ITS Architecture includes other types of personnel from the transit industry, such as the street supervisor or dispatcher.

The transit route data is supplied to the map update provider to enable the supplier to produce transit route maps and include them in the digitized map databases sent to other ITS functions. The raw route data is also made available to other ITS functions so that where possible they can display transit route maps using their current map display data.

DFD:4.1 Operate Transit Vehicles and Facilities

The processes in this DFD provide the Operate Transit Vehicles and Facilities feature for the Manage Transit function. They provide information on the current state of operation of transit vehicles, and how they are performing against the schedules. These processes collect operational data from transit vehicles for use by other facilities in the Manage Transit and other ITS functions, and for the management of the deviation of transit vehicles from their schedules. The processes are responsible for keeping vehicles on schedule and taking action to get them back on schedule when any deviations are found. Two types of actions are supported, one for single vehicles and the other for multiple vehicles. In both cases, instructions will be sent to the vehicle operator(s) and vehicle priority requested through the Manage Traffic function - see DFD 1. This function includes sending transit probe and vehicle location data to the Manage Traffic function and receiving data concerning current incidents in the roadway that affect transit operations.

The key points about the facility are as follows:

- data from sensors on-board transit vehicles is stored centrally for use within the rest of the facility;
- data is used to provide other ITS functions with information about transit system performance;
- information about arrival time of the next service is provided for use at roadside locations;
- correction of service deviations is provided separately for single and multiple vehicles;
- single vehicle corrective action uses priority at intersections and driver instructions;
- multiple vehicle corrective action uses service changes and wide ranging intersection priority;
- deviation data is sent to the multimodal transportation service provider for service coordination;
- one type of transit vehicle operator authentication is provided by the Transit Management Center to the transit vehicle;
- asset restriction data (height, weight, etc.), maintenance and construction work planning information, and road weather information, is distributed to this function from the Maintenance and Construction function for use in determining deviations from transit routes and schedules.

There are nine processes and one DFD that comprise this DFD:

(a) Process On-Board Systems Data (4.1.1)
(b) Determine Transit Vehicle Deviation and Corrections (DFD 4.1.2)
(c) Provide Transit Vehicle Location Data (4.1.3)
(d) Manage Transit Vehicle Deviations (4.1.4)
(e) Provide Transit Vehicle Status Information (4.1.5)
(f) Manage Transit Vehicle Operations (4.1.6)
(g) Provide Transit Vehicle Deviation Data Output Interface (4.1.7)
(h) Provide Transit Operations Data Distribution Interface (4.1.8)
(i) Process Transit Vehicle Sensor Maintenance Data (4.1.9)

Data from on-board the transit vehicle is provided by process (a) and (on request) from process (i). It is supplied to process (f) for storage. The data from process (a) is also provided to processes in (b), and to process (c). This process is responsible for providing the vehicle location based on the standard location data received from the Provide Driver and Traveler Services function (see DFD 6), plus inputs peculiar to transit vehicle operation, e.g., passenger doors opening, transit vehicle operator authentication. The location data is again sent for storage by process (f) and used by processes in (b), and process (d) for the management of deviations from schedules. Processes (e) and (h) provide access to the stored operational data to other parts of the Manage Transit function, the transit system operator, and to other ITS functions. Process (d) determines the corrective action for service deviations that are large or in the rural environment, where the effects can be different from those in the urban environment. Output of service corrections produced by this process is provided to multimodal transportation service providers through process (g), and to transit vehicle operators through the interface process in (b).

The above processes form a cohesive group. Partial implementation could be provided if, for example, the facility for the organized restoration of transit services after any kind of deviation was not required. Process (g) can be omitted where there are no other transportation services with which coordination needs to be maintained.

DFD:4.1.2 Determine Transit Vehicle Deviation and Corrections

The processes in this DFD provide the Determine Transit Vehicle Deviation and Corrections facility within the Manage Transit function. They are responsible for providing a facility that enables transit vehicle deviations to be calculated and corrective instructions provided to the transit vehicle operator when the deviation is small or in an urban environment. These processes use the data provided by the Process On-Board Systems Data function plus the current transit routes and schedules to determine the expected time of arrival (ETA) of a transit vehicle and its deviation (if any) from the schedule. Information concerning current incidents on a transit route also affects the transit vehicle deviation from the route or schedule. All of this information is sent for storage so that it can be used by other ITS functions, and is also sent to a process in the main facility in case several vehicles are involved. When the deviation only involves one vehicle, corrective instructions are sent to the vehicle operator, individual vehicle priority is requested at intersections, and data is sent to the multimodal transportation service provider to enable coordination with other services.

The key points about the facility are as follows:

- schedule deviations and corrections are determined from transit vehicle position and current schedules;
- corrective instructions are provided to the transit vehicle operator where deviation is small and in urban environments;
- status of transit schedules and passenger loading is received from the transit vehicle operator and sent on to the process in Manage Transit that manages the transit operations data;
- local roadside priority is requested from Manage Traffic function for late running transit vehicles;
- deviation data is sent to other processes for use within this function and by other ITS functions;
- deviation data is sent to the multimodal transportation service provider for service coordination.

There are five processes in this DFD:

(a) Determine Transit Vehicle Deviation and ETA (4.1.2.1)
(b) Determine Transit Vehicle Corrective Instructions (4.1.2.2)
(c) Provide Transit Vehicle Operator Interface (4.1.2.3)
(d) Provide Transit Vehicle Correction Data Output Interface (4.1.2.4)
(e) Request Transit Vehicle Priorities (4.1.2.5)

The determination of transit vehicle deviation and estimated time of arrival (ETA) is carried out by process (a). The data is passed to process (b) for determination of the corrective instructions and to process (c) for output to the transit vehicle operator. When the instructions are produced by process (b), they are also output to the vehicle operator by process (c) and are sent to the multimodal transportation service provider through process (d). Status of transit schedules and passenger loading is received from the transit vehicle operator by process (c) and sent on to the process in Manage Transit that manages the transit operations data. Requests for priority for the transit vehicle at traffic intersections are sent to the Provide Device Control facility (see DFD 1.2) through process (e).

The above processes form a cohesive group from which only the Provide Transit Vehicle Correction Data Output Interface function could be omitted without loss of facilities. This process is not needed where there are no other transportation services with which coordination has to be maintained.

DFD:4.2 Plan and Schedule Transit Services

The processes in this DFD provide the Plan and Schedule Transit Services facility within the Manage Transit function. The term "transit services" is used as the collective name for transit routes and schedules. These processes provide the management of the route planning and scheduling of both regular and demand responsive transit services. The generation of new regular transit routes and schedules is done at the request of the transit system operator and takes into account the operational data plus input from a variety of other sources. New schedules can be generated separately from routes, and can be produced in response to inputs from parking lots if a change to the current static parking lot information service is needed. The new routes and services are made available to this and other ITS functions, plus external agencies. The generation of demand responsive transit services is provided in response to requests from the Provide Driver and Traveler Services function - see DFD 6. The services will be personalized to suit the traveler's request and will make use of regular transit services where possible.

The key points about the facility are as follows:

- transit service determination is initiated by the transit system operator and uses a variety of inputs;
- transit service details are sent to other Manage Transit facilities and ITS functions;
- transit service details are sent to other transit centers and multimodal transportation service providers;
- transit service details are sent to Manage Archived Data function;
- transit route details can be used to overlay route data onto existing digitized map data;
- demand responsive transit facility provides personalized transport for travelers;
- demand responsive transit services will use regular services where and when possible;
- current incidents data is received by this function for use in determining deviations from transit routes and schedules.

There are two DFDs and two processes that comprise this DFD:

(a) Provide Demand Responsive Transit Service (DFD 4.2.1)
(b) Provide Transit Plans Store Interface (4.2.2)
(c) Generate Transit Routes and Schedules (DFD 4.2.3)
(d) Manage Transit Archive Data (4.2.4)

The details of transit routes generated by processes in (c) can be used by other facilities as the background to transit data displays. They are also sent to the map update provider. This enables the provider to generate the route details in digitized form as part of the next map data update, and to provide transit route information by other means, such as printed transit maps, etc.

The processes are organized so that either the demand responsive transit or regular transit service determinations can be omitted from any particular implementation. To this end they each have their own separate communication links with the transit system operator and other ITS functions.

DFD:4.2.1 Provide Demand Responsive Transit Service

The processes in this DFD comprise the Provide Demand Responsive Transit Service facility within the Manage Transit function. The processes in this facility generate transit schedules that are tailored to the specific needs of travelers. These processes provide the response to a traveler's request for a demand responsive transit service. This request is received from the Provide Driver and Traveler Services function and will therefore be made as part of a trip plan by the traveler. Details of the proposed service are sent back to the traveler for confirmation, after which they are sent to both the transit vehicle operator and the transit system operator.

The key points about the facility are as follows:

- demand responsive transit services tailored to a traveler's needs are requested as part of trip plans;
- demand responsive transit services will be integrated into regular transit services if possible;
- demand responsive transit service is only activated after confirmation from the traveler;
- demand responsive transit service details are made available for regular transit service generation.

There are six processes in this DFD:

(a) Process Demand Responsive Transit Trip Request (4.2.1.1)
(b) Compute Demand Responsive Transit Vehicle Availability (4.2.1.2)
(c) Generate Demand Responsive Transit Schedule and Routes (4.2.1.3)
(d) Confirm Demand Responsive Transit Schedule and Route (4.2.1.4)
(e) Process Demand Responsive Transit Vehicle Availability Data (4.2.1.5)
(f) Provide Demand Responsive Transit Vehicle Operator Interface (4.2.1.6)

The request from the traveler for a demand responsive transit service originates in the Provide Driver and Traveler Services function and is received by process (a). It is passed to process (c) which generates details of the service, using details of the regular transit services, plus the vehicle availability provided through processes (b) and (e). Details of the newly generated service are sent back to the traveler through process (a) and are stored to await confirmation. This is again received by process (a) which passes it on to process (d). This generates the data for the transit vehicle operator, the transit system operator, the Generate Transit Vehicle Operator Schedules facility - see DFD 4.5, and for loading into a store for use by the Generate Transit Routes and Schedules facility - see DFD 4.2.3 below.

The processes above form a cohesive group. They have their own links to other ITS functions and only require a link to the store of regular transit services within the Manage Transit function. However it would be possible for these processes to operate without reference to the regular transit services if coordination with their activities is not required.

DFD:4.2.3 Generate Transit Routes and Schedules

The processes in this DFD provide the Generate Transit Routes and Schedules facility within the Manage Transit function. The processes in this facility determine new routes and schedules for regular transit operations and output them to other processes within the Manage Transit and other ITS functions. The determination processes use parameters provided by transit system operators, data from other transit centers (Other Transit Management) and multimodal transportation service providers, operational data from the current regular transit services, as well as the current regular transit routes and schedules, plus the most popular demand responsive transit services. New routes are always determined first and then new schedules applied to them. However new schedules can be determined for an existing set of routes. The route and schedule generation processes are run at the request of a transit system operator, but requests for the generation of new schedules can also come from parking lots to accommodate the fluctuating demands of static and dynamic parking lot information. Details of the new services are sent to the sources of input data listed above. They are also sent to other processes in this and other ITS functions. In some cases, this data may also be requested by these processes where it is possible that they have missed an update.

The key points about the facilities that these processes provide are as follows:

- transit service determination is initiated by a transit system operator;
- transit service determination uses data from many sources;
- transit schedule determination can be initiated from parking lots to suit static and dynamic parking lot needs;
- transit services data is automatically output to other service providers and Manage Transit facilities;
- transit services data is available for use by other ITS functions on request.

There are nine processes that comprise this DFD:

(a) Generate Transit Routes (4.2.3.1)
(b) Generate Transit Schedules (4.2.3.2)
(c) Produce Transit Service Data for External Use (4.2.3.3)
(d) Provide Transit Sys Operator Interface for Services Generation (4.2.3.4)
(e) Manage Transit Operational Data Store (4.2.3.5)
(f) Produce Transit Service Data for Manage Transit Use (4.2.3.6)
(g) Provide Interface for Other Transit Management Data (4.2.3.7)
(h) Provide Interface for Transit Service Raw Data (4.2.3.8)
(i) Update Transit Map Data (4.2.3.9)

Transit routes and schedules are generated by processes (a) and (b), at the instigation of a transit system operator through process (d). They use data from the stores of operational data provided by process (e), parameters provided by a system operator through process (d), the most popular demand responsive transit services, and the current regular transit routes and schedules. The results are sent to the store of raw routes and schedules data through process (h). Data about transit services is automatically sent to other parts of the function through process (f), and on request to other ITS functions through process (c). The exchange of service data with other transit centers is provided through process (g) and only takes place when a new set of services is generated. Transit map data is updated in process (i) from data received from process (d), and placed in a data store for use by other processes in the Manage Transit function.

The determination of routes and schedules for use by the regular transit operation also takes into account data provided by other transit centers and multimodal transportation service providers. This is designed to achieve coordination between geographically adjacent transit operations areas, and between transit and other types of passenger service provision, e.g., heavy rail, ferries, and airlines.

DFD:4.3 Schedule Transit Vehicle Maintenance

The processes in this DFD provide the Schedule Transit Vehicle Maintenance facility within the Manage Transit function. These processes enable transit vehicle maintenance to be scheduled and monitored, and for the work to be assigned to maintenance technicians. They use the operational data provided by the processes in the Operate Transit Vehicles and Facilities function (DFD 4.1) and the maintenance specifications for each type of vehicle. A log is maintained of all maintenance activity so that current progress on activities and individual technician assignments can be tracked and monitored by the transit system operator.

The key points about the facility are as follows:

- maintenance is scheduled from operational data collected by the transit vehicles;
- maintenance schedules include the assignment of technicians to carry out specific tasks;
- the transit system operator has ultimate control over all maintenance activities.

There are seven processes in this DFD:

(a) Monitor Transit Vehicle Condition (4.3.1)
(b) Generate Transit Vehicle Maintenance Schedules (4.3.2)
(c) Generate Technician Work Assignments (4.3.3)
(d) Monitor and Verify Maintenance Activity (4.3.4)
(e) Report Transit Vehicle Information (4.3.5)
(f) Update Transit Vehicle Information (4.3.6)
(g) Manage Transit Vehicle Operations Data Store (4.3.7)

The current transit vehicle condition is provided to process (a), which compares it against the vehicle's maintenance specifications obtained from the store of transit vehicle operations data managed by process (g). When maintenance is found to be required, data is sent to process (b) which generates the maintenance schedules. These are passed to process (c) which assigns the work to a particular technician according to their availability and skills. Process (d) monitors the state of the maintenance activity from the vehicle status and receives updates from the maintenance technician through process (f) and the transit vehicle operations data store managed by process (g). It sends the results back to process (c) to enable the technician to be assigned new work. The transit system operator can monitor the state of maintenance activity using the data in the transit vehicle operations data store and update vehicle maintenance specifications through process (e). The above processes form a tightly coupled group, although they are able to operate independently.

DFD:4.4 Support Transit Security and Coordination

The processes in this DFD make up the Support Transit Security and Coordination facility within the Manage Transit function. These processes enable incidents that occur either on-board transit vehicles or in other parts of the transit network to be reported and actions coordinated with the emergency services. These processes manage the actions that are taken when an emergency occurs on-board a transit vehicle (coordinated with DFD 5.1.7) or within a transit facility, modal interchange facility, or transit depot. Notification of an emergency may come from travelers via such things as panic buttons, from a transit vehicle operator, or from surveillance equipment located at transit stops and other parts of the transit network. The processes work to pre-defined plans of action for each type of emergency situation and communicate with the Manage Emergency Services function (see DFD 5) for coordination of emergency service activities and multiple agency responses to incidents. The processes also manage transit security such as video/audio surveillance and sensor management for threat information, authenticating the transit vehicle operator to the vehicle, and remote disabling of a vehicle during an incident, as well as disaster and evacuation planning and support for Emergency Management and wide area alerts displayed in the transit network. The processes also communicate with the transit system operator to both gain approval for and keep informed of, the actions being taken, and for actual input of actions if none are defined. Automatic output of information about emergencies to the media is also provided.

The key points about the facility are as follows:

- transit system operators can monitor and respond to incidents and security issues detected in the transit system;
- details of incidents and security threats are sent to the Manage Emergency Services function for a response;
- transit system operators can define responses to incidents and threats and the way activities are coordinated;
- incidents may be reported by transit vehicle operators and travelers, or detected by sensors in the transit system;
- information about incidents is automatically passed to the media;
- threat sensors (e.g., thermal, acoustic, radiological, chemical), object, motion and intrusion detection sensors are used to detect threats to transportation infrastructure;
- sensors are also used to monitor the condition of transit infrastructure (which is represented by the Security Monitoring Subsystem, SMS);

- video and/or audio surveillance is performed on-board a transit vehicle (coordinated with DFD 5.1.7), or via the RTS or SMS which may include transit facilities and infrastructure.

There are four processes and one DFD that comprise this DFD:

(a) Provide Transit Security and Emergency Management (4.4.1)
(b) Coordinate Multiple Agency Responses to Transit Incidents (4.4.2)
(c) Generate Responses for Transit Incidents (4.4.3)
(d) Provide Transit System Operator Security Interface (4.4.4)

The incident, emergency, and threat data obtained by process (a) is passed to process (b). This is responsible for coordinating activities with the emergency services and uses a pre-planned sequence of activities prepared by the transit system operator. If there are no pre-planned activities to suit a particular incident or emergency, the transit system operator will be prompted to provide the activities in real time. Process (a) also coordinates disaster and evacuation planning and support with processes in the Manage Emergency function. These processes may be implemented as a single coordinated group. For some implementations, process (c) may be omitted so that the transit system operator must always actively participate in the response to incidents, emergencies, and threats.

DFD:4.5 Generate Transit Vehicle Operator Schedules

The processes in this DFD make up the Generate Transit Vehicle Operator Schedules facility within the Manage Transit function. These processes produce transit vehicle operator work assignments, schedules, and routes, based on such things as previous work history and seniority. Operators are assigned to their duties based on a number of criteria, including availability, previous experience, performance on previous assignments, seniority, and personal preferences. Activities are monitored by the transit system operator who can update the data about individual transit vehicle operators.

The key points about the facility are as follows:

- the transit system operator manages the allocation of transit vehicle operator to routes and schedules;
- transit vehicle operators' allocation depends on performance, cost effectiveness, preferences, and availability;
- transit vehicle operator allocations are provided for both regular and demand responsive (paratransit) services.

There are eight processes that comprise this DFD:

(a) Assess Transit Vehicle Operator Performance (4.5.1)
(b) Assess Transit Vehicle Operator Availability (4.5.2)
(c) Assess Transit Vehicle Operator Cost Effectiveness (4.5.3)
(d) Assess Transit Vehicle Operator Eligibility (4.5.4)
(e) Generate Transit Vehicle Operator Route Assignments (4.5.5)
(f) Update Transit Vehicle Operator Information (4.5.6)
(g) Report Transit Vehicle Operator Information (4.5.7)
(h) Provide Transit Vehicle Operator Information Store Interface (4.5.8)

Transit vehicle operator route assignments are produced by the process in (e). This uses the data from the store of transit vehicle operator information, managed by process (h), to match drivers with the routes and schedules provided by the Plan and Schedule Transit Services facility (DFD 4.2). It runs when it receives a new set of regular or demand responsive (paratransit) transit services. The data in the store of transit vehicle operator information is updated as a result of data being supplied by the transit system operator through processes (f) and (g). When process (h) loads the data into the store, it also sends the data to each of the processes (a) through (d) for analysis. These processes return the results of their analysis to process (h), which when they are all done will send the resulting complete set of data to process (e) to generate a new set of assignments.

The above processes may be implemented as a single coordinated group or in a reduced form leaving out some or all of processes (a) through (d). The result of the omission of some or all of these processes will be to reduce the factors that are taken into account when making transit vehicle operator route assignments.

DFD:4.6 Collect Transit Fares in the Vehicle

The processes in this DFD make up the Collect Transit Fares in the Vehicle facility within the Manage Transit function. These processes collect fares from travelers as they board transit vehicles, for the use of current transit services, advanced payments for transit services, and for other (yellow pages) services. The fare payment processing may be carried out interactively from on-board the vehicle, or may be held until the vehicle reaches a convenient point and then carried out as a batch transaction. The processes support the use of debit/credit cards, including those with stored credit value, as may be issued by transit operators as well as financial institutions. When a violation of an interactive payment transaction is detected, an image of the offending traveler will be obtained from the vehicle for use by the law enforcement agency.

The key points about the facility are as follows:

- transit vehicle fare collection is provided either on-board the vehicle or as advanced payment (at the roadside, via a kiosk, online, etc.);
- fare processing can be interactive, or as a batch when the vehicle reaches a convenient point;
- advanced payment of transit fares, tolls, and parking lot charges is supported.

There are eight processes in this DFD.

(a) Detect Traveler on Vehicle (4.6.1)
(b) Determine Traveler Needs on Vehicle (4.6.2)
(c) Determine Transit Fare on Vehicle (4.6.3)
(d) Manage Transit Fare Billing on Vehicle (4.6.4)
(e) Provide Traveler Fare Payment Interface on Vehicle (4.6.5)
(f) Update Transit Vehicle Fare Data (4.6.6)
(g) Provide Transit Vehicle Passenger Data (4.6.7)
(h) Manage Transit Vehicle Advanced Payments (4.6.8)

Detection of a traveler by process (a) and the collection of the desired destination data by process (e) enables the transit fare to be calculated by processes (b) and (c). This data is passed to process (d) which determines whether the payment will be processed interactively, i.e., as travelers board the vehicle, or as a batch. Batch processing will take place either when the vehicle reaches a convenient point on its route or at the request of the transit vehicle operator. In both cases the tag data provided by the traveler will be checked against the list of bad payers requested by process (d) from the Provide Electronic Fare Collection facility of the Provide Electronic Payment Services function - see DFD 7.3. If a match is found, the traveler is informed and the payment transaction is aborted. Travelers are also informed of the successful completion of a payment transaction.

The selection of the appropriate fare processing option is made by the transit vehicle operator. Failure of the transfer of data for batch processing will be notified to the operator who can then request a re-transmission of the data. These two fare processing options are provided to enable the optimum use of the vehicle to the central transit management facility communications network. Thus for example, in urban environments where there may be many travelers boarding vehicles, the batch mode of processing will be employed, while in rural environments or for demand responsive transit operation, where the number of users may be less frequent, interactive processing can be used. The actual fare payment processing will be carried out by processes in the Provide Electronic Fare Collection facility of the Provide Electronic Payment Services function - see DFD 7.3. Facilities for travelers to pay for transit fares, tolls and parking lot charges in advance are also provided through process (e) and (advanced

payments only) process (h). Processes (f) and (g) are used to manage data stores containing information about transit fares and transit passengers and trips.

The above processes are intended to be implemented as a single coordinated group. However some of the interfaces in process (e) could be omitted if only transit fare processing is to be provided and the reporting process (g) could also be left out if its functionality is not required by a particular transit operation.

DFD:4.7 Provide Traveler Roadside Facilities

The processes in this DFD make up the facility Provide Traveler Roadside Facilities within the Manage Transit function. These processes provide travelers at the roadside with information and the collection of payment for services that they require. These processes act as the interface through which the traveler can obtain information and pay for the use of services at a roadside location, such as a transit stop. The information provided includes transit services in general, and the time at which the next transit vehicle is due to arrive at the location. Information provided by transit vehicles approaching the location is also automatically output to the traveler. Payment by the traveler for the use of current transit services, advanced payments for transit services and for other (yellow pages) services, is supported by the processes, as is the use of debit/credit cards, including those with stored credit value, as may be issued by transit operators as well as financial institutions. When a violation of a payment transaction is detected, an image of the offending traveler will be obtained from the roadside for use by the law enforcement agency.

The key points about the facility are as follows:

- travelers can request transit service information and can receive data about approaching services;
- transit fares can be collected at the roadside before travelers board a vehicle;
- data about transit services in general can be requested by travelers;
- data from on-board approaching transit vehicles is automatically output to the traveler;
- data is stored locally in case contact with the transit vehicle is lost and to avoid repetitive requests.

There is one process and one DFD that comprise this DFD:

(a) Provide Traveler Roadside & Vehicle Data Interface (4.7.1)
(b) Collect Transit Fares at the Roadside (DFD 4.7.2)

These two sets of processes can be implemented independently at some or all roadside locations. They could share the same physical facilities such as power supply, communications interface, and be located within the same roadside physical structure.

DFD:4.7.2 Collect Transit Fares at the Roadside

The processes in this DFD make up the Collect Transit Fares at the Roadside facility within the Manage Transit function. These processes enable transit fares to be collected from travelers at the roadside before they board the vehicle. The processes operate together in much the same way as those performing a similar function on-board the transit vehicle. They also enable the traveler to obtain information about and pay for other (yellow pages) services, and to pay for tolls and parking lot charges in advance.

The key points about the facility are as follows:

- transit fare collection is provided without travelers needing to stop while boarding the vehicle;
- fare processing is interactive as the travelers pass through the roadside location;
- travelers may request and pay for other (yellow pages) services;
- advanced payment of transit fares, tolls, and parking lot charges is supported.

There are seven processes in this DFD:

(a) Detect Traveler at Roadside (4.7.2.1)
(b) Determine Traveler Needs at Roadside (4.7.2.2)
(c) Determine Transit Fare at Roadside (4.7.2.3)
(d) Manage Transit Fare Billing at Roadside (4.7.2.4)
(e) Provide Traveler Roadside Fare Interface (4.7.2.5)
(f) Update Roadside Transit Fare Data (4.7.2.6)
(g) Provide Transit Roadside Passenger Data (4.7.2.7)

Detection of a traveler passing through the roadside facility by process (a) and the collection of the desired destination data by process (e) enables the transit fare to be calculated by processes (b) and (c). This data is passed to process (d) which sends the data to the Transit Management Center for payment processing. This is always carried out interactively as even with large numbers of travelers, there should be no constraints on the communications with the Transit Management Center that there would be with a transit vehicle. Interactive processing also enables the images of all users making invalid payments to be obtained. Facilities for travelers to pay for transit fares, tolls, and parking lot charges in advance are also provided through process (e). Processes (f) and (g) are used to manage data stores containing information about transit fares and transit passengers and trips obtained at the roadside.

The above processes are intended to be implemented as a single coordinated group. However some of the interfaces in process (e) could be omitted if only transit fare processing is to be provided and the reporting process (g) could also be left out if its functionality is not required by a particular transit operation.

DFD: 5 Manage Emergency Services

The processes in this DFD make up the Manage Emergency Services function. This function is responsible for the management of the emergency services' response to incidents and communications with law enforcement agencies. An interface is also provided to the Manage Traffic function for the coordination of incident management functions (including resource coordination between traffic management and emergency management) and to provide priority for emergency vehicles at signalized roadway intersections and freeway ramps. The User Services Requirement satisfied by this functional process tree include those from the following User Services:

1.6 Traffic Control
2.4 Public Travel Security
3.1 Electronic Payment Services
4.3 On-Board Safety and Security Monitoring
4.5 Hazardous Materials Security and Incident Response
4.6 Freight Mobility
5.1 Emergency Notifications and Personal Security
5.2 Emergency Vehicle Management
5.3 Disaster Response and Evacuation
7.1 Archived Data Function
8.1 Maintenance and Construction Operations

The key points about the function are as follows:

- ITS functions can automatically call-out appropriate emergency services to an incident;
- Confirmation of response action is provided to the emergency services operator;
- Emergency telephone and E911 systems can call-out appropriate emergency services to an incident;
- Information about incidents can be exchanged with the Manage Incidents facility;
- Emergency vehicles can be provided preemption routing along their routes to an incident;
- Incident responses can be coordinated with other Emergency Management Systems;
- ITS functions provided with access to law enforcement agencies for action on violations;
- Disaster response and evacuation planning and management is handled by this DFD and coordinated with other DFD's.

There are seven processes subordinate to this DFD, three of which are themselves DFDs:

(a) Provide Emergency Service Allocation (DFD 5.1)
(b) Provide Operator Interface for Emergency Data (5.2)
(c) Manage Emergency Vehicles (DFD 5.3)
(d) Provide Law Enforcement Allocation (DFD 5.4)
(e) Update Emergency Display Map Data (5.5)
(f) Manage Emergency Services Data (5.6)
(g) Coordinate Disaster Response and Evacuation (DFD 5.7)

Data about incidents is received by the processes in (a) which determine the response plan from data set up by the emergency services operator. This data is then passed to the processes in (c) for the dispatch of suitable vehicles, and back to the source of the incident information via a process in (a). The processes in (c) monitor the activities of all vehicles and maintain a store of vehicle status from which availability can be determined. They also obtain the route for the vehicle(s) from the Provide Driver and Traveler Services function and send data about the route to the Manage Traffic function to enable an emergency vehicle preemption routing to be provided.

There can be several sets of the processes in (c) above, one for each type of emergency service. The processes in (a) will then send their dispatch data to the most appropriate set(s) of processes in (c). The link to other Emergency Management Services enables coordination to be achieved across jurisdictional and/or operational boundaries thereby helping to achieve the best possible response to an incident. Process (g) handles disaster response and evacuation planning and management and coordinates these functions with other DFD's in the Manage Traffic, Manage Transit, Manage Emergency, Provide Driver and Traveler Services, and Manage Maintenance and Construction facilities.

DFD:5.1 Provide Emergency Service Allocation

This DFD shows the processes that make up the Provide Emergency Services Allocation facility within the Manage Emergency Services function. These processes receive reported incident data and initiate the appropriate response. They also detect and verify emergencies and threats and provide traveler and remote area security.

The key points about the facility are as follows:

- Facilities are provided to identify the type of emergency dependent on source;
- Response plan is determined from allocation criteria and sent to the vehicle dispatch function;
- Emergency services status reporting facility is provided for other ITS functions;
- Emergencies and threats are detected and verified from video/audio surveillance and from sensors in the roadway, in the transportation infrastructure, or on a transit vehicle;
- Traveler and remote area security is managed and coordinated between processes in this DFD and other areas of the architecture, such as Manage Traffic, Manage Transit, and Manage Emergencies.

There are eight processes in this DFD, and two are also DFDs:

a) Detect and Verify Emergencies (DFD 5.1.1)
b) Determine Coordinated Response Plan (5.1.2)
c) Communicate Emergency Status (5.1.3)
d) Manage Emergency Response (5.1.4)
e) Manage Emergency Service Allocation Store (5.1.5)
f) Process Mayday Messages (5.1.6)
g) Provide Traveler and Remote Area Security (DFD 5.1.7)
h) Manage Wide Area Alerts And Advisories (5.1.8)

The data about incidents is received by process (a) which formats it and passes it to process (b). In the event that the incident has been declared a disaster, threat, or major emergency, this process recognizes that additional coordination between multiple agencies may be required which is beyond normal incident response. In this event, data is passed on to the Manage Disaster Response and Evacuation Function (DFD 5.7) for the additional coordination and management needs. Process (b) requests the appropriate response data from the store of predefined responses through process (e). The response is loaded into a coordination plan which is sent to processes (c) and (d). Process (c) sends data acknowledging the receipt of the incident data back to the source of the data and also provides access to the log of incident responses maintained by process (d). This process manages the response to the incident, sending data to the dispatch vehicles facility and obtaining data about hazardous cargoes when commercial vehicles are involved. Process (g) manages traveler and remote area security from video/audio surveillance and from sensors in the roadway, in the transportation infrastructure, or on a transit vehicle. This data is sent to processes in DFD 5.1.1 to determine if a threat exists, then to DFD 5.7 to coordinate the response to a threat or disaster.

These processes are intended to work as a coordinated group in a single implementation. If necessary some of the sources of emergency data for process (a) can be omitted if they do not exist in some implementations.

DFD:5.1.1 Detect and Verify Emergencies

This DFD shows the processes that make up the Detect and Verify Emergencies facility within the Provide Emergency Service Allocation function. These processes receive reported incident data from a number of inputs including 911 call takers, mayday service providers, weather services, commercial vehicle operations and transit agencies. This process then coordinates the inputs in order to pass on the verified incident to the process to Determine the Coordinated Response Plan as well as other functions within Provide Emergency Service Allocation.

The key points about the facility are as follows:

- Facilities are provided to identify the type of emergency dependent on source;
- Includes sensors and surveillance processing to detect emergencies and possible threat conditions;
- Verified emergencies are passed onto other ITS functions.

There are four processes in this DFD, and one is also a DFD:

a) Coordinate Emergency Inputs (5.1.1.1)
b) Identify Commercial Vehicle Emergencies (5.1.1.2)
c) Collect Incident and Event Data (5.1.1.3)
d) Detect and Verify Emergencies from Surveillance and Sensors (DFD 5.1.1.4)

The data about incidents is received by processes (b) and (c) which formats it and passes it to process (a). Other incidents may be detected directly from surveillance and sensors within process (d). As incidents are detected from (d) or threat conditions detected those will also be passed to process (a). Process (a) then passes the collected and verified incident data onto other ITS functions to formulate the response. Process (b) would primarily be involved in collecting data about hazardous cargoes when commercial vehicles are involved. These processes are intended to work as a coordinated group in a single implementation. If necessary some of the sources of emergency data can be omitted if they do not exist in some implementations.

DFD:5.1.1.4 Detect and Verify Emergencies from Surveillance and Sensors

This DFD shows the processes that make up the Detect and Verify Emergencies from Surveillance and Sensors facility within the Manage Emergency Services function. These processes analyze sensor and surveillance data collected from secure areas, detect threats and other potential incidents, and exchange threat information with other functions.

The key points about the facility are as follows:

- Sensor and surveillance equipment controlled and monitored for operational status and equipment faults;
- Sensor and surveillance data analyzed to detect and verify threats;
- Detected threats correlated with alerts and advisories received from other processes and terminators;
- Threat information disseminated to other functions;
- Sensor and surveillance data processing controlled by operator interface;
- Infrastructure integrity monitored and disseminated to other functions;
- Traveler images are analyzed and matched.

There are six processes in this DFD:

a) Manage Secure Area Sensors (5.1.1.4.1)
b) Manage Secure Area Surveillance (5.1.1.4.2)
c) Analyze Threats (5.1.1.4.3)
d) Disseminate Threat Info (5.1.1.4.4)
e) Analyze Traveler Image (5.1.1.4.5)
f) Provide Operator Interface for Security (5.1.1.4.6)

Video and audio surveillance data collected from all secure areas is input to process (b), analyzed and correlated. The data and the processing results are then forwarded to process (f) for output to the operator and to process (c) for correlation with collected sensor data and data from other sources, such as emergency management functions in other jurisdictions and from Alerting and Advisory Systems. Similarly, sensor data (threat sensors, object, motion, and intrusion) collected from all secure areas is input to process (a), analyzed and correlated. The data and the processing results are then forwarded to process (f) for output to the operator and to process (c) for correlation with collected surveillance data and data from other sources. Following threat analysis in process (c), the results are output to process (d) for dissemination to other major functions. Process (f) controls all processing and analysis of collected sensor and surveillance data from (a) and (b). Data collected from another process is input to process (a) to monitor infrastructure integrity; the results are forwarded to other processes. Raw surveillance (images) are input to process (e) and used by (e) to match images received from Alerting and Advisory Systems (AAS). Matching results are returned to the operator interface, process (f) and to the AAS. All

surveillance and sensor faults collected by processes (a) and (b) are sent to other processes in the Manage Maintenance and Construction facility for correction.

DFD:5.1.7 Provide Traveler and Remote Area Security

This DFD shows the processes that make up the Provide Traveler and Remote Area Security facility within the Manage Emergency Services function. These processes collect and preliminarily analyze sensor and surveillance data from secure areas. These secure areas include those frequented by travelers (rest stops, transit stops, on-board transit vehicles, etc.) and those typically away from travelers (bridges, tunnels, etc.). These processes also provide an interface to the traveler and transit vehicle operator for reporting emergencies.

The key points about the facility are as follows:

- Raw and preliminarily processed sensor and surveillance data to other processes within the Manage Emergency Services function;
- Sensor and surveillance data analyzed to detect threats;
- Sensors and surveillance equipment monitored to detect and report any sensor faults;
- Interface to travelers and transit vehicle operators for reporting of emergencies and broadcast advisory messages to all travelers in the secure area.

There are four processes in this DFD, three of which are DFDs themselves:

a) Provide Traveler Security (DFD 5.1.7.1).
b) Provide Remote Security (DFD 5.1.7.2).
c) Provide Transit Vehicle Security (DFD 5.1.7.3).
d) Manage Alarms (5.1.7.4).

Processes (a), (b), and (c) represent similar processes located in different places. Process (a) represents function located in areas frequented by travelers, process (b) represents function located in remote areas typically away from travelers, and process (c) represents function on-board a transit vehicle. In all three processes, video and audio surveillance data are collected, preliminarily processed, and both the raw and processed data, as well as any potential threats or incidents detected are sent to center processes for further correlation, verification, and dissemination to other functions. All surveillance and sensor status and faults collected by processes (a), (b), and (c) are sent to other processes which then forward them to the Manage Maintenance and Construction facility for correction. Processes (a) and (c) provide an interface to the traveler (or transit vehicle operator) for declaring emergencies, and receive advisory information from another process in the Manage Emergency Services function for broadcast in the secure area. The declared emergencies are input to process (d) and sent on to other facilities that collect and respond to all potential incidents in the Manage Emergency Services facility. The above processes may be implemented as a single coordinated group or in part.

DFD:5.1.7.1 Provide Traveler Security

This DFD shows the processes that make up the Provide Traveler Security facility within the Manage Emergency Services function. These processes collect and preliminarily analyze sensor and surveillance data from areas frequented by travelers, such as transit stops, rest stops, etc. These processes also provide an interface to the traveler for reporting emergencies.

The key points about the facility are as follows:

- Raw and preliminarily processed sensor and surveillance data to other processes within the Manage Emergency Services function;
- Sensor and surveillance data analyzed to detect threats;
- Sensors and surveillance equipment monitored to detect and report any sensor faults;
- Interface to travelers for reporting of emergencies and broadcast advisory messages to all travelers in the secure area.

There are five processes in this DFD:

a) Surveil Traveler Secure Area (5.1.7.1.1)
b) Process Traveler Secure Area Surveillance (5.1.7.1.2)
c) Collect Traveler Secure Area Sensor Data (5.1.7.1.3)
d) Process Traveler Secure Area Sensor Data (5.1.7.1.4)
e) Report Traveler Emergencies (5.1.7.1.5)

In traveler secure areas, video and audio surveillance data are collected by process (a) and are output to process (b) for further processing in the field, and to other processes in the Manage Emergency Services facility for center analysis. Similarly, process (c) collects data from sensors such as threat sensors, object detection sensors, and motion and intrusion sensors and outputs that raw data to process (d) for further processing in the field, and to other processes in the Manage Emergency Services facility for center analysis. Field-processed sensor and surveillance data, as well as any indication of potential incidents or threats based on preliminary field analysis, are output from (b) and (d) and sent to center processes for further correlation, verification, and dissemination to other functions. All surveillance and sensor status and faults collected by processes (a) and (c) are sent to other processes which then forward them to the Manage Maintenance and Construction facility for correction. Process (e) provides an interface to the traveler for declaring emergencies, and receives advisory information from another process in the Manage Emergency Services function for broadcast to all travelers in the secure area.

DFD:5.1.7.2 Provide Remote Security

This DFD shows the processes that make up the Provide Remote Security facility within the Manage Emergency Services function. These processes collect and preliminarily analyze sensor and surveillance data from areas typically away from travelers, such as bridges, tunnels, etc.

The key points about the facility are as follows:

- Raw and preliminarily processed sensor and surveillance data to other processes within the Manage Emergency Services function;
- Sensor and surveillance data analyzed to detect threats;
- Sensors and surveillance equipment monitored to detect and report any sensor faults.

There are four processes in this DFD:

a) Surveil Secure Area (5.1.7.2.1)
b) Process Secure Area Surveillance (5.1.7.2.2)
c) Collect Secure Area Sensor Data (5.1.7.2.3)
d) Process Secure Area Sensor Data (5.1.7.2.4)

In remote secure areas, video and audio surveillance data are collected by process (a) and are output to process (b) for further processing in the field, and to other processes in the Manage Emergency Services facility for center analysis. Similarly, process (c) collects data from sensors such as threat sensors, object detection sensors, motion and intrusion sensors, and infrastructure integrity sensors, and outputs that raw data to process (d) for further processing in the field, and to other processes in the Manage Emergency Services facility for center analysis. Field-processed sensor and surveillance data, as well as any indication of potential incidents or threats based on preliminary field analysis, are output from (b) and (d) and sent to center processes for further correlation, verification, and dissemination to other functions. All

surveillance and sensor status and faults collected by processes (a) and (c) are sent to other processes which then forward them to the Manage Maintenance and Construction facility for correction.

DFD:5.1.7.3 Provide Transit Vehicle Security

The processes in this DFD make up the Provide Transit Vehicle Security facility within the Manage Transit function. As part of securing the transit vehicle, the processes collect surveillance data on-board the transit vehicle by use of video and audio equipment and collect sensor data from sensors on-board the transit vehicle. This data is then processed to determine if a threat exists, and sent on to other processes within Transit Management and Emergency Management to determine the correct response activity to take. In addition to the surveillance and sensor activities on-board the transit vehicle, the transit vehicle operator or the traveler can send a silent (or audible, in the case of the operator) alarm to the transit system operator indicating an emergency situation on-board the vehicle. The operator may also turn on a covert mike so that the center may listen in. In addition to these functions, the transit vehicle operator may initiate operator logon, which initiates the operator authentication process either on the vehicle or at the center. During an incident (e.g., a hijacking, a criminal act, or a terrorist act), the center may remotely disable the transit vehicle through processes in this DFD.

The key points about the facility are as follows:

- Raw and preliminarily processed sensor and surveillance data to processes within the Manage Emergency Services function;
- Sensor and surveillance data analyzed to detect threats;
- Sensors and surveillance equipment monitored to detect and report any sensor faults;
- Interface to travelers on-board a transit vehicle for reporting of emergencies and broadcast advisory messages to all travelers in the secure area (i.e., on-board the vehicle);
- Transit Center may remotely disable a transit vehicle during an emergency;
- Operator authentication is performed either on the vehicle or at the center; operator or traveler may initiate a silent (or audible) alarm.

There are six processes in this DFD:

(a) Surveil Secure Vehicle Area (5.1.7.3.1)
(b) Process Secure Vehicle Area Surveillance (5.1.7.3.2)
(c) Collect Secure Vehicle Area Sensor Data (5.1.7.3.3)
(d) Process Secure Vehicle Area Sensor Data (5.1.7.3.4)
(e) Manage Secure Vehicle Emergencies (5.1.7.3.5)
(f) Provide Transit Vehicle Operator Interface for Emergencies (5.1.7.3.6)

In secure areas on-board the vehicle, video and audio surveillance data are collected by process (a) and are output to process (b) for further processing in the field, and to other processes in the Manage Emergency Services facility for center analysis. Similarly, process (c) collects data from sensors such as threat sensors and object detection sensors, and outputs that raw data to process (d) for further processing in the field, and to other processes in the Manage Emergency Services facility for center analysis. Field-processed sensor and surveillance data, as well as any indication of potential incidents or threats based on preliminary field analysis, are output from (b) and (d) and sent to center processes for further correlation, verification, and dissemination to other functions. All surveillance and sensor status and faults collected by processes (a) and (c) are sent to other processes which then forward them to the Manage Maintenance and Construction facility for correction. Process (e) receives advisory information from another process in the Manage Emergency Services function for broadcast to all travelers in the secure area (i.e., on-board the transit vehicle). Process (e) also allows the traveler to declare an emergency and allows the Transit Management Center to remotely disable a transit vehicle during an emergency. Process (f) provides an interface to the transit vehicle operator for declaring emergencies and receives the request for the transit vehicle operator to be authenticated by either the Center or on-board the vehicle.

DFD:5.3 Manage Emergency Vehicles

The eight processes in this DFD provide the Manage Emergency Vehicles facility within the Manage Emergency Services function. These processes dispatch the appropriate emergency vehicles to the incident and monitor their status.

The key points about the facility are as follows:

- Vehicle type is selected to suit the incident;
- Status of vehicles monitored at all times to determine availability;
- Routes generated for vehicles to get to incidents;
- Vehicle preemption along routes and at intersections provided via the Manage Traffic function.

There are eight processes in this DFD:

a) Select Response Mode (5.3.1);
b) Dispatch Vehicle (5.3.2);
c) Track Vehicle (5.3.3);
d) Assess Response Status (5.3.4);
e) Provide Emergency Personnel (5.3.5);
f) Maintain Vehicle Status (5.3.6);
g) Provide Emergency Vehicle Route (5.3.7);
h) Collect Environmental Data on Emergency Vehicle (5.3.8).

Details of an incident are received by the process in (a) which dispatches the appropriate vehicle(s). It obtains current vehicle status from the store of this data via process (f) and sends the dispatch information to the selected vehicle(s) and driver(s) via processes (b) and (e). If the correct number of vehicles are not available, the process reports this information back to the management process in the Provide Emergency Services Allocation facility - see DFD 5.1. Process (b) requests a route for the vehicles from process (g). Process (h) collect environmental data from the vehicle and sends it to process (f) for maintaining the vehicle. Vehicles that are dispatched provide updates to their status through process (d). Process (c) is able to provide local signal preemption at intersections for vehicles on their way to incidents. This will supplement the signal preemption route requested by process (b) from the Manage Traffic function.

DFD:5.4 Provide Law Enforcement Allocation

The eight processes in this DFD provide the Provide Law Enforcement Allocation function. These processes receive violation data from other ITS functions and send it to the appropriate law enforcement agency.

The key points about their functions are as follows:

- The law enforcement agency tasked with responding to each type of violation is pre-defined;
- These processes just report the violations, responsibility for eventual prosecution of offenders rests with the law enforcement agency;

There are eight processes in this DFD:

a) Process TM Detected Violations (5.4.1);
b) Process Violations for Tolls (5.4.2);
c) Process Parking Lot Violations (5.4.3);
d) Process Fare Payment Violations (5.4.4);
e) Process Vehicle Fare Collection Violations (5.4.5);
f) Process CV Violations (5.4.6);
g) Process Roadside Fare Collection Violations (5.4.7);
h) Process Emissions Violations (5.4.8).

These processes each provide interfaces to law enforcement agencies for different ITS functions. With the exception of processes (a) and (f) the data about violators is provided by facilities in the Provide

Electronic Payment Services function - see DFD 7. The data provided by this function concerns those drivers or travelers who are trying to make invalid toll, parking lot charge or transit fare payments. Process (a) receives data from the Manage Traffic function - see DFD 1, about high occupancy vehicle (HOV) lane and pollution violations. Process (f) receives data from the Manage Commercial Vehicles function - see DFD 2 about invalid payments for electronic credentials and tax filing by commercial vehicle managers or commercial vehicle owner drivers. Process (g) receives data from vehicle fare collection - see DFD 4.7.2. Process (h) receives data from the department of motor vehicles regarding violations in emissions. Processes (a), (b) and (c) which all deal with violations by drivers, will request details of their vehicles from the appropriate Department of Motor Vehicles office. This data will be added to that already provided by the particular ITS function. The processes can be implemented individually as required by each associated ITS function.

DFD:5.7 Coordinate Disaster Response and Evacuation

This DFD shows the processes that make up the Manage Disaster Response and Evacuation facility within emergency management. These processes receive reported incident data that has been classified as a disaster, evacuation need, or other major emergency and initiate the appropriate coordination between agencies and appropriate response.

The key points about the facility are as follows:

- Facilities are provided to identify the current status of the transportation system.
- Coordination between multiple agencies is accomplished to form a response and recover plan for a disaster or other major emergency.
- Coordination between multiple agencies is accomplished to manage an evacuation plan including the reentry to the area.

There are six processes in this DFD:

a) Assess System Status For Disasters (5.7.1).
b) Provide Disaster Response Coordination (5.7.2).
c) Assess System Status For Evacuation (5.7.3).
d) Provide Evacuation Coordination (5.7.4).
e) Manage Evacuation (5.7.5).
f) Provide Safeguard System Control (5.7.6).

The data about incidents that has been declared a disaster or other major emergency is received by process (a). This process then collects information regarding the current status of the transportation network to establish the damage to equipment, infrastructure, etc. and what remains operational on the network. This data is then sent to process (b) which manages the coordination and formation of an appropriate response and recovery plan between multiple agencies. The response plan is then sent back to process (a) which forwards it to the Provide Emergency Services Allocation Functions in DFD 5.1. If an evacuation is needed, process (a) forwards all relevant information to process (c). This process reassesses the transportation network to what resources and facilities are available for use in the evacuation. This information is then forwarded to process (d) where a coordination effort between multiple agencies is managed to develop an evacuation and reentry plan for the evacuation area. The resulting evacuation plan is then sent to process (e) where the evacuation is managed. In both cases of the disaster response and evacuation, data about the current status of the transportation network and how well the plans are working is being reassessed by processes (a) and (c) so that the plans can be modified and improved as the disaster or evacuation progresses.

DFD:5.7.6 Provide Safeguard System Control

This DFD shows the processes that make up the Provide Safeguard System Control facility within the Manage Emergency Services function. These processes monitor and control safeguard systems, equipment used to mitigate the impact of incidents on transportation infrastructure (e.g., blast shields, tunnel exhaust systems, etc.).

The key points about the facility are as follows:

- Deployment of safeguard system is controlled upon receipt of deployment request from other processes;
- Outputs data to the process that controls dynamic message signs (DMS) to inform travelers of safeguard system activation;
- Safeguard systems equipment monitored to detect and report any sensor faults;
- Forwards deployment information to another process for archival.

There are two processes in this DFD:

a) Control Safeguard Systems (5.7.6.1)
b) Manage Safeguard Systems (5.7.6.2)

Process (b) receives direction from other processes outside this DFD to activate the safeguard systems. Upon receipt of this direction, process (b) sends control information to process (a), which represents the safeguard systems themselves. To notify travelers of system deployment status, both processes are able to send information to another process for display on a dynamic message sign. Safeguard faults collected by process (a) are sent to process (b) and then on to another process in the Manage Maintenance and Construction facility for correction. Operational and fault status of the safeguard systems are collected by process (a), then sent to (b), and then forwarded to the process that requested safeguard system activation. Process (b) forwards information to other processes for archival.

DFD: 6 Provide Driver and Traveler Services

The processes in this DFD are responsible for multimodal trip planning, route guidance and advisory functions such as traffic and incident information, for all types of travelers and drivers. It also enables them to confirm and pay for yellow pages services and provides personal emergency notification functions. The driver interface to the Provide Vehicle Monitoring and Control functions is provided, as is that to other functions, to enable advisory information to be output to both drivers and travelers. The multimodal trip planning function enables trips to include private car and regular transit modes, plus ridesharing, demand responsive transit and other modes such as walking, cycling, etc. Links are also provided to multimodal transportation service providers so that travelers may use modes such as heavy rail and airlines as part of their trips. Both centralized dynamic and autonomous modes of on-line guidance are provided for drivers and travelers, with drivers also being able to use current link journey times as part of the autonomous vehicle guidance. 511 traveler information systems are supported. Travelers are alerted of natural and man-made disasters.

The User Service Requirements that are included in this functional process tree are:

1.1 Pre-Trip Travel Information
1.2 En Route Driver Information
1.3 Route Guidance
1.4 Ride Matching and Reservation
1.5 Traveler Services Information
2.2 En Route Transit Information
5.1 Emergency Notification and Personal Security

The key points about the function are as follows:

- Travelers may plan, confirm and be guided along single mode or multimodal trips;
- En route advisory traffic and transit information provided for drivers and travelers aboard transit vehicles;
- Drivers are provided with a vehicle interface for automatic control and output of warning/safety messages;
- Travelers (including those aboard transit vehicles) may obtain information on and pay for yellow pages services;
- Travelers may obtain event information;
- Travelers may receive alert notification in the case of natural and man-made disasters, child abductions, etc.;
- Vehicle and personal traveler guidance may be provided dynamically or autonomously;
- Dynamic guidance provided centrally using current traffic and transit information;
- Autonomous guidance using in-vehicle data that can be supplemented with current traffic information;
- Autonomous personal traveler guidance using a personal navigable database;
- Traveler may use home, office, or travel agent's computer, kiosk, or personal portable device (ppd);
- Personal security provided for drivers and travelers through personal portable devices and kiosks;
- 511traveler information systems are supported;

The processes subordinate to this DFD are all themselves DFDs:

a) Provide Trip Planning Services (DFD 6.1)
b) Provide Information Services (DFD 6.2)
c) Provide Traveler Services at Kiosks (DFD 6.3)
d) Manage Ridesharing (DFD 6.4)
e) Manage Traveler Information Services (DFD 6.5)
f) Provide Guidance and Trip Planning Services (DFD 6.6)
g) Provide Driver Personal Services (DFD 6.7)
h) Provide Traveler Personal Services (DFD 6.8)

The term "ISP" is used in this function. It stands for Information Service Provider, and is the generic name given to the functional entity that is actually implementing the facility. Thus an ISP operator is someone who works for the ISP organization in much the same way as a transit system operator.

DFD:6.1 Provide Trip Planning Services

The six processes in this DFD comprise the Provide Trip Planning Services facility within the Provide Driver and Traveler Services function. These processes enable travelers to plan trips and make other (yellow pages) service reservations.

The key points about the facility are as follows:

- Multimodal trip planning available to include private car, transit, demand responsive transit, ridesharing and other modes, e.g., walking and cycling, plus services from Multimodal Transportation Service Providers;
- Trip planning available for routes using all modes of transportation, and based on incidents, evacuation plans, and other factors;
- Traveler provided with details of the best possible route including its cost;
- Trip confirmation reserves any included services e.g., demand responsive transit and ridesharing;
- Trip confirmation may also involve payment for services it includes;
- Yellow pages services may be included in trip plan, confirmation and payment;

- ISP operator controls parameters used in selecting the best modes for trips;
- Data about the types of services and trips requested is stored for later archival.

There are six processes in this DFD:

a) Provide Trip Planning Information to Traveler (6.1.1)
b) Confirm Traveler's Trip Plan (6.1.2)
c) Manage Multimodal Service Provider Interface (6.1.3)
d) Provide ISP Operator Interface for Trip Planning Parameters (6.1.4)
e) Collect Service Requests and Confirmation for Archive (6.1.5)
f) Manage Traveler Info Archive Data (6.1.6)

The traveler's trip request is received by process (a) which determines the route that provides the best match to the request. In doing this the process will be guided by the traveler's requirements and by the parameters set up by the ISP operator through process (d). Process (a) will obtain vehicle, transit and other mode route details from the Provide Guidance and Trip Planning Services facility - see DFD 6.6. If required the process will also obtain details of multimodal services from process (c), a demand responsive transit service from the Provide Demand Responsive Transit Service facility (see DFD 4.2.1), or details of a rideshare that fits in with the trip plan from the Manage Ridesharing facility - see DFD 6.4. The travelers' confirmation of a previously requested trip and any required payments are received by process (b). This makes any necessary reservations with the previously mentioned facilities and gets the payments transacted by the Collect Advanced Payments facility - see DFD 7.4.1. These four processes are coupled through their joint use of the two data stores. However some implementations could omit the process in (c) if no interface to multimodal transportation service providers is required.

The parameters set up through process (d) by the ISP operator for use in trip planning, influence the type of trip that is provided in response to requests from travelers. They will control the degree to which the preferences and constraints specified by the traveler in the trip request should be ignored, and to set the priority that will be given to the use of non-private vehicle modes. For example, the parameters will give the weighting that should be applied to one preference, e.g., start and arrival time, over that which requests the use of several modes. Thus for example, a traveler may find that the proposed trip starts earlier or finishes later (and therefore takes longer) than requested in order to accommodate the use of modes other than the private car. Processes (e) and (f) collect data about the types of trips and services requested by travelers for later archival, and could therefore be implemented separately, depending upon whether archival will be supported by the implementation.

DFD:6.2 Provide Information Services

This DFD shows the seven processes that make up the Provide Information Services facility within the Provide Driver and Traveler Services function. This facility provides advisory and broadcast information to drivers and travelers aboard transit vehicles.

The key points about the facility are as follows:

- Advisories provided to drivers about traffic, transit, events, disasters, wide area alert and evacuation information, and yellow pages services;
- Advisories provided to travelers aboard transit vehicles, including alerts and advisories pertaining to major emergencies or manmade disasters, traffic conditions, yellow pages information, transit stop and route data, etc.;
- The traveler can make a specific request for information or can submit a travel profile for subsequent transmission of information to the traveler.
- Driver advisories are selected to be relevant to the vehicle's current location;
- Drivers are also provided with warning messages produced by the vehicle control functions;
- Drivers are provided with work zone intrusion alerts from on-board and roadside sensors;
- Travelers and travelers aboard transit vehicles are able to make and pay for yellow pages reservations.

There are seven processes in this DFD, and one is itself a DFD:

a) Provide Advisory and Broadcast Data (DFD 6.2.1)
b) Prepare and Output In-vehicle Displays (6.2.2)
c) Provide Traveler Advisory Interface (6.2.3)
d) Collect Yellow Pages Data (6.2.4)
e) Provide Driver Information Interface (6.2.5)
f) Provide Yellow Pages Data and Reservations (6.2.6)
g) Provide Transit Advisory Data on Vehicle (6.2.7)

Requests for advisory information are input by the driver through process (e), and to travelers aboard transit vehicles through processes (c) and (g). These are sent to process (b) which adds the vehicle location and sends the necessary data requests to processes in (a), and to process (f). The responses are received by process (b) and sent back to whichever process was the source of the request. Process (b) will also receive broadcast data from processes in (a) and the output from various in-vehicle functions from facilities in the Provide Vehicle Monitoring and Control function - see DFD 3. It will be responsible for setting different priority levels for the outputs to the driver though process (e) so that advisory, broadcast, safety and warning messages are overlaid on top of vision enhancement data, with safety or warning messages themselves taking priority over and overlaying advisory or broadcast messages.

Although all of these processes depend on others in the group for data, they will each operate continuously and independently so that the data can be processed, stored and accumulated in a timely fashion.

DFD:6.2.1 Provide Advisory and Broadcast Data

This DFD shows the processes that make up the Provide Advisory and Broadcast Data facility within the Provide Information Services function. These processes obtain traffic and transit data from other ITS functions for use in advisory and broadcast data outputs. Environmental data is collected from vehicle-based sensors.

The key points about the facility are:

- Traffic and transit data is requested from the Manage Traffic and Manage Transit functions;
- Data from the Manage Traffic function regarding traffic state and incidents provided as they occur;
- Environmental data collected from vehicle-based sensors;
- Data for advisory information output provided on request and can be filtered by vehicle location;
- Data for broadcast information output determined using parameters set up by the ISP operator.

There are six processes in this DFD:

a) Collect Traffic Data for Advisory Messages (6.2.1.1)
b) Provide Traffic and Transit Advisory Messages (6.2.1.2)
c) Collect Transit Data for Advisory Messages (6.2.1.3)
d) Provide Traffic and Transit Broadcast Messages (6.2.1.4)
e) Provide ISP Operator Broadcast Parameters Interface (6.2.1.5)
f) Collect Environmental Probe Data (6.2.1.6)

Process (a) requests traffic data from the Manage Traffic facility and receives data about planned and predicted. Transit data is requested by process (c) from the Manage Transit facility. Each process loads the data it receives into its own data store and forwards it to processes (b) and (d). Process (b) retrieves data when requests are received from other processes within the Provide Information Services facility - see DFD 6.2, and can filter the output based on the vehicle location supplied with the request. Broadcast data is output periodically by process (d) when an analysis of the two data stores shows that they contain information that is of importance. The analysis is carried out using stored parameters provided by the ISP operator through process (e).

These processes may be used in several combinations to suit individual implementation requirements. For example, processes (a), (b), and (c) may be implemented as a group to provide advisory data. Processes (d) and (e) could be added later to provide a broadcast data facility. Alternatively either processes (a) or (c) could be omitted to provide a service of just traffic or just transit information respectively. Process (f) operates independently, periodically providing aggregated environmental probe data from sensors on the private vehicles it services.

DFD:6.3 Provide Traveler Services at Kiosks

The processes in this DFD comprise the Provide Traveler Services at Kiosks facility within the Provide Driver and Traveler Services function. These processes enable the traveler to obtain traffic and transit information and to plan trips from a kiosk.

The key points about the facility are as follows:

- Travelers can plan trips and get traffic, transit, events, and yellow pages services information;
- Trips may be multimodal, including demand responsive transit and ridesharing;
- Planned trips may be confirmed and paid for in advance as may yellow pages services;
- Travelers may also obtain traffic and transit information without planning any trips or making reservations;
- Travelers may also receive evacuation-related information and wide area alerts;
- Kiosks may be at the roadside, in shopping malls, and at other major trip generation sites.

There are four processes in this DFD:

a) Get Traveler Request (6.3.1)
b) Inform Traveler (6.3.2)
c) Provide Traveler Kiosk Interface (6.3.3)
d) Update Traveler Display Map Data at Kiosk (6.3.4)

These processes form a tightly coupled group and communicate with many other ITS functions. The traveler provides trip planning, trip confirmation, plus traffic and transit information requests through process (c). These are sent to process (a) which distributes the trip planning and confirmation requests to the appropriate processes in the Provide Trip Planning Services facility - see DFD 6.1. Requests for traffic and transit information are sent for implementation by process (b) which also receives the results from the trip planning requests made by process (a). All data received by process (b) is sent to process (c) for output to the traveler. Travelers can request as many trip plans as are needed before an acceptable match is found to their trip requirements. Data used for previous inputs and regularly used data is kept in the store of traveler regular data by process (c). The outputs produced by process (c) may be shown against a background of digitized map data produced by process (d). This map data is requested automatically, at a frequency set up in process (d) when the supplier or owner installs it within the kiosk.

DFD:6.4 Manage Ridesharing

The four processes in this DFD provide the Manage Ridesharing facility within the Provide Driver and Traveler Services function. These processes enable travelers whose destinations and time of travel match to share rides for some or their entire trip.

The key points about the facility are as follows:

- Travelers are matched to share transport (private car or van) for as much of their trip as possible;
- Travelers must specify the time of day, source and destination of their trip;
- Travelers may also specify any preferences or constraints on the rideshare arrangement;
- Once a rideshare is confirmed, the traveler may make a payment to the service (if required).

There are four processes in this DFD:

a) Screen Rider Requests (6.4.1)
b) Match Rider and Provider (6.4.2)
c) Report Ride Match Results to Requestor (6.4.3)
d) Confirm Traveler Rideshare Request (6.4.4)

The traveler's rideshare request is received by process (a) from the Provide Trip Planning Services facility - see DFD 6.1. It checks the data to see if the traveler is eligible for ride sharing and if not, sends a negative response to process (c) which sends it back to the process from which the request originated. If the traveler is eligible, process (a) sends the data to process (b). This process tries to match the traveler's trip data with both existing ridesharing travelers and those for whom no match could previously be found. The results are sent to process (c) which compares the result with the original request and if satisfactory again sends the result back to the process from which the request originated. Traveler ride share confirmations are received by process (d) which obtains payment for the service through the Collect Advanced Payments facility - see DFD 7.4.1. If payment is successfully completed it then sends the ride share details to process (b) for the records of successful ride shares to be updated.

These processes form a tightly coupled group and cannot be implemented other than as a group. Travelers are themselves expected to contact others in the matched rideshare, or those who have yet to find a match. Once this has been successfully done, the travelers will be expected to make their own arrangements for sharing the cost of each trip. Processes (a) and (b) will require sophisticated screening techniques to highlight any travelers making repeated requests for the wrong reasons.

DFD:6.5 Manage Traveler Information Services

The processes in this DFD provide the Manage Traveler Information Services facility within the Provide Driver and Traveler Services function. These processes collect and update data about incidents, road construction, weather, events, detours, road closures, care facilities, and evacuation. These processes collect and disseminate alerts to travelers concerning natural or man-made disasters, civil emergencies, child abductions, severe weather watches and warnings, etc. Support for 511 traveler information systems is provided. These processes also enable travelers to plan trips and to make yellow page service reservations, and to make payment for those services that they need. These processes inform travelers about local events and emergency situations.

The key points about the facility are as follows:

- Collect and update data about incidents, road construction, weather, events, detours, road closures, care facilities, and evacuation;
- Alert travelers in cases of natural or man-made disasters, civil emergencies, child abductions, severe weather watches and warnings, etc.;
- Support 511 traveler information systems;
- Yellow pages services information is obtained from many sources in response to traveler requests;
- Some data is provided automatically without the need for a specific traveler request;
- Yellow pages providers register (and possibly pay for this registration) before their data can be sent to travelers;
- Event information is provided to travelers.

There are six processes in this DFD:

a) Collect and Update Traveler Information (6.5.1)
b) Provide Traveler Yellow Pages Information and Reservations (6.5.2)
c) Register Yellow Pages Service Providers (6.5.3)
d) Provide Traveler Event Information (6.5.4)
e) Manage Emergency Traveler Information (6.5.5)
f) Provide 511 Traveler Information (6.5.6)

Traveler information about incidents, road construction, evacuations, weather, events, and yellow pages data is obtained by process (a), either by requesting it from the media, event promoters, or yellow pages service providers, or by receiving it as unsolicited input, e.g., weather, road network, incident, or evacuation information. All the data that the process receives is loaded into the store of tourist information. Process (b) receives requests for information and payments for services from travelers via processes in the Provide Traveler Services at Kiosks and Provide Traveler Services at Personal Devices facilities - see DFDs 6.3 and 6.8.3 respectively. If the information requested by the traveler is not in the store of tourist information, process (b) requests process (a) to obtain the missing data. Payment transactions are passed by process (b) to the Collect Advanced Payments facility - see DFD 7.4.1. Yellow pages service providers can enable details of their services to be made available to travelers by requesting and paying for registration through process (c). Process (d) collects event information and distributes it to travelers via kiosks and personal devices. Process (e) receives alert information and transportation system status and passes to other processes to be sent on to travelers. Process (f) collects traffic, transit, event, weather, yellow pages, and multimodal data and upon request, outputs the data for the specified region to the Telecommunications System for Traveler Information terminator.

Processes (a) through (d) form a tightly coupled group. The requirement that yellow pages service providers must pay to register before details of the service(s) that they provide are made available to travelers provided through process (c), could be omitted from individual implementations, if the ISP did not want to use this as a source of income. Processes (e) and (f) may each be implemented separately.

DFD:6.6 Provide Guidance and Trip Planning Services

This DFD shows the processes that make up the Provide Guidance and Trip Planning Services facility in the Provide Driver and Traveler Services function. These processes select vehicle routes for a variety of applications using current, historical, and predicted traffic conditions.

The key points about the facility are as follows:

- Routes provided for trip planning, dynamic guidance and special uses (such as transport of vehicles carrying hazardous materials);
- Traveler routes and guidance may be multimodal using private cars, transit and other modes;
- Route selection takes into account current, historical, and predicted conditions obtained from the Manage Traffic and Manage Transit functions;
- Other route selection data is provided by weather services and the map update provider;
- Route details for commercial vehicles with unusual cargoes sent to the Manage Incidents facility.

There are five processes in this DFD, and one is itself a DFD:

a) Provide Multimodal Route Selection (6.6.1)
b) Select Vehicle Route (DFD 6.6.2)
c) Update Other Routes Selection Map Data (6.6.3)
d) Select Transit Route (6.6.4)
e) Select Other Routes (6.6.5)

Requests for traveler guidance and trip planning, plus commercial vehicle route requests are received by process (a). The traveler requests are received from the Provide Traveler Services at Kiosks and at Personal Devices facilities - see DFDs 6.3 and 6.8.3 respectively. The commercial vehicle route requests are received from the Manage Commercial Vehicle Fleet Operations and Driver Operations - see DFDs 2.1 and 2.2). The requests for vehicle routes are passed directly to the processes in (b) and the results returned to the requesting facilities. The traveler requests are analyzed by process (a) to see which modes of travel can be used. Based on this analysis, it sends route requests to the processes in (b), and/or process (d), and/or process (e) to build up a contiguous route for the trip plan or guidance. Process (a) may iterate the requests, changing the modal transfer points until it arrives at an optimal solution to suit

the traveler's trip plan or guidance request. Process (c) runs at the request of the ISP operator through the interface process in (b), and updates the store of map data used by process (e).

Drivers are in fact a special group of travelers and it will be possible for a traveler to become a driver for part of a trip. Both mobile and infrastructure based guidance systems can be supported since the processes are not aware of how information on traveler location is provided. Autonomous vehicle guidance is supported either as the prime function or when no guidance information is received by the vehicle from the central facility. In the latter situation the guidance process will continue operating in the vehicle using the most recently obtained route until new data is received. Details about the most commonly used routes will be retained to prevent repeated data entry by the traveler. Autonomous vehicle guidance can be provided in basic form using an on-board navigable map database which contains details of all route segments, plus average historical journey times and queue times. This may be supplemented with more up to date journey and queue times that are available from the central facility to provide an enhanced autonomous guidance. The choice of which of the three forms of guidance to use (dynamic, autonomous, or enhanced autonomous) is up to the driver either through the type of equipment that is installed in the vehicle, or through choice when guidance is requested. The highest level of guidance available (if requested) will always be used and only degrade if communication with the source of dynamic guidance is lost. When in
dynamic guidance, a new route will be calculated at selected points as the vehicle or traveler moves towards the final destination. This ensures that the route takes into account the most up to date traffic and transit data.

Disabled travelers (including drivers) are accommodated through the use of variables that identify their unique preferences and constraints. These variables are part of the data used to request a route. They enable the special needs of these groups of travelers to be taken into account when preparing routes and when giving guidance.

DFD:6.6.2 Select Vehicle Route

This DFD shows the processes that provide the Select Vehicle Route facility within the Provide Guidance and Trip Planning Services function. The processes are responsible for selecting routes that are only for use by private cars and commercial vehicles.

The key points about the facility are as follows:

- Routes are selected using a variety of parameters, e.g., safest, least used, etc. and traffic data;
- Additional data requested from ITS functions serving other areas when routes go outside local area;
- Traffic and vehicle probe data plus previously selected routes can be used in calculation of route;
- Route data can be used in predictive model generation and demand forecasting by Manage Traffic function;
- Map updates describing the surface street and freeway network are provided by the map update supplier;
- Parameters controlling route selection set up by ISP operator;
- In-vehicle guidance only provided when acceptance received from the vehicle.

There are six processes in this DFD:

a) Calculate Vehicle Route (6.6.2.1)
b) Provide Vehicle Route Calculation Data (6.6.2.2)
c) Provide Route Segment Data for Other Areas (6.6.2.3)
d) Update Vehicle Route Selection Map Data (6.6.2.4)
e) Provide ISP Operator Route Parameters Interface (6.6.2.5)
f) Calculate Vehicle Probe Data for Guidance (6.6.2.6)

Requests for vehicle routes and in-vehicle guidance are received by process (a). This selects a route using the parameters in the store set up by the ISP operator through process (e), the road and freeway geometry provided by the map update provider through process (d), traffic data provided by process (b) and data from the store of previously selected routes. In-vehicle guidance uses the same sources of data, except that the road and freeway geometry is much more detailed so that the driver can be given detailed instructions, such as which lane to take. When the route for guidance is first selected, it is sent to the vehicle, but guidance will only begin once the driver has positively accepted the route. Traffic data for use by process (a) is provided by process (b) using data requested from the Display and Output Traffic Data facility - see DFD 1.1.4, plus data provided by the predictive model (see process (c) in DFD 1.1), vehicle probes through process (f) and the Determine Road and Freeway State and Review and Manage Incident Data facilities - see DFDs 1.2.2 and 1.3.2. If process (a) cannot find the data that it needs, it requests process (b) to obtain the data from ITS functions in other areas. Process (b) uses the link data provided by the Manage Traffic function to request the required data through process (c).

When determining a route, process (a) will use the preferences and constraints specified in the route request (such as a route that avoids freeways), and the parameters set up by the ISP operator. These parameters take preference over the preferences in a traveler's route request, and are designed to enable the use of certain types of road, modes, etc. to be given priority.

The processes also provide routes for commercial vehicles, when requested by the appropriate supporting functions. Route selection for transit vehicles has not been included since they operate over pre-determined routes. For inter-surface street public transport routes, especially those used by express bus services, the driver could obtain guidance in the same way as the driver of any other vehicle.

The processes (a) and (b) run continuously, but independently. This allows the route calculation work to proceed while new or additional data is being obtained. The calculation process is prompted to refine its results every time the data in either of the two stores of road data is updated, ensuring that the routes being used by the vehicles take account of the latest changes in traffic conditions.

DFD:6.7 Provide Driver Personal Services

This DFD shows the processes that make up the Provide Driver Personal Services facility within the Provide Driver and Traveler Services function. These processes provide in-vehicle security and guidance services to the driver.

The key points about the facility are as follows:

- Personal security is provided through driver action, e.g., pressing a panic button;
- Vehicle guidance can be dynamic or autonomous.

The processes subordinate to this DFD are themselves DFDs:

a) Provide Driver Personal Security (DFD 6.7.1)
b) Provide On-line Vehicle Guidance (DFD 6.7.2)

The processes in the two DFDs are intended to be provided separately, with the exception that the security processes in (a) make use of the vehicle location provided by a process in (b). It is also expected that they will share a common data output mechanism through the functionality provided by the Provide Information Services facility in DFD 6.2.

DFD:6.7.1 Provide Driver Personal Security

This DFD shows the processes that make up the Provide Driver Personal Security facility within the Provide Driver Personal Services function. The processes enable the driver to call for emergency services in the event of an incident.

The key points about the facility are as follows:

- Driver has only to initiate emergency message building process;
- Output of messages provided through the driver advisory message interface.

There are two processes in this DFD:

a) Build Driver Personal Security Message (6.7.1.1)
b) Provide Driver In-vehicle Communications Function (6.7.1.2)

These processes must be implemented together. Process (a) supports the driver's ability to call for emergency services in the event that the vehicle is involved in an accident, or an incident occurs to which the driver wishes to summon the emergency services. In both cases only one input is required and all output is passed through process (b) to the Provide Emergency Service Allocation facility - see DFD 5.1. The emergency message received in acknowledgment by process (b) is sent to the Provide Information Services facility - see DFD 6.2 for output to the driver. The store containing the vehicle identity will be set up by the manufacturer.

DFD:6.7.2 Provide On-line Vehicle Guidance

This DFD shows the processes that make up the Provide On-line Vehicle Guidance facility within the Provide Driver Personal Services function. These processes provide in-vehicle guidance on request from the driver.

The key points about the facility are as follows.

- Three types of in-vehicle guidance are available, including dynamic and two types of autonomous;
- Dynamic guidance is provided by a centralized route selection function;
- Autonomous guidance uses an in-vehicle database which may be enhanced by link journey times obtained centrally;
- Driver may choose the guidance type depending upon vehicle equipment and communications links;
- In-vehicle trip planning available by specifying a route start time later than the current time;
- If dynamic guidance fails, the guidance will continue based on the last data received.

There are four processes in this DFD, and one is itself a DFD:

a) Provide Vehicle Guidance (DFD 6.7.2.1)
b) Process Vehicle Location Data (6.7.2.2)
c) Provide Driver Guidance Interface (6.7.2.3)
d) Update Vehicle Navigable Map Database (6.7.2.4)

Guidance requests from drivers are received by process (c) and passed to the processes in (a) for implementation. Depending on the type of guidance selected (and available), they will communicate with a central facility (dynamic guidance) or use the store of navigable map data maintained by process (d) to provide the requested guidance. This will only commence when the driver provides positive acknowledgment of the message that the processes in (a) have a route and are ready to begin guidance. All guidance output to the driver is sent to process (c) and provided in a form that does not impair the driver's ability to control the vehicle.

The data in the store of navigable map data is updated by process (d) when a request is received from the

driver through process (c). The completion of the update depends on successful completion of the payment transaction sent by process (d) to the Collect Advanced Payments facility - see DFD 7.4.1. Vehicle location data is provided by process (b) for use by the processes in (a) and for use by other facilities and ITS functions. Disabled drivers are accommodated by specifying their needs using the preferences and constraints variables in the data used for the guidance request input to process (c). This ensures that they are guided to such things as the parking spaces for the disabled, etc.

In-vehicle trip planning is available by specifying a start time that is later than the current time. In this case no guidance data is provided by the processes in (a), and is replaced by simple route data, i.e., a list of route segments that will make up the proposed trip. In-vehicle guidance assumes that the start time is almost immediate.

DFD:6.7.2.1 Provide Vehicle Guidance

This DFD shows the three processes that make up the Provide Vehicle Guidance facility within the Provide On-line Vehicle Guidance function. These processes determine the actual vehicle guidance method, and generate the route and guidance instructions.

The key points about the facility are as follows:

- Guidance type depends on driver's request and on the availability of in-vehicle equipment;
- Dynamic guidance requires a communications links to a central facility;
- If dynamic guidance fails then autonomous guidance is automatically provided until it is restored;
- Autonomous guidance may use link travel times provided centrally, at the driver's request.

There are three processes in this DFD:

a) Determine In-vehicle Guidance Method (6.7.2.1.1)
b) Provide Dynamic In-vehicle Guidance (6.7.2.1.2)
c) Provide Autonomous In-vehicle Guidance (6.7.2.1.3)

The process in (a) is responsible for deciding on the type of guidance to be used and setting up the data sent to the chosen route calculation process. This data defines the type of route and the preferences and constraints that are to be applied to the calculation process. These will have been set up by the driver through the interface process in the Provide On-line Vehicle Guidance facility - see DFD 6.7.2, except when the request is for a route involving automatic highway system (ahs) lanes. In this instance the constraints in particular will be set by process (b) so that this type of lane is used. If these lanes are not available at some point, the route will be specified with the end of the last ahs lane as a new route calculation point, so that alternative preferences and constraints can be used. If the driver omits data from the guidance request, the option is provided for its direct input, or the use of data from the store of retained data.

If dynamic guidance is selected then process (a) sends the route request to process (b) for the addition of the vehicle location and communication with the Select Vehicle Route facility - see DFD 6.6.2. The data that is returned to process (b) is sent to process (a) and then to the driver interface. If no route can be provided by process (b), then process (a) sends the request to process (c) which provides autonomous guidance. At the driver's request, this may make use of link journey times provided by the Select Vehicle Route facility. Failure of dynamic guidance will cause process (a) to request autonomous guidance from process (c) starting at the vehicle's current location.

When providing dynamic guidance, process (b) will continually monitor the vehicle's location. When the vehicle reaches pre-defined points on the route (way points), it will request a new route from the Select Vehicle Route facility. It will also provide the facility with its location at the end of each route segment so that the facility has a feedback of the actual segment journey times (probe data).

The processes (b) or (c) above may be omitted from any particular implementation or offered as options since they are independent. However if the process in (c) is not included, and the communications link with the source of dynamic guidance data fails, then the vehicle will be left to depend on the last set of dynamic guidance data that it received. This cannot now be updated if the vehicle departs from the originally specified route since no autonomous guidance will be available.

DFD:6.8 Provide Traveler Personal Services

This DFD shows the processes that make up the Provide Traveler Personal Services facility within the Provide Driver and Traveler Services function. These processes provide personal security, on-line guidance, and traveler information to a traveler using a personal portable device. Traveler information and trip planning is provided for travelers using a personal (but not portable) device.

The key points about the facility are as follows:

- To access the security or on-line guidance features, the traveler must be using a personal portable device (ppd);
- Personal security is provided through traveler action, e.g., pressing a panic button, on the ppd;
- On-line traveler guidance can be dynamic or autonomous;
- Traveler information is requested and provided in a similar way to that at a kiosk.

The processes subordinate to this DFD are all themselves DFDs:

a) Provide On-line Traveler Guidance (DFD 6.8.1)
b) Provide Traveler Personal Security (DFD 6.8.2)
c) Provide Traveler Services at Personal Devices (DFD 6.8.3)

These three sets of processes can form a coupled group. The processes (b) and (c) could be provided as options in any implementation, because they both make use of the traveler location provided by a process in (a).

DFD:6.8.1 Provide On-line Traveler Guidance

This DFD shows the processes that make up the Provide On-line Traveler Guidance facility within the Provide Traveler Personal Services function. These processes provide the traveler with on-line guidance that may be dynamic or autonomous.

The key points about the facility are as follows:

- On-line guidance provides detailed instructions for a traveler along a route;
- Guidance request includes preferences and constraints for travelers with special needs;
- Trip planning available by specifying a route start time that is later than the current time;
- Guidance and trip planning available for multimodal routes, including heavy rail and airline services;
- Often used traveler data can be retained for future re-use.

There are five processes in this DFD, and one is itself a DFD:

a) Provide Traveler Guidance (DFD 6.8.1.1)
b) Provide Personal Portable Device Guidance Interface (6.8.1.2)
c) Process Personal Portable Device Location Data (6.8.1.3)
d) Update Traveler Navigable Map Database (6.8.1.4)
e) Provide Traveler Emergency Message Interface (6.8.1.5)

Guidance requests from travelers are received by process (b) and passed to the processes in (a) for implementation. Depending on the type of guidance selected (and available), they will communicate with a central facility (dynamic guidance) or use the store of navigable map data maintained by process (d) to provide the requested guidance. This will only commence when the traveler provides positive acknowledgment of the message that the processes in (a) have a route and are ready to begin guidance. All guidance output to the traveler is sent to process (b) and provided in a form that does not distract the traveler so that they become a hazard or nuisance to others.

The data in the store of navigable map data is updated by process (d) when a request is received from the traveler through process (b). The completion of the update depends on successful completion of the payment transaction sent by process (d) to the Collect Advanced Payments facility - see DFD 7.4.1. Traveler location data is provided by process (c) for use by the processes in (a) and for use by other facilities and ITS functions. Process (e) provides output of the response to an emergency request from the traveler through processes in the Provide Traveler Personal Security facility - see DFD 6.8.2. The above processes support the traveler's use of multimodal routes, the choice of modes being specified by the traveler as part of the data input process (b). Similarly travelers with special needs, e.g., those who are deaf, wheelchair bound, or have a guide dog, can register their special requirements as part of the input data to ensure that they are guided to elevators, seats for disabled travelers, etc. and warned of escalators, road crossings, etc. The actual guidance information provided as output from process (b) will have enough detail for travelers to 'navigate' themselves through the transportation network, including when to cross the street, which transit service to take, where to change from one service to another, etc.

DFD:6.8.1.1 Provide Traveler Guidance

This DFD shows the processes that make up the Provide Traveler Guidance facility within the Provide On-line Traveler Guidance function. These processes determine the actual traveler guidance method, and generate the route and guidance instructions.

The key points about the facility are as follows:

- Guidance type depends on the traveler's request and on the availability of specific ppd equipment;
- Dynamic guidance requires communications links to a central facility;
- If dynamic guidance fails then autonomous guidance is automatically provided until it is restored.

There are three processes in this DFD:

a) Determine Personal Portable Device Guidance Method (6.8.1.1.1)
b) Provide Personal Portable Device Dynamic Guidance (6.8.1.1.2)
c) Provide Personal Portable Device Autonomous Guidance (6.8.1.1.3)

The process in (a) is responsible for deciding on the type of guidance to be used and setting up the data sent to the chosen route calculation process. This data defines the type of route and the preferences and constraints that are to be applied to the calculation process. These will have been set up by the traveler through the interface process in the Provide On-line Traveler Guidance facility - see DFD 6.8.1. If the traveler omits data from the guidance request, the option is provided for its direct input, or the use of data from the store of retained data.

If dynamic guidance is selected then process (a) sends the route request to process (b) for the addition of the traveler's location and communication with the Provide Guidance and Trip Planning Services facility - see DFD 6.6. The data that is returned to process (b) is sent to process (a) and then to the traveler interface. If no route can be provided by process (b), then process (a) sends the request to process (c) which provides autonomous guidance. Failure of dynamic guidance will cause process (a) to request autonomous guidance from process (c) starting at the traveler's current location. When providing dynamic guidance, process (b) will continually monitor the traveler's location. When pre-defined points on the route (way points) are reached, it will request a new route from the Provide On-line Traveler Guidance facility.

The processes (b) or (c) above may be omitted from any particular implementation or offered as options since they are independent. However if the process in (c) is not included, and the communications link with the source of dynamic guidance data fails, then the traveler will be left to depend on the last set of dynamic guidance data that they received. This cannot now be updated if the traveler departs from the originally specified route since no autonomous guidance will be available.

DFD:6.8.2 Provide Traveler Personal Security

This DFD shows the processes that make up the Provide Traveler Personal Security facility within the Provide Traveler Personal Services function. The processes enable the traveler to use a personal portable device (ppd) to call for emergency services in the event of an incident.

The key points about the facility are as follows:

- Traveler has only to initiate emergency message building process;
- Output of messages provided through the traveler guidance interface.

There are two processes in this DFD:

a) Build Traveler Personal Security Message (6.8.2.1)
b) Provide Traveler Emergency Communications Function (6.8.2.2)

These processes must be implemented together. Process (a) supports the traveler's ability to call for emergency services following involvement in an accident, or an incident occurs to which the traveler wishes to summon the emergency services. In both cases only one input is required and all output is passed through process (b) to the Provide Emergency Service Allocation facility - see DFD 5.1. The emergency message received in acknowledgment by process (b) is sent to the Provide Traveler On-line Guidance facility - see DFD 6.8.1 for output to the traveler. The store containing the traveler identity will be set up by the manufacturer of the personal portable device.

DFD:6.8.3 Provide Traveler Services at Personal Devices

The processes in this DFD provide the Provide Traveler Services at Personal Devices facility within the Provide Traveler Personal Services function. These processes enable the traveler to obtain traffic and transit information and to plan trips from a personal device.

The key points about the facility are as follows:

- Travelers can plan trips and obtain traffic, transit, events, and yellow pages services information;
- Trips may be multimodal, including such things as demand responsive transit and ridesharing;
- Planned trips may be confirmed and paid for in advance as may yellow pages services;
- Travelers may also obtain traffic and transit information without planning any trips or making reservations;
- Provides "kiosk" type facilities for travelers using their own personal devices.

There are four processes in this DFD:

a) Get Traveler Personal Request (6.8.3.1)
b) Provide Traveler with Personal Traveler Information (6.8.3.2)
c) Provide Traveler Personal Interface (6.8.3.3)
d) Update Traveler Personal Display Map Data (6.8.3.4)

The traveler provides trip planning, trip confirmation, plus traffic and transit information requests through process (c). These are sent to process (a), which distributes the trip planning and confirmation requests to the appropriate processes in the Provide Trip Planning Services facility - see DFD 6.1. Requests for traffic and transit information are sent for implementation by process (b) which also receives the results from the trip planning requests made by process (a). All data received by process (b) is sent to process (c) for output to the traveler. Travelers can request as many trip plans as are needed before an acceptable match is found to their trip requirements. Data used for previous inputs and regularly used data is kept in the store of traveler regular data by process (c). The outputs produced by process (c) may be shown against a background of digitized map data produced by process (d). This process will also update the store of map data on request from the traveler through process (c), and successful completion of payment through the Collect Advanced Payments facility - see DFD 7.4.1.

These processes form a tightly coupled group and communicate with many other ITS functions. They can only be implemented as a group, except that process (d) may be omitted if digitized map data is not to be used as the background for data output.

DFD: 7 Provide Electronic Payment Services

The processes in this DFD are responsible for the Provide Electronic Payment Services function. This function is responsible for enabling drivers and travelers to pay for their journeys and for other services. It also collects charges for yellow pages services and has an interface to the Manage Transit function for the management of fare collection plus advanced payment of fares and other services. The User Service Requirements satisfied by this functional process tree include those from User Service 3.1, "Electronic Payment Services".

The key points about this function are as follows:

- Facilities are provided for non-stop toll, fare and parking lot charges collection;
- Drivers and travelers can pay for tolls, fares, parking lot charges in advance;
- Additionally travelers can only pay for yellow pages services in advance;
- Images of those making invalid payments are sent to the Provide Law Enforcement Allocation function;
- The only item of data required by the driver for toll or parking lot charges is an identity.

The processes subordinate to this DFD are all themselves DFDs:

a) Provide Electronic Toll Payment (DFD 7.1)
b) Provide Electronic Parking Payment (DFD 7.2)
c) Provide Electronic Fare Collection (DFD 7.3)
d) Carry-out Centralized Payments Processing (DFD 7.4)
e) Provide Traveler Card Interfaces (DFD 7.5)

The above processes are able to implement a flexible toll, transit fare, and parking lot charging policy that enables each of these to change or be changed by time of day, day or week, or in response to input from the service providers, who may be influenced by the Manage Travel Demand facility - see DFD 1.4. This is designed to provide some influence over the modal split of travelers' journeys between the private car and transit modes of transportation.

DFD:7.1 Provide Electronic Toll Payment

The processes in this DFD are responsible for the Provide Electronic Toll Payment facility within the Provide Electronic Payment Services function. These processes transact the payments for tolls either for current use by drivers, or as advanced payments by travelers.

The key points about the facility are as follows:

- Drivers can pay tolls without stopping or slowing down as they pass toll plazas;
- Drivers can also pay in advance for transit fares and parking lot charges;
- Images of drivers making invalid payments are sent to the Provide Law Enforcement Allocation function.
- A record of all transactions is periodically sent to the toll operator, toll administrator, and in a sanitized form, to the Manage Archived Data function - see DFD 8.

There are 7 processes in this DFD, and one is itself a DFD:

a) Process Electronic Toll Payment (DFD 7.1.1)
b) Produce Roadside Displays (7.1.2)
c) Obtain Toll Violator Image (7.1.3)
d) Provide Driver Toll Payment Interface (7.1.4)
e) Detect Vehicle for Tolls (7.1.5)
f) Distribute Advanced Charges and Fares (7.1.6)
g) Provide Traveler Card Interface for Tolls (7.1.7)

The processes in this group provide all the facilities for handling both current and advanced toll payments. They form a tightly coupled group that should be implemented in their entirety. However process (f) could be omitted if particular implementations are not supporting the advanced payments of tolls, parking lot charges, and transit fares.

DFD:7.1.1 Process Electronic Toll Payment

The processes in this DFD are responsible for the Process Electronic Toll Payment facility within the Provide Electronic Payment Services function. These processes transact the payments for current and advanced tolls.

The key points about the facility are as follows:

- Tolls are calculated by vehicle characteristics and are set by the toll administrator;
- Support is provided for the "closed" type of toll system;
- A record of all transactions is provided for the toll operator and administrator;
- All vehicles are checked for advanced payment before being billed for the current toll;
- Average journey time between toll plazas is provided as probe data to other ITS functions;
- Operational data is provided to the Manage Archived Data function;

- Wide area alert notification is sent to the toll operator from the process that manages these notifications.

There are 11 processes in this DFD:

a) Read Tag Data for Tolls (7.1.1.1)
b) Calculate Vehicle Toll (7.1.1.2)
c) Manage Bad Toll Payment Data (7.1.1.3)
d) Check for Advanced Tolls Payment (7.1.1.4)
e) Bill Driver for Tolls (7.1.1.5)
f) Collect Probe Data from Toll Transactions (7.1.1.6)
g) Update Toll Price Data (7.1.1.7)
h) Register for Advanced Toll Payment (7.1.1.8)
i) Manage Toll Processing (7.1.1.9)
j) Determine Advanced Toll Bill (7.1.1.10)
k) Manage Toll Archive Data (7.1.1.11)

The processes in this group enable payments for tolls to be made by drivers without stopping and also support a flexible toll price structure. Toll prices may be changed at any time by the service provider through process (g). They are implemented immediately by this process, which also sends them to the store of prices maintained by the Carry-out Centralized Payments Processing facility - see DFD 7.4, for use by the Provide Driver and Traveler Services function - see DFD 6. This last set of data may be sent on request or whenever a change in price is made. Price changes may come directly on the initiative of the toll administrator or indirectly through a request to the provider from the Manage Travel Demand facility - see DFD 1.4, via process (g). Toll charges paid in advance will be unaffected by any new price structure. In addition to managing toll processing and payment, process (i) receives alert notification from the toll administrator, coordinates this notification with the process in EM (DFD 5.1) that manages wide area alerts, and sends the notification on to process (d) where it is sent to the toll operator.

DFD:7.2 Provide Electronic Parking Payment

The processes in this DFD are responsible for the Provide Electronic Parking Payment facility within the Provide Electronic Payment Services function. These processes transact the payments for parking lot charges either for current use by drivers, or as advanced payments by drivers and travelers.

The key points about the facility are as follows:

- Drivers can pay parking lot charges without leaving their vehicles or stopping the vehicle;
- Drivers can also pay in advance for tolls and transit fares;
- Images of drivers making invalid payments are sent to the Provide Law Enforcement Allocation function.

There are 7 processes in this DFD, and one is itself a DFD:

a) Process Electronic Parking Lot Payment (DFD 7.2.1)
b) Produce Parking Lot Displays (7.2.2)
c) Obtain Parking Lot Violator Image (7.2.3)
d) Provide Driver Parking Lot Payment Interface (7.2.4)
e) Detect Vehicle for Parking Lot Payment (7.2.5)
f) Distribute Advanced Tolls and Fares (7.2.6)
g) Provide Traveler Card Interface for Parking (7.2.7)

The processes in this group provide all the facilities for handling both current and advanced parking lot charge payments from vehicles without stopping. They form a tightly coupled group that should be implemented in their entirety. However process (f) could be omitted if particular implementations are not supporting the advanced payments of parking lot charges, tolls, and transit fares.

DFD:7.2.1 Process Electronic Parking Lot Payment

The processes in this DFD are responsible for the Process Electronic Parking Lot Payment facility within the Provide Electronic Payment Services function. These processes transact the payments for current and advanced parking lot charges.

The key points about the facility are as follows:

- Charges are calculated by vehicle characteristics and are set by the parking service provider;
- All vehicles are checked for advanced payment before being billed for the current charge;
- A record of all transactions is provided for the parking lot operator and service provider;
- Operational data is provided to the Manage Archived Data function.

There are ten processes in this DFD:

a) Read Parking Lot Tag Data (7.2.1.1)
b) Calculate Vehicle Parking Lot Charges (7.2.1.2)
c) Collect Bad Charge Payment Data (7.2.1.3)
d) Check for Advanced Parking Lot Payment (7.2.1.4)
e) Bill Driver for Parking Lot Charges (7.2.1.5)
f) Manage Parking Lot Financial Processing (7.2.1.6)
g) Update Parking Lot Data (7.2.1.7)
h) Register for Advanced Parking Lot Payment (7.2.1.8)
i) Manage Parking Lot Reservations (7.2.1.9)
j) Determine Advanced Charges (7.2.1.10)

The processes in this group enable payments for parking lot charges to be made by drivers without stopping and also support a flexible parking lot charge structure. Parking lot prices may be changed at any time by the operator through process (g). This data is implemented immediately by this process, which also sends it to the store of prices maintained by the Carry-out Centralized Payments Processing facility - see DFD 7.4, so that it can be used by the Provide Driver and Traveler Services function - see DFD 6. This last set of data may be sent on request or whenever a change in price is made. The price changes may come directly on the initiative of the parking operator or indirectly through a request to the provider from the Manage Demand facility - see DFD 1.4, via process (g). Parking lot charges paid in advance will be unaffected by any new price structure.

DFD:7.3 Provide Electronic Fare Collection

The processes in this DFD provide the Electronic Fare Collection facility within the Provide Electronic Payment Services function. These processes transact the payments for transit fares either for current trips by travelers, or as advanced payments by drivers and travelers.

The key points about the facility are as follows:

- Travelers can pay fares without stopping as they board the transit vehicle or at a transit stop;
- Travelers can also pay in advance for tolls and parking lot charges, as well as for yellow pages services;
- Travelers may request payment of the fare by a third party;
- Images of travelers making invalid payments are sent to the Manage Emergency Services function.

There are 5 processes in this DFD and one is itself a DFD:

a) Process Electronic Transit Fare Payment (DFD 7.3.1)
b) Distribute Advanced Tolls and Parking Lot Charges (7.3.2)
c) Get Traveler Image for Violation (7.3.3)
d) Provide Remote Terminal Traveler Card Interface (7.3.4)
e) Provide Transit Vehicle Traveler Card Interface (7.3.5)

The processes in this group provide all the facilities for handling both current and advanced fares. They form a tightly coupled group that should be implemented in their entirety. However process (b) could be omitted if particular implementations are not supporting the advanced payments of parking lot charges, tolls, and transit fares. Similarly, either process (d) or (e) could be omitted if particular implementations are not supporting fare collection either at the roadside or on-board vehicles respectively.

DFD:7.3.1 Process Electronic Transit Fare Payment

The processes in this DFD are responsible for the Process Electronic Transit Fare Payment facility within the Provide Electronic Payment Services function. These processes transact the payments for current and advanced transit fares.

The key points about the facility are as follows:

- Support is provided for transit fare collection on vehicles or at the roadside;
- Payment of transit fares collected on the vehicle may be processed interactively or in batches;
- All travelers are checked for advanced payment before being billed for the current fare.

There are seven processes in this DFD:

a) Register for Advanced Transit Fare Payment (7.3.1.1)
b) Determine Advanced Transit Fares (7.3.1.2)
c) Manage Transit Fare Financial Processing (7.3.1.3)
d) Check for Advanced Transit Fare Payment (7.3.1.4)
e) Bill Traveler for Transit Fare (7.3.1.5)
f) Collect Bad Transit Fare Payment Data (7.3.1.6)
g) Update Transit Fare Data (7.3.1.7)

The processes in this group enable fare payments to be made by travelers without stopping and also support a flexible fare price structure. Fares may be changed at any time by the transit system operator through input to process (g). This process implements the new fares immediately by sending data to the Collect Transit Fares on the Vehicle and Collect Transit Fares at the Roadside facilities - see DFDs 4.6 and 4.7.2 respectively, and also for use by the Provide Driver and Traveler Services function (DFD 6) through the store of prices maintained by the Carry-out Centralized Payments Processing facility - see DFD 7.4. This last set of data may be sent on request, or whenever a change is made by the transit system operator. The validity of transit fares already paid in advance is unaffected by any new price structure.

DFD:7.4 Carry-out Centralized Payments Processing

The processes in this DFD provide the Carry-out Centralized Payments Processing facility within the Provide Electronic Payment Services function. These processes provide a central store for pricing

information and a central payments facility.

The key points about the facility are as follows:

- Central store of prices is provided for use by the Provide Driver and Traveler Services function;
- Yellow pages services cost processing is provided for advanced traveler payments.
- Interface is provided for collection of payee data.

There are 3 processes in this DFD, and one is itself a DFD:

a) Collect Advanced Payments (DFD 7.4.1)
b) Collect Price Data for ITS Use (7.4.2)
c) Route Traveler Advanced Payments (7.4.3)

The processes in (a) and (c) must be implemented together to support traveler advanced payments for confirmed trips. Process (c) acts as the communications interface for advanced payments with the toll, parking lot charge, and transit fare collection facilities in the Provide Electronic Payment Services function - see DFDs 7.1, 7.2, and 7.3. Process (b) maintains a store of prices that are provided by these other facilities. It operates independently and need only be implemented if needed.

DFD:7.4.1 Collect Advanced Payments

The processes in this DFD provide the Collect Advanced Payments facility within the Provide Electronic Payment Services function. These processes enable payments to be made for services provided as part of several ITS functions.

The key points about the facility are as follows:

- All transactions are sent to the financial institution for clearance and payment;
- Processes for specific types of payments can be implemented individually.

There are eight processes in this DFD:

a) Process Commercial Vehicle Payments (7.4.1.1)
b) Process Yellow Pages Services Provider Payments (7.4.1.2)
c) Process Driver Map Update Payments (7.4.1.3)
d) Process Traveler Map Update Payments (7.4.1.4)
e) Process Traveler Other Services Payments (7.4.1.5)
f) Process Traveler Trip and Other Services Payments (7.4.1.6)
g) Collect Payment Transaction Records (7.4.1.7)
h) Process Traveler Rideshare Payments (7.4.1.8)

These processes are each responsible for transacting payments with the financial institution. The payments transacted comprise those for commercial vehicle administration (see DFD 2.5), yellow pages provider registration (see DFD 6.5), map updates for drivers and travelers (see DFDs 6.7.2, 6.8.1, and 6.8.3), other (yellow pages) services for travelers (see DFDs 4.6 and 4.7.2), and ridesharing (see DFD 6.4). The results of the transaction are always returned to the requesting process, and are also sent to process (g) which maintains a store of transaction records. A summary report, without the identities of the payees or other sensitive financial information, is periodically sent by process (g) to the Manage Archived Data function - see DFD 8. These processes can be implemented separately with the obvious exception of that in (g) which depends on one or more of the others for its source of data. If the process in (f) is implemented, it will require the distribution process described in the previous DFD for the advanced payment of toll, parking lot charges, and transit fares to be completed. The process in (b) enables the Provide Driver and Traveler Services function (DFD 6) to obtain income from giving travelers access to details of the services available from yellow pages service providers.

DFD:7.5 Provide Traveler Card Interfaces

The processes in this DFD make up the Provide Traveler Card Interface facility within the Provide

Electronic Payment Services function. These processes enable drivers and travelers to pay for services provided by ITS functions.

The key points about the facility are as follows:

- Traveler Card / Payment Instrument may be credit/debit card or some form of electronic purse;
- Credit identity from credit/debit card is used for service payment billing through financial institution;
- Stored credit value from electronic purse is directly decreased by the cost of the service.

There are 4 processes in this DFD:

a) Provide Vehicle Traveler Card Interface (7.5.1)
b) Provide Traveler Roadside Traveler Card Interface (7.5.2)
c) Provide Personal Traveler Card Interface (7.5.3)
d) Provide Traveler Kiosk Traveler Card Interface (7.5.4)

Each of these processes can be implemented separately. They each provide an interface that is linked to a particular ITS function. This interface enables the driver, traveler, or traveler to provide data that enables them to pay for services provided by ITS functions. These services comprise such things as updates to navigable map databases and digitized map displays, payment for other (yellow pages) services, and advanced payments.

DFD: 8 Manage Archived Data

This DFD shows the processes that provide the Manage Archived Data function. This function is responsible for providing facilities to collect ITS and related data, archive it, and make it available to other user systems for use in transportation administration, policy evaluation, safety, planning, performance monitoring, program assessment, operations, and research applications. The User Service Requirements satisfied by this functional process tree include those from User Service 7.1 "Archived Data Function".

The key points about the function are as follows:

- Data collected from each ITS function and center-type terminators
- Collected data formatted and stored into a permanent data store
- Appropriate meta-data attached with each incoming data set
- Schema, security, and format of data managed through the interface with the Archived Data Administrator
- Coordination with other archives allows data to be shared across multiple sites
- User systems request data or a catalog of data
- User systems request analyses of the archive data such as fusion, mining, or aggregations
- Data extracted from the archive to support government reporting requirements
- Archive on-demand allows additional data to be selected for import into the archive by users systems
- Roadside data collected directly for archive purposes

There are nine processes in this DFD:

a) Get Archive Data (8.1)
b) Manage Archive (8.2)
c) Manage Archive Data Administrator Interface (8.3)
d) Coordinate Archives (8.4)
e) Process Archived Data User System Requests (8.5)
f) Analyze Archive (8.6)
g) Process On Demand Archive Requests (8.7)
h) Prepare Government Reporting Inputs (8.8)
i) Manage Roadside Data Collection (8.9)

DFD: 9 Manage Maintenance and Construction

The processes in this DFD are responsible for the Manage Maintenance and Construction function. This DFD includes the management of maintenance and construction vehicle fleets, roadway maintenance activities (winter treatment and routine maintenance), work zone activities, collection of environmental data, and dissemination of work plans, road condition, and environmental information to other transportation functions. The User Service Requirements satisfied by this functional process tree include those from User Services 5.3, "Disaster Response and Evacuation", and 8.1, “Maintenance and Construction Operations”.

The key points about the function are as follows:

- Maintenance and construction fleet managers dispatch, route, and track their vehicles, and may remotely operate the operational equipment on those vehicles;
- Location, safety status, operating condition, and operational status are monitored on maintenance and construction vehicles;
- Work zone activity, field equipment repair, winter maintenance, and routine roadway maintenance needs are determined, scheduled, monitored, and shared with other agencies;
- Automated roadway treatment facilities are supported;
- Resources such as materials, fleet equipment and vehicles are managed;
- Work zone activity is managed, including control of roadside and maintenance and construction vehicle work zone devices;
- Crew movements are monitored and alerts issued if a crew member approaches the work zone boundary;
- Vehicle intrusions into a work zone are detected by roadside equipment and maintenance and construction vehicles, and intrusion alerts are issued to maintenance and construction vehicle operators and crew members;
- Environmental information is collected from sensors at the roadside and on vehicles and from other agencies, processed, and disseminated to other agencies;
- Plans and activities are coordinated with other ITS functions for disaster and evacuation situations.

The processes subordinate to this DFD are all themselves DFDs:

a) Manage M&C Vehicles (DFD 9.1)
b) Manage Roadway M&C Activities (DFD 9.2)
c) Manage Work Zones (DFD 9.3)
d) Manage Environmental Information (DFD 9.4)

The above processes are able to implement a maintenance and construction management function including vehicle fleet management, maintenance and construction activity needs assessment and scheduling, work zone management and crew safety measures, and serve as a central point for collection, processing, and dissemination of environmental information. This is designed to assist in effective and timely maintenance and construction operations, coordinated with other transportation agencies to maximize efficiency and minimize the risk of incidents in the rest of the transportation network.

DFD:9.1 Manage M&C Vehicles

The seven processes in this DFD provide the Manage M&C Vehicles facility within the Manage Maintenance and Construction function. These processes together provide a fleet management function for maintenance and construction vehicles by providing dispatching and routing, tracking vehicle locations and work activities, scheduling vehicle maintenance, and monitoring operational status.

The key points about the facility are as follows:

- Dispatching and routing of maintenance and construction vehicles;
- Tracking vehicle location, safety status, operating condition, and operational status;
- Maintenance and construction vehicle instructions dependent upon winter or non-winter conditions, incidents, and traffic congestion;
- Preventive and corrective vehicle maintenance automatically scheduled by fleet manager or via direct monitoring of the vehicles themselves by the repair facility;
- Incident and traffic flow information from traffic and emergency management functions, as well as transportation system status during disasters or evacuations is collected to provide an overall view of the road network for maintenance and construction activities;
- Maintenance and construction provides the overall view of the road network collected by its sensors, vehicles, and field personnel to Traffic Management and Emergency Management in support of traffic management, incident management, disaster response, and evacuation;
- Receive wide area alerts from emergency management and distribute to maintenance and construction personnel;
- Control of on-board equipment is provided, both by the vehicle operator and remotely from a center;
- Field equipment repair status is collected and infrastructure health is monitored via sensors on vehicles and at the roadside.

There are seven processes in this DFD:

a) Manage M&C Systems On-Board (9.1.1)
b) Collect M&C Vehicle Data On-Board (9.1.2)
c) Track M&C Vehicles and Equipment (9.1.3)
d) Manage M&C Vehicle Fleet (9.1.4)
e) Schedule M&C Vehicle Maint (9.1.5)
f) Provide M&C Vehicle Operator Interface for Maint (9.1.6)
g) Process Road Network Information (9.1.7)

The processes in this group provide all the facilities for the management of a fleet of maintenance and construction vehicles, from operation to vehicle repair. They form a tightly coupled group that could be implemented in its entirety, depending upon the degree of automation envisioned by the maintenance operation. The processes include some advanced functions that might be omitted if particular implementations are not supporting remote control of on-board vehicle maintenance equipment, or infrastructure sensor control.

DFD:9.2 Manage Roadway M&C Activities

This DFD shows the eight functions that provide the Manage Roadway M&C Activities facility within the Manage Maintenance and Construction function. This facility includes determination of maintenance

and construction needs, scheduling assets to address those needs, and collecting work activity status.

The key points about the facility are as follows:

- Equipment repair, winter maintenance, and routine roadway maintenance needs are determined;
- Resource needs from other agencies are collected and resolved;
- Disaster response and evacuation plans are coordinated with Emergency Management;
- Maintenance Decision Support system makes maintenance recommendations based on current weather, needs, and resources available with parameter input from center personnel;
- Schedules for roadway maintenance are generated and shared with other agencies;
- Roadway maintenance status is collected and shared with other agencies and the function that schedules maintenance and construction activities;
- Map data is used to assist in tracking resources, provide routing recommendations, and monitoring work activities;
- Materials usage and storage is tracked;
- Data is archived to assist in tracking transportation infrastructure health and determining repair needs, monitoring work activity performance, and analyzing trends;
- An automated roadway treatment system operates based on environmental sensors and control parameters from a center.

There are eight processes in this DFD, and two are themselves DFDs:

a) Schedule M&C Activities (9.2.1)
b) Status Current M&C Activities (9.2.2)
c) Determine M&C Needs (DFD 9.2.3)
d) Manage M&C Map Data (9.2.4)
e) Provide M&C Center Personnel Interface for Maint (9.2.5)
f) Manage Infrastructure Monitoring and Treatment Systems (DFD 9.2.6)
g) Manage M&C Archive Data (9.2.7)
h) Manage M&C Materials (9.2.8)

The processes (a), (b), (c), (d), (e), and (h) in this group determine maintenance needs, schedule work activities to address them, and track the status of those activities and the resources required to complete them. Process (f) is somewhat different in that it automatically determines when roadway treatment should be applied based on roadway sensors, and therefore operates rather independently. Process (g) serves only as a storage point for maintenance and construction data and therefore could be modified to collect only that data required by the implementation.

DFD:9.2.3 Determine M&C Needs

This DFD shows the processes that provide the Determine M&C Needs facility within the Manage Roadway M&C Activities function. These processes identify equipment requiring repair, winter maintenance needs, resource requirements, and then request maintenance and construction work to be scheduled. They coordinate M&C resource needs as part of planning for disaster response or evacuation. An automated Maintenance Decision Support system function is also supported.

The key points about the facility are:

- Equipment repair, winter maintenance, and routine roadway maintenance needs are determined;
- Resource needs from other agencies are collected and resolved;
- Disaster response or evacuation plans are coordinated with emergency management;
- Maintenance Decision Support system makes maintenance recommendations based on current weather, needs, and resources available with parameter input from center personnel.

There are five processes in this DFD:

a) Determine Winter Roadway Treatment Needs (9.2.3.1)
b) Determine Roadway M&C Needs (9.2.3.2)
c) Provide Maintenance Decision Support (9.2.3.3)
d) Manage M&C Resource Needs (9.2.3.4)
e) Collect Roadside Equipment Status (9.2.3.5)

The processes in this group provide all the facilities for determining maintenance and construction needs, from roadside equipment repair, to winter and routine maintenance, to handling resource requests from other agencies. All except process (c) work together, although (a) could be omitted if winter roadway treatment is not required in the implementation. Process (c) is used in more advanced applications in which specific maintenance and construction recommendations are produced automatically, without personnel intervention except for system parameter inputs.

DFD:9.2.6 Manage Infrastructure Monitoring and Treatment Systems

This DFD shows the processes that make up the Manage Infrastructure Monitoring and Treatment Systems facility within the Manage Roadway M&C Activities function. These processes control and manage the automated roadway treatment functions and transportation infrastructure sensor equipment interface.

The key points about the facility are:

- An automated roadway treatment system operates based on environmental sensors and under center control;
- Advisory messages to motorists are displayed on dynamic message signs to warn of ongoing roadway treatment or the environmental condition that required that treatment (e.g., icy roads);
- Infrastructure sensors located on the roadway and on the maintenance and construction vehicle are monitored and managed remotely.

There are three processes in this DFD:

a) Operate Roadway Automated Treatment System (9.2.6.1)
b) Control Roadway Automated Treatment System (9.2.6.2)
c) Operate Infrastructure Monitoring Devices (9.2.6.3)

The processes (a) and (b) provide all the facilities for handling automated roadway treatment and form a tightly coupled group that should be implemented in its entirety. In process (c), roadside sensor equipment detecting transportation infrastructure faults is monitored by a center, and therefore should be implemented with complementary processes 1.1.1.6 (Collect Infrastructure Sensor Data) and 9.1.1 (Manage M&C Systems On-Board).

DFD:9.3 Manage Work Zones

The processes in this DFD provide the Manage Work Zones facility within the Manage Maintenance and Construction function. These processes control activity in the work zone, collect and disseminate information about work zones to other agencies, monitor vehicle speeds through the work zone, and detect vehicle intrusion into the work zone.

The key points about the facility are as follows:

- Work zone activity is managed, including control of roadside and maintenance and construction vehicle work zone devices;
- Crew movements are monitored and alerts issued if a crew member approaches the work zone boundary;
- Information about work zone activity, including status and other data, is collected, analyzed, and disseminated to other agencies;
- Individual vehicle speed through the work zone is monitored, and speed is enforced by reporting violations to traffic management or maintenance and construction management agencies, or posting on driver information devices such as dynamic message signs;
- Vehicle intrusions into the work zone are detected and crew alerts are issued.

The processes subordinate to this DFD are all themselves DFDs:

a) Control Work Zone Activity (DFD 9.3.1)
b) Manage Work Zone Data (DFD 9.3.2)
c) Manage Vehicle Speed (DFD 9.3.3)
d) Manage WZ Intrusion Warning (DFD 9.3.4)

The processes in this group provide all the facilities for managing activities in work zones. Both (a) and (b) form a tightly coupled group that should be implemented in together. Processes (c) and (d) can each be implemented separately, but should be considered as part of the overall function since they enhance safety for the work zone crew, passing vehicles, and maintenance and construction vehicles.

DFD:9.3.1 Control Work Zone Activity

This DFD shows the processes that make up the Control Work Zone Activity facility within the Manage Work Zones function. These processes manage activity in the work zone by monitoring crew movements and controlling work zone devices located both at the roadside and within the maintenance and construction vehicle.

The key points about the facility are:

- Work zone devices, such as dynamic message signs, CCTVs, or intrusion alert devices located at the roadside or on maintenance and construction vehicles are controlled;
- Crew movements are monitored and alerts issued if a crew member approaches the work zone boundary.

There are four processes in this DFD:

a) Operate Work Zone Devices (9.3.1.1)
b) Operate WZ Devices On-Board (9.3.1.2)
c) Monitor Crew Movement (9.3.1.3)
d) Monitor Crew Movement On-Board (9.3.1.4)

The processes (a) and (b) provide the facilities for handling the control of work zone devices from a center and from on-board a maintenance and construction vehicle, respectively. Therefore, one or both of the options may be implemented. Processes (c) and (d) are similar in that crew movements may be monitored from the roadside (as in process c) and/or from a maintenance and construction vehicle (as in process d). Again, one or both of the options may be implemented.

DFD:9.3.2 Manage Work Zone Data

This DFD shows the processes that make up the Manage Work Zone Data facility within the Manage Work Zones function. These processes collect status and data about work zone activities from field personnel and roadside devices, analyze it, and prepare it for dissemination to other agencies.

The key points about the facility are:

- Information about work zone activity, including status and other data, is collected, analyzed, and disseminated to other agencies.

There are four processes in this DFD:

a) Status Work Zone Activity (9.3.2.1)
b) Collect Work Zone Data (9.3.2.2)
c) Generate Work Zone Information for Distribution (9.3.2.3)
d) Provide M&C Field Personnel Interface for Work Zones (9.3.2.4)

The processes in this group provide all the facilities for collecting data and disseminating information about work zone activities. They form a tightly coupled group that should be implemented in its entirety.

DFD:9.3.3 Manage Vehicle Speed

This DFD shows the processes that make up the Manage Vehicle Speed facility within the Manage Work Zones function. These processes monitor a vehicle's speed as it passes through a work zone, determine if a speed violation has occurred, and report to traffic and maintenance and construction agencies, as well as enforcement agencies.

The key points about the facility are:

- Individual vehicle speed through the work zone is monitored and aggregated to provide an overall speed;
- Unsafe or excessive vehicle speeds, including environmental conditions, are detected;
- Speed enforcement is provided by monitoring speeds, providing camera images, and by reporting violations to traffic management or maintenance and construction management agencies, posting on driver information devices such as dynamic message signs, or informing an enforcement agency.

There are four processes in this DFD:

a) Collect Vehicle Speed (9.3.3.1)
b) Monitor Vehicle Speed in Work Zone (9.3.3.2)
c) Monitor Vehicle Speed on Roadway (9.3.3.3)
d) Support Vehicle Speed Enforcement (9.3.3.4)

The processes in this group provide all the facilities for monitoring vehicle speeds in a work zone and reporting violations. They form a tightly coupled group that could be implemented in its entirety. However, process (b) involves enforcement via a maintenance and construction agency whereas process (c) involves enforcement via a traffic management agency. Process (d) could be omitted if direct control of the speed sensor by an enforcement agency is not required.

DFD:9.3.4 Manage WZ Intrusion Warning

This DFD shows the processes that make up the Manage WZ Intrusion Warning facility within the Manage Work Zones function. These processes alert maintenance and construction vehicle occupants and work zone crew members when a vehicle intrusion into the work zone has been detected.

The key points about the facility are:

- Vehicle intrusions into a work zone are detected by roadside equipment and maintenance and construction vehicles;
- Intrusion alerts are issued to maintenance and construction vehicle operators and crew members.

There are four processes in this DFD:

a) Detect Work Zone Intrusion (9.3.4.1)
b) Provide Work Zone Intrusion Alert (9.3.4.2)
c) Detect Work Zone Intrusion On-Board (9.3.4.3)
d) Provide On-Board Work Zone Intrusion Alert (9.3.4.4)

The processes in this group provide all the facilities to detect work zone intrusion using sensors on-board a maintenance and construction vehicle (processes c and d) and at the roadside (processes a and b). Therefore, one or both of the options may be implemented, depending upon the location of the intrusion sensors.

DFD:9.4 Manage Environmental Information

The five processes in this DFD provide the Manage Environmental Information facility within the Manage Maintenance and Construction function. These processes collect environmental data from other agencies, such as the weather service, and from sensors at the roadside and on vehicles. This DFD then processes that data and disseminates it to other agencies.

The key points about the facility are as follows:

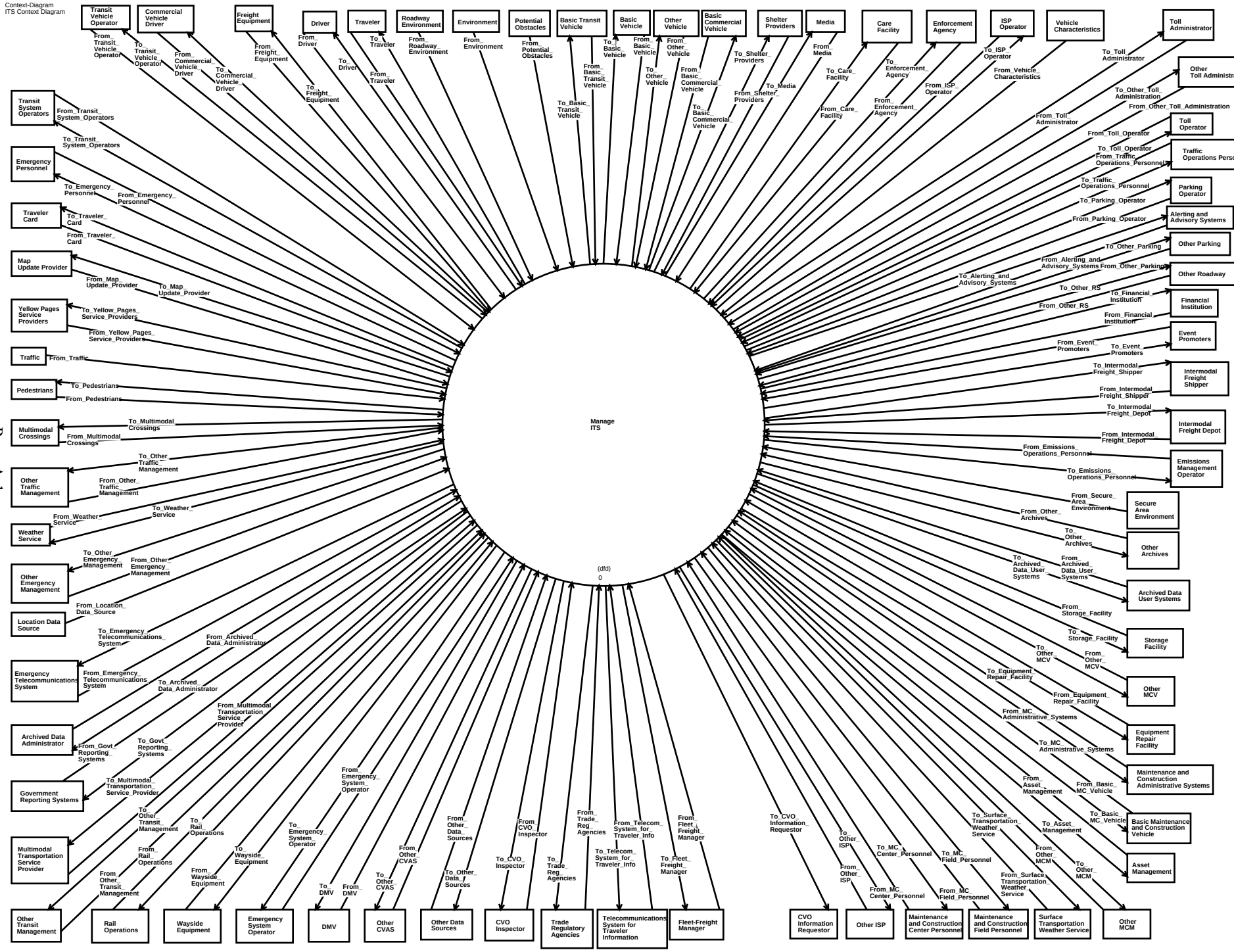
- Environmental data is collected from sensors at the roadside and on-board probe vehicles, such as private vehicles, transit vehicles, emergency vehicles, and maintenance and construction vehicles;
- Environmental data is collected from weather service providers and from other agencies;
- All of this environmental data is then processed and disseminated to other agencies.

There are five processes in this DFD:

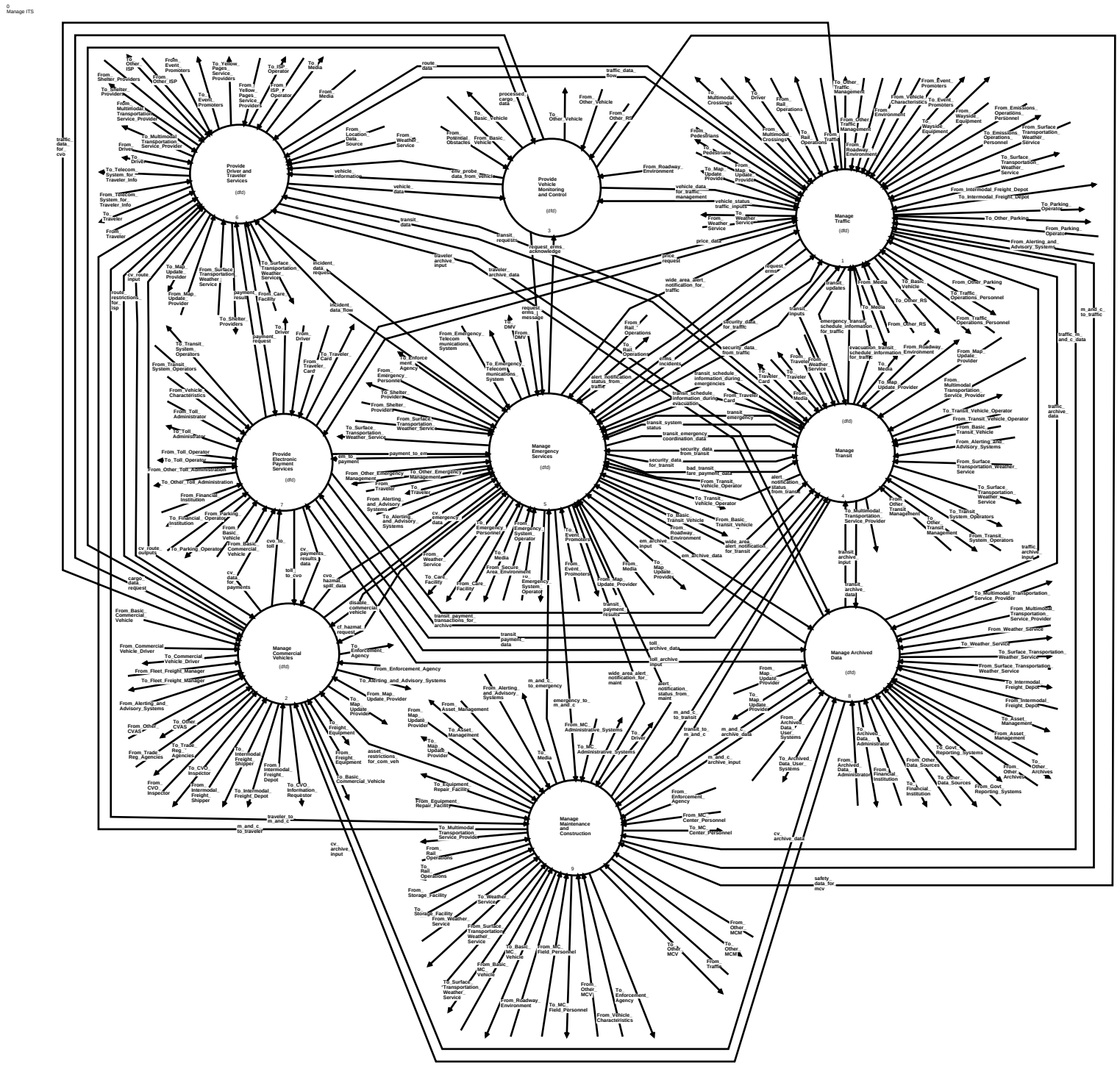
a) Collect Environmental Data On-Board (9.4.1)
b) Collect Environmental Data (9.4.2)
c) Process Environmental Data (9.4.3)
d) Disseminate Environmental Information (9.4.4)
e) Provide M&C Center Personnel Interface for Environment (9.4.5)

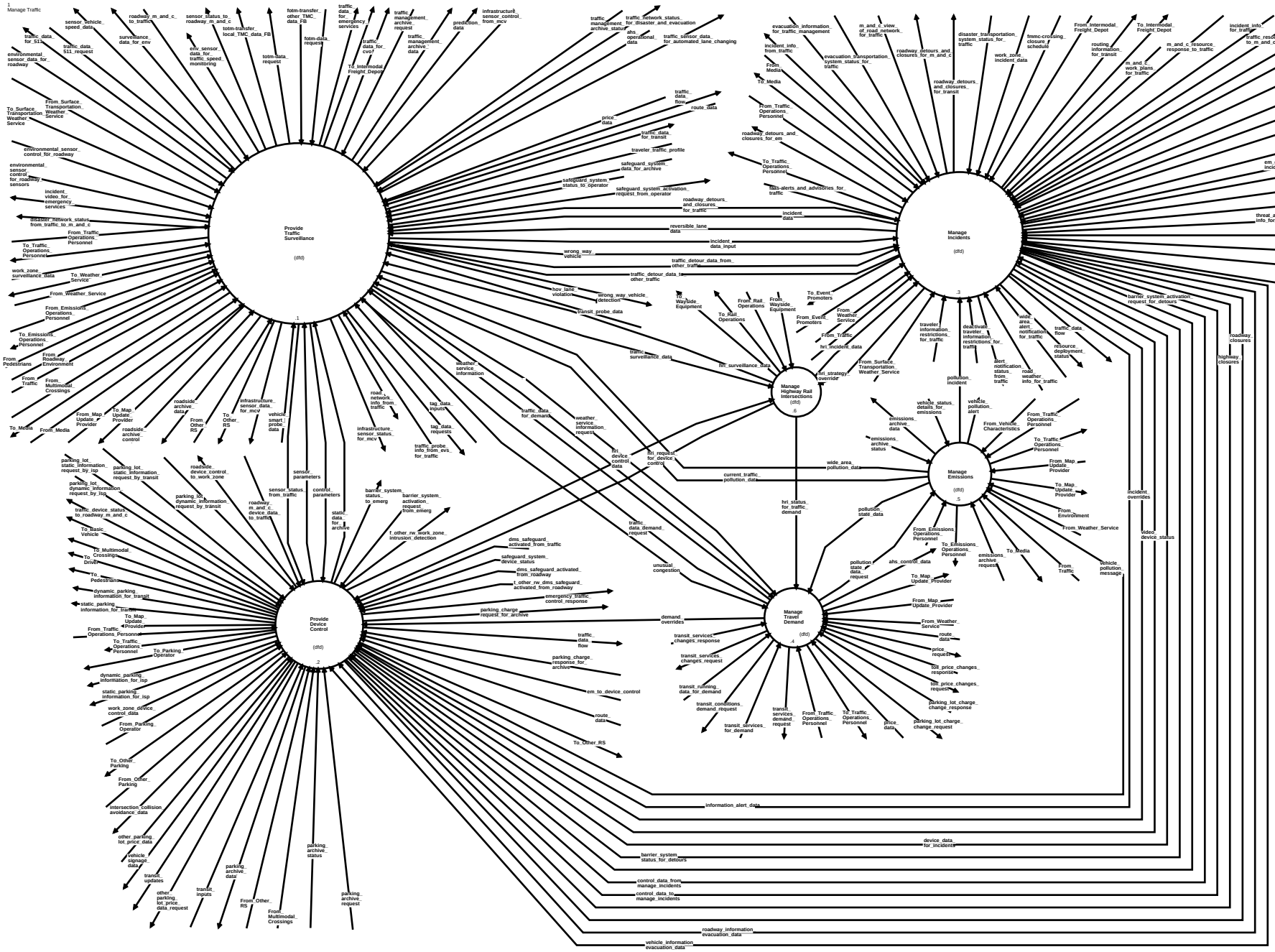
The processes in this group provide all the facilities for the collection of environmental data, processing, and dissemination to other agencies. Processes b) through e) form a tightly coupled group relating to collection of environmental information from roadside sensors that should be implemented in their entirety. Process a) provides a similar environmental data collection, but from on-board sensors and may be implemented separately or jointly with the collection of environmental data from roadside sensors.

ITS Context Diagram

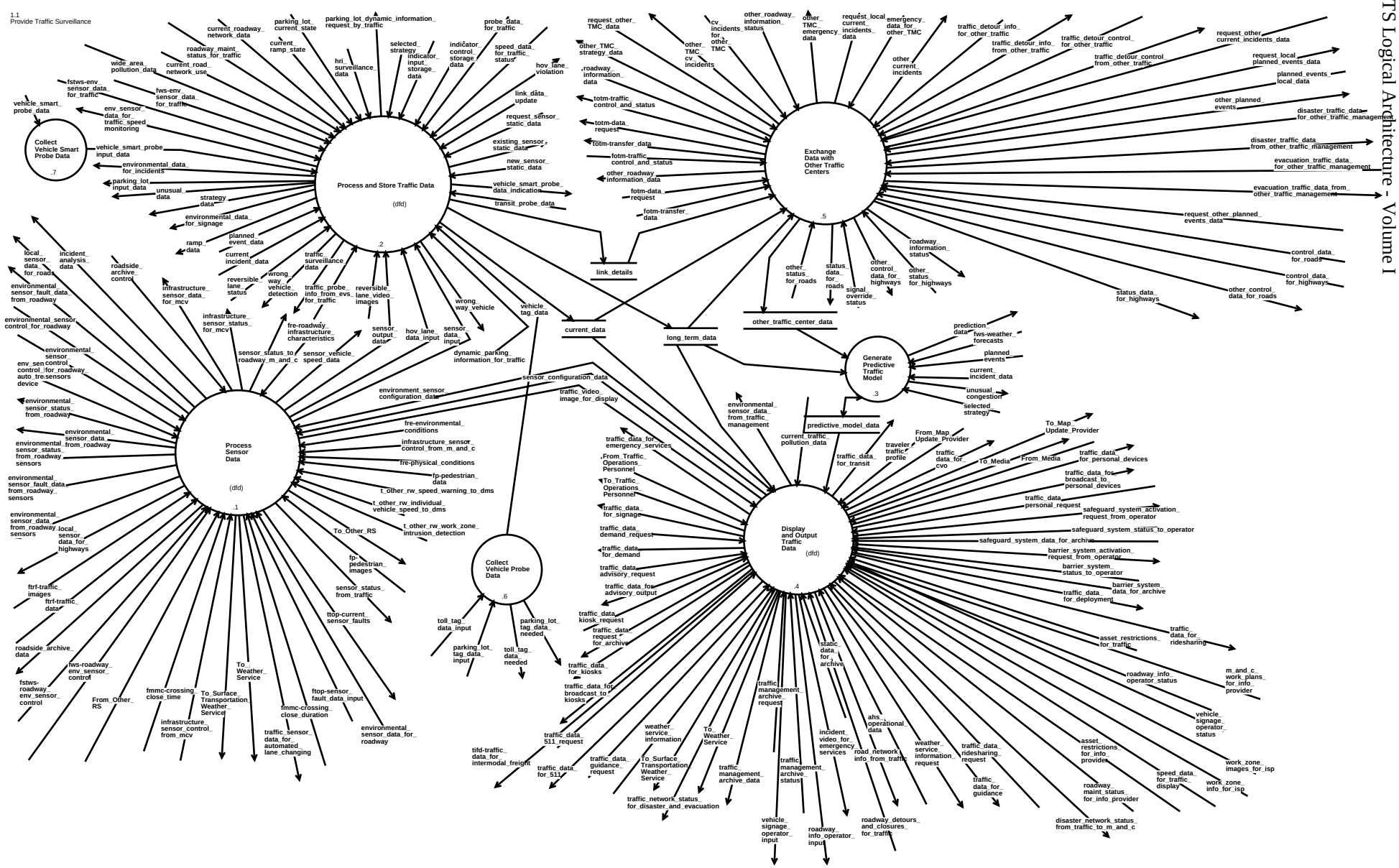


Manage ITS

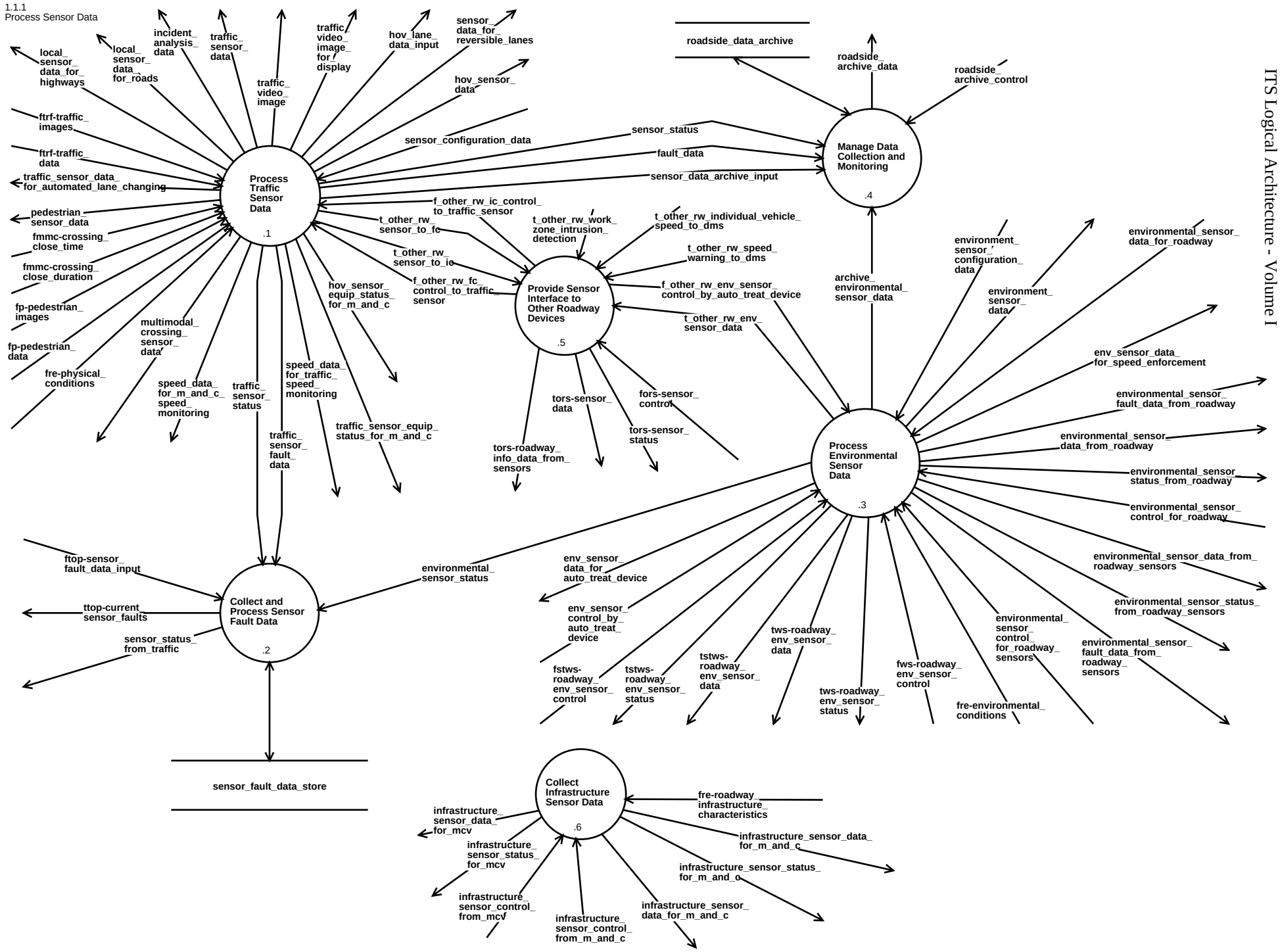

0
Manage ITS
Provide Driver and Traveler Services
(dfd)
6
Provide Vehicle Monitoring and Control
(dfd)
3
Manage Traffic
(dfd)
1
Provide Electronic Payment Services
(dfd)
7
Manage Emergency Services
(dfd)
5
Manage Transit
(dfd)
4
Manage Commercial Vehicles
(dfd)
2
Manage Archived Data
(dfd)
8
Manage Maintenance and Construction
(dfd)
9


1
Manage Traffic
Provide Traffic Surveillance
(dfd)
1
Manage Incidents
(dfd)
3
Manage Highway Rail Intersections
(dfd)
6
Manage Emissions
(dfd)
5
Manage Travel Demand
(dfd)
4
Provide Device Control
(dfd)
2

Provide Traffic Surveillance

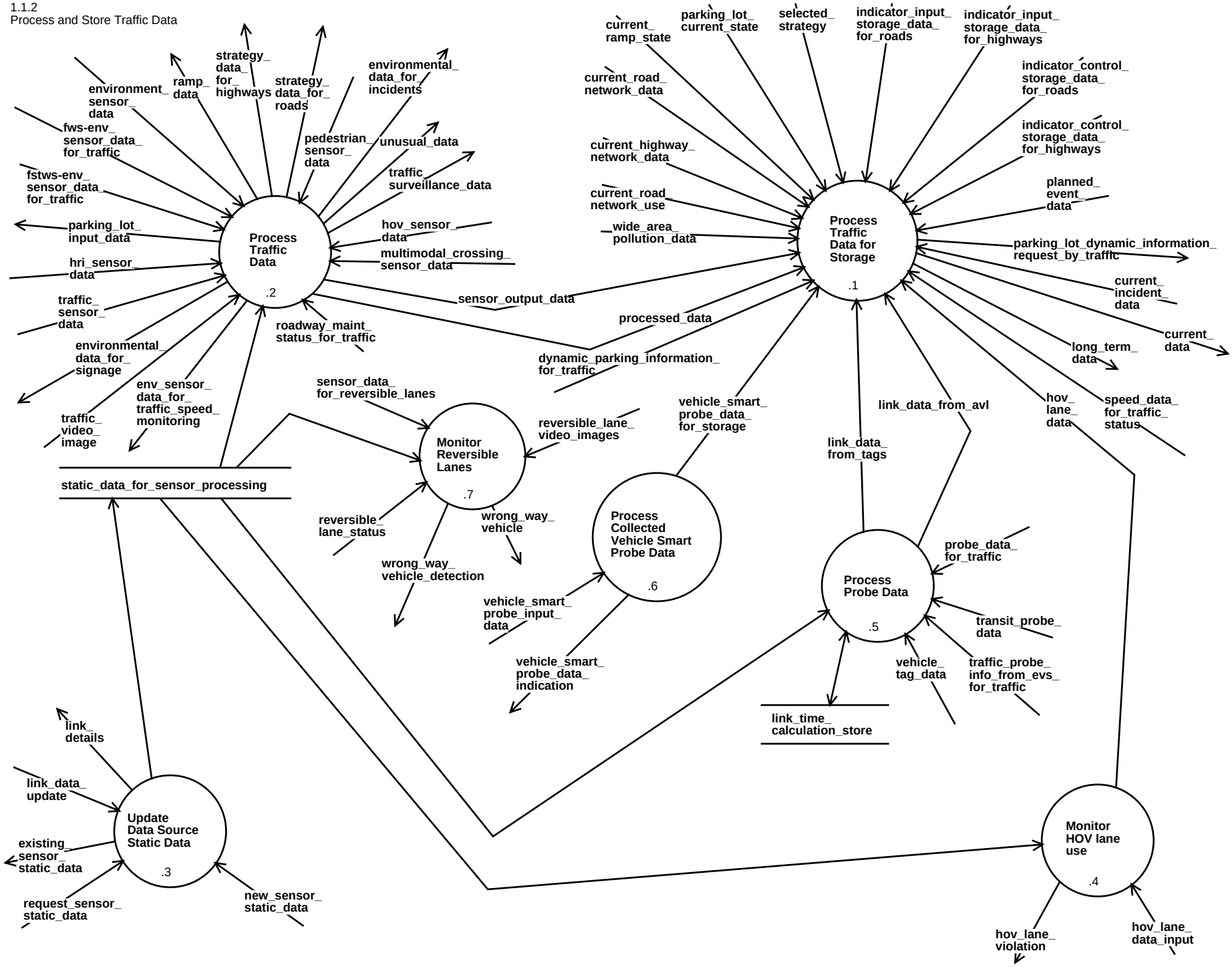


Process Sensor Data

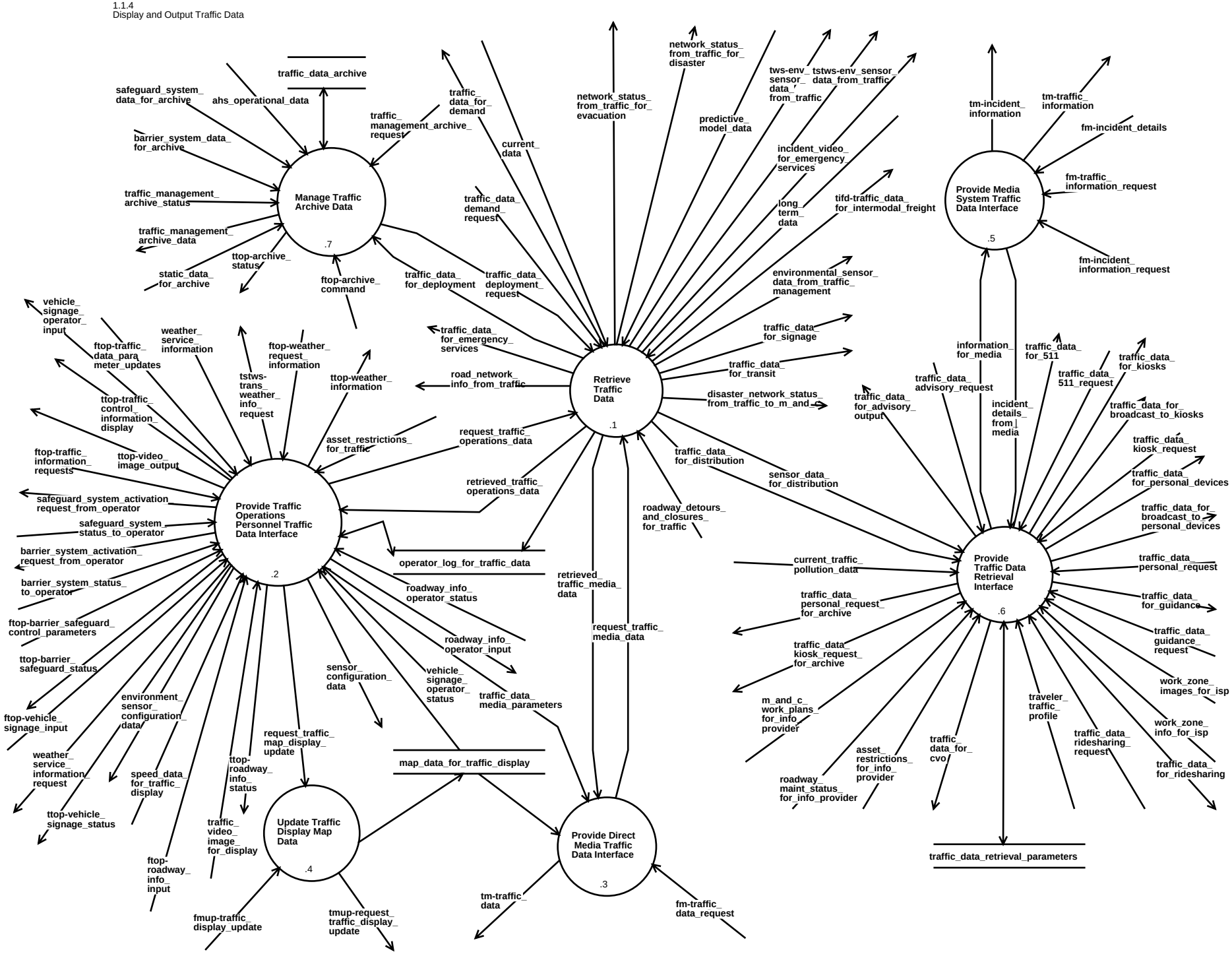


Process and Store Traffic Data

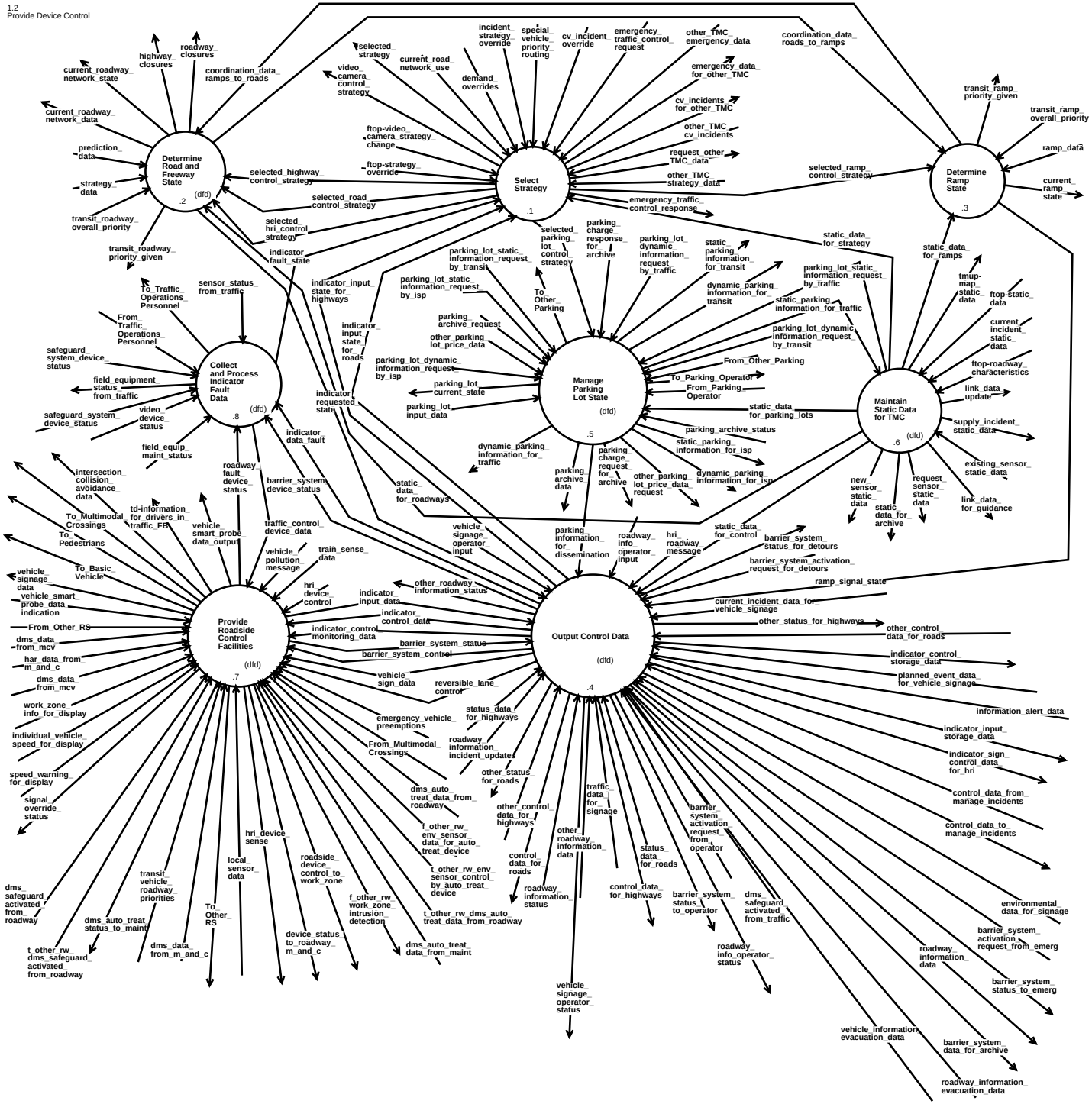
1.1.2
Process and Store Traffic Data



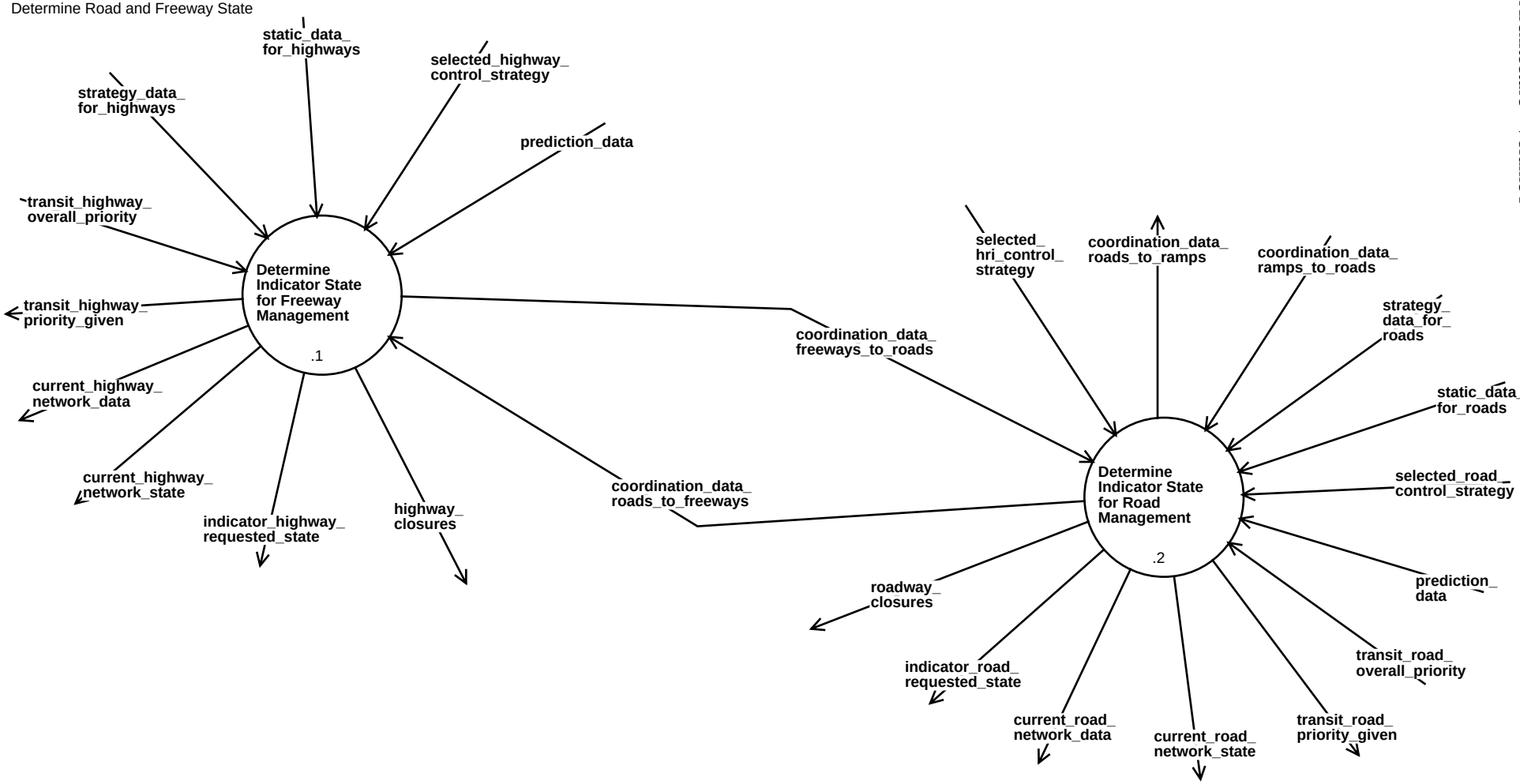
Display and Output Traffic Data



Provide Device Control

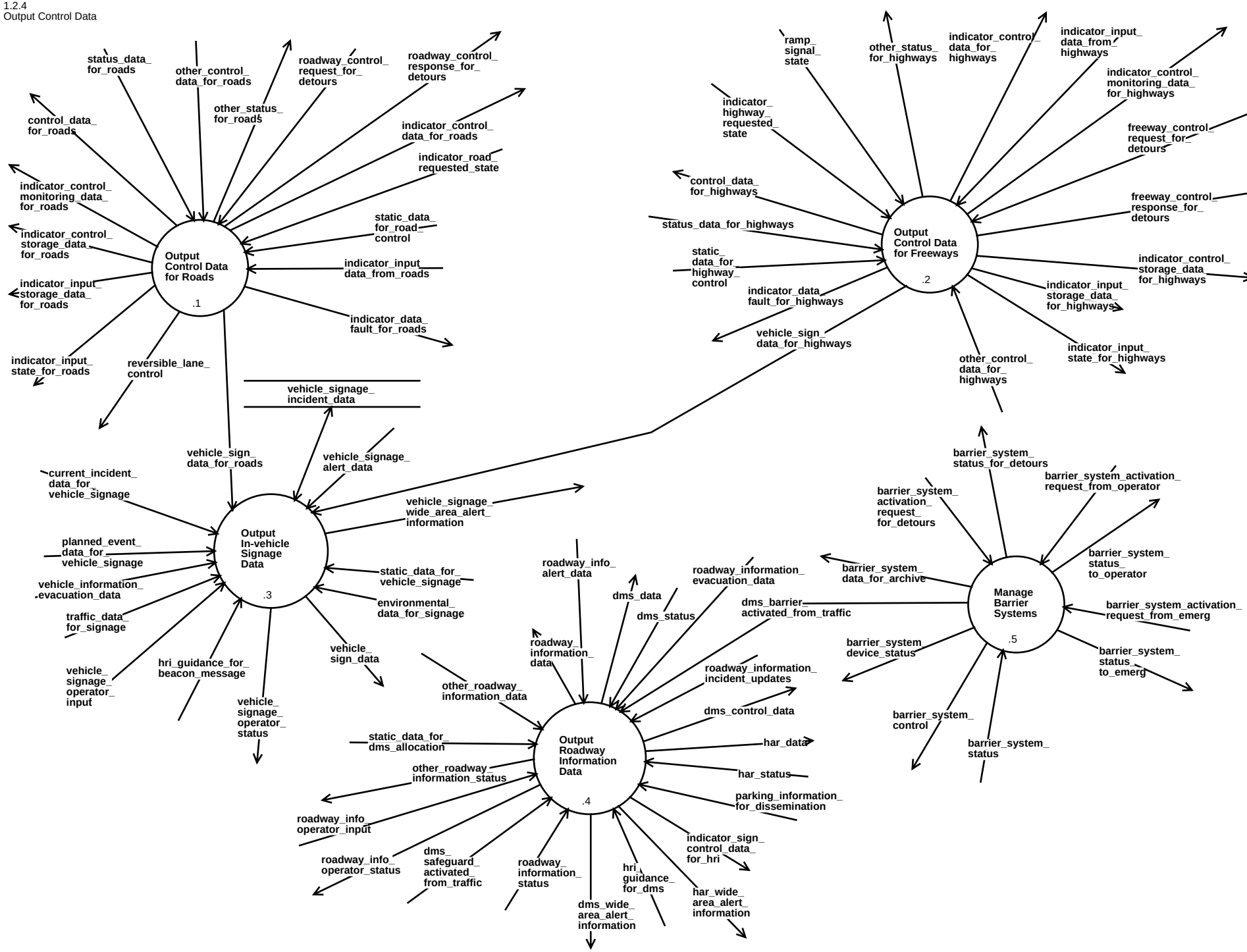


1.2.2
Determine Road and Freeway State

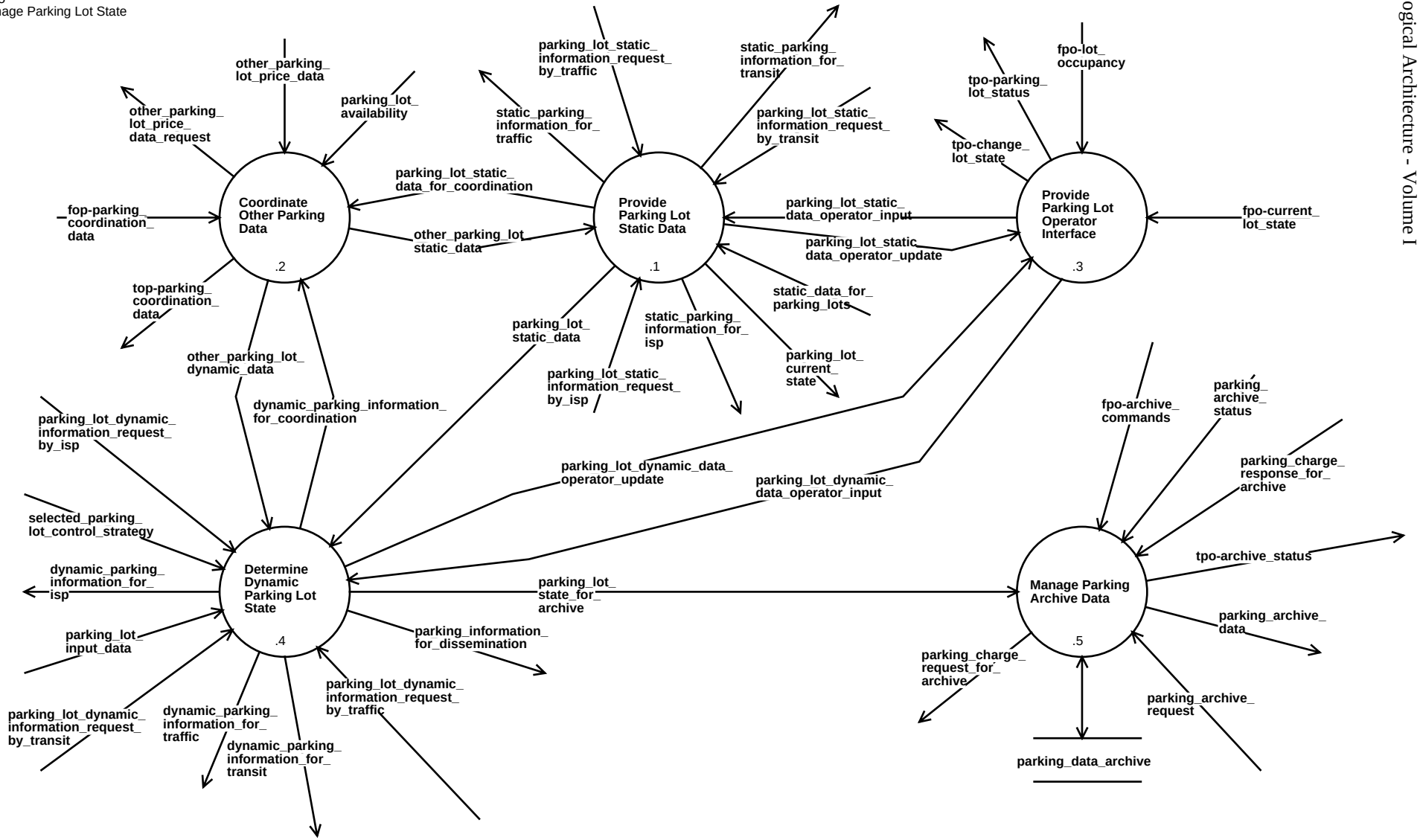


Output Control Data

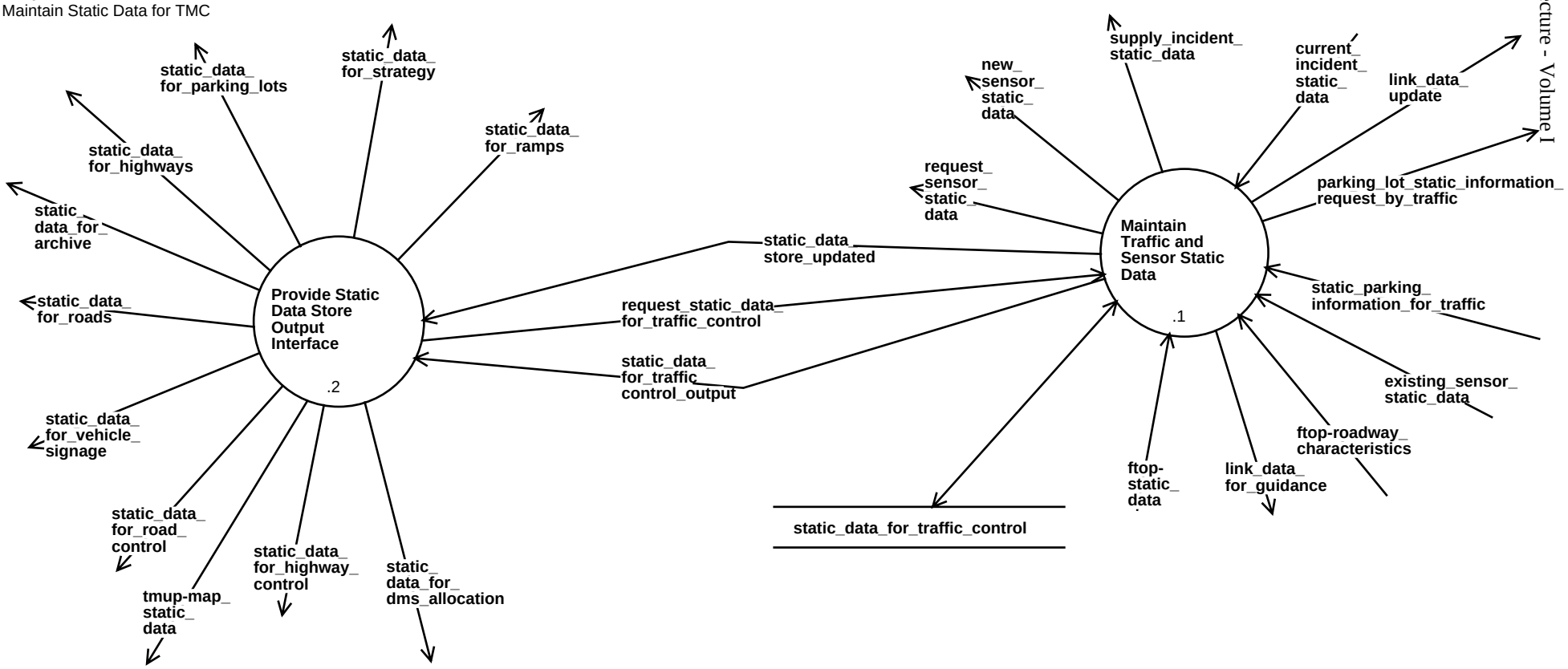
1.2.4
Output Control Data



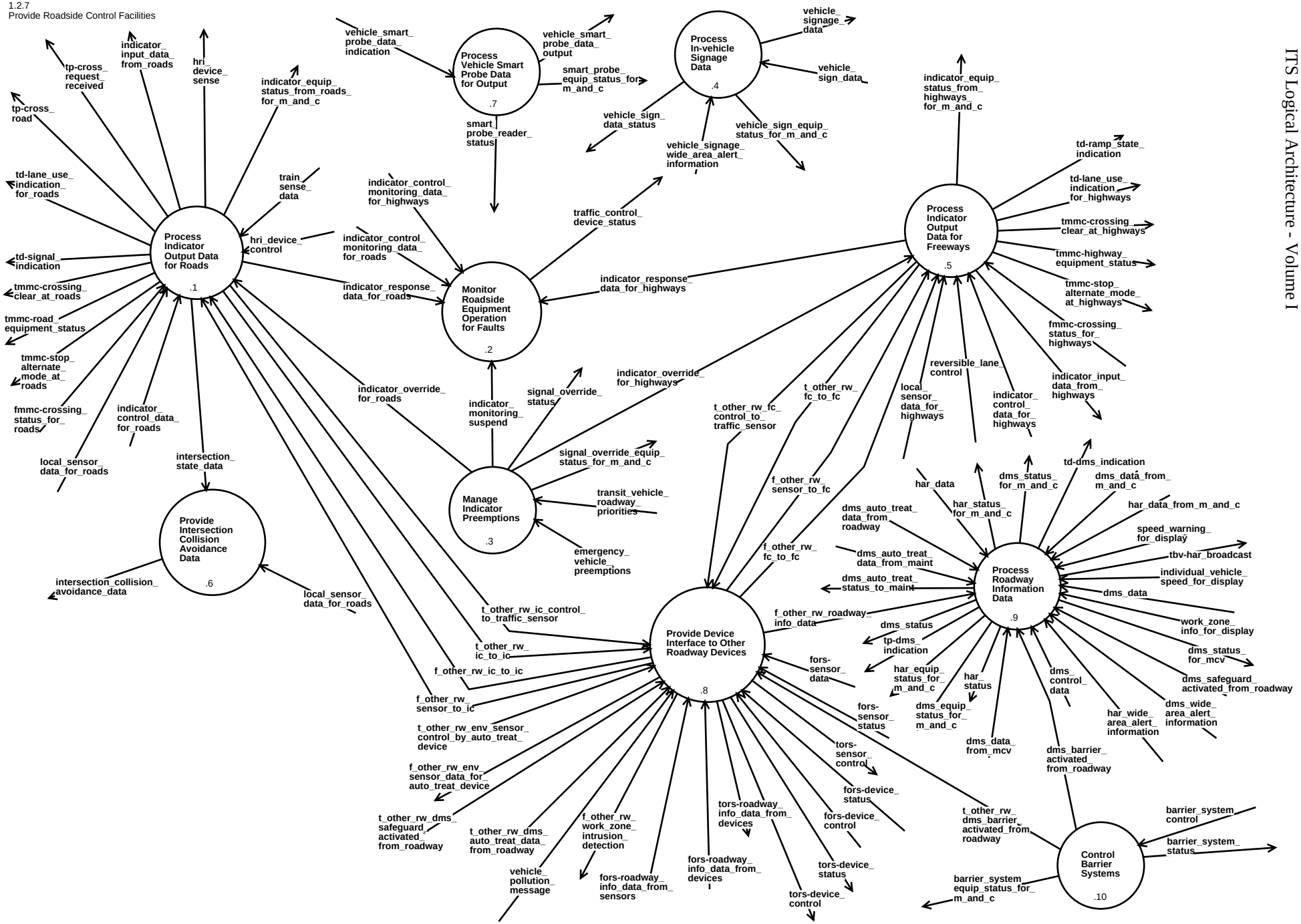
1.2.5
Manage Parking Lot State



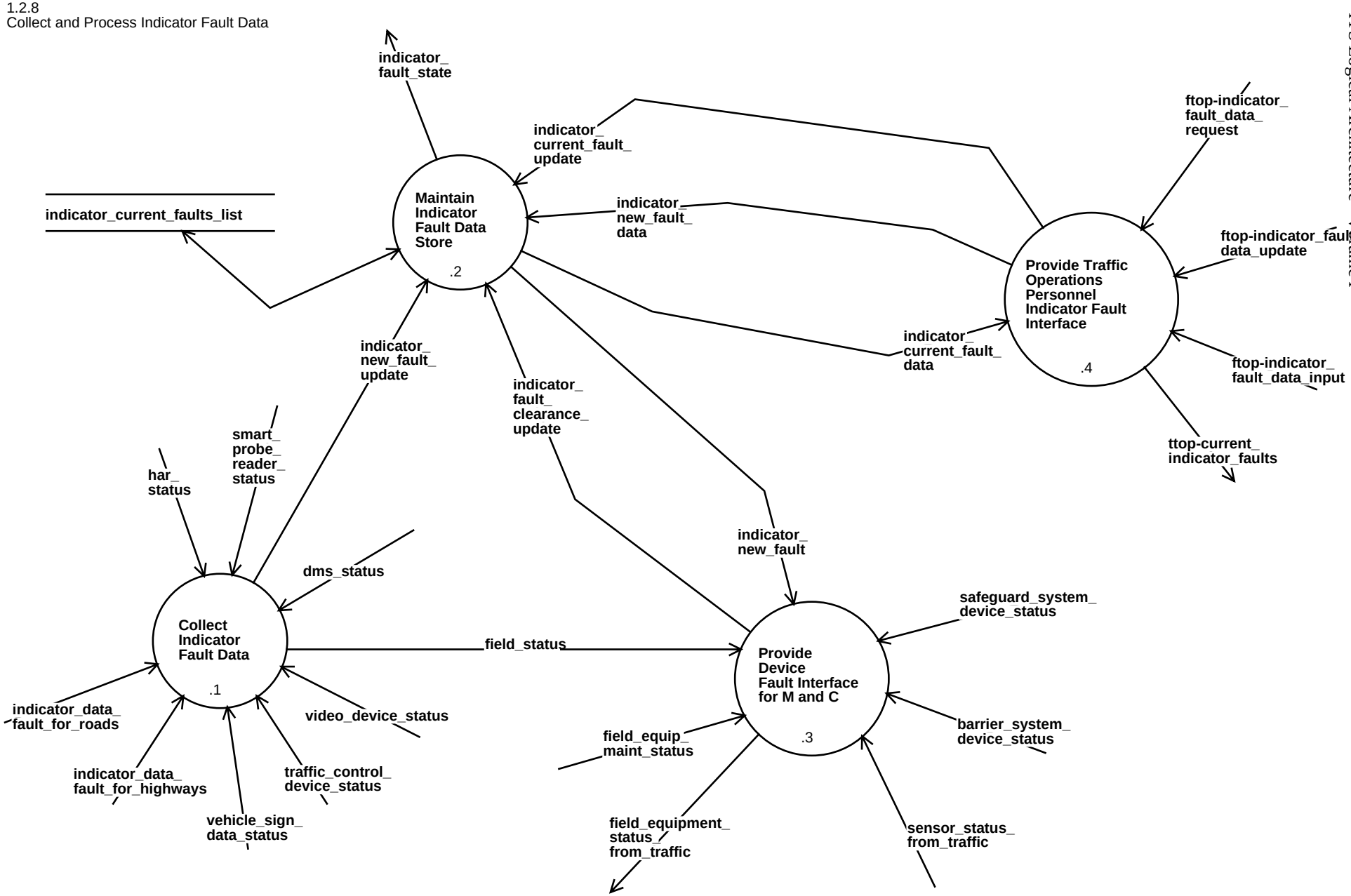
1.2.6
Maintain Static Data for TMC



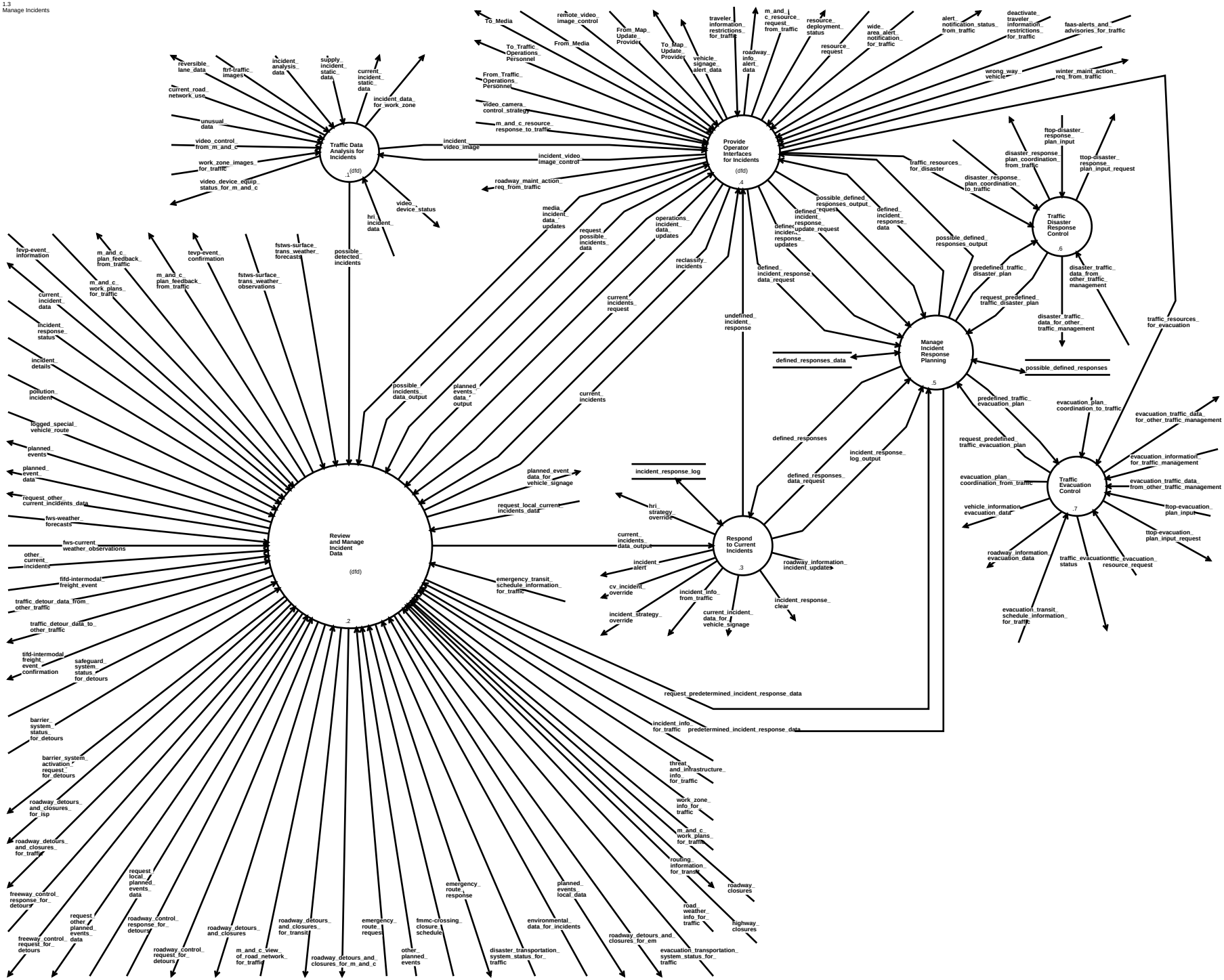
Provide Roadside Control Facilities



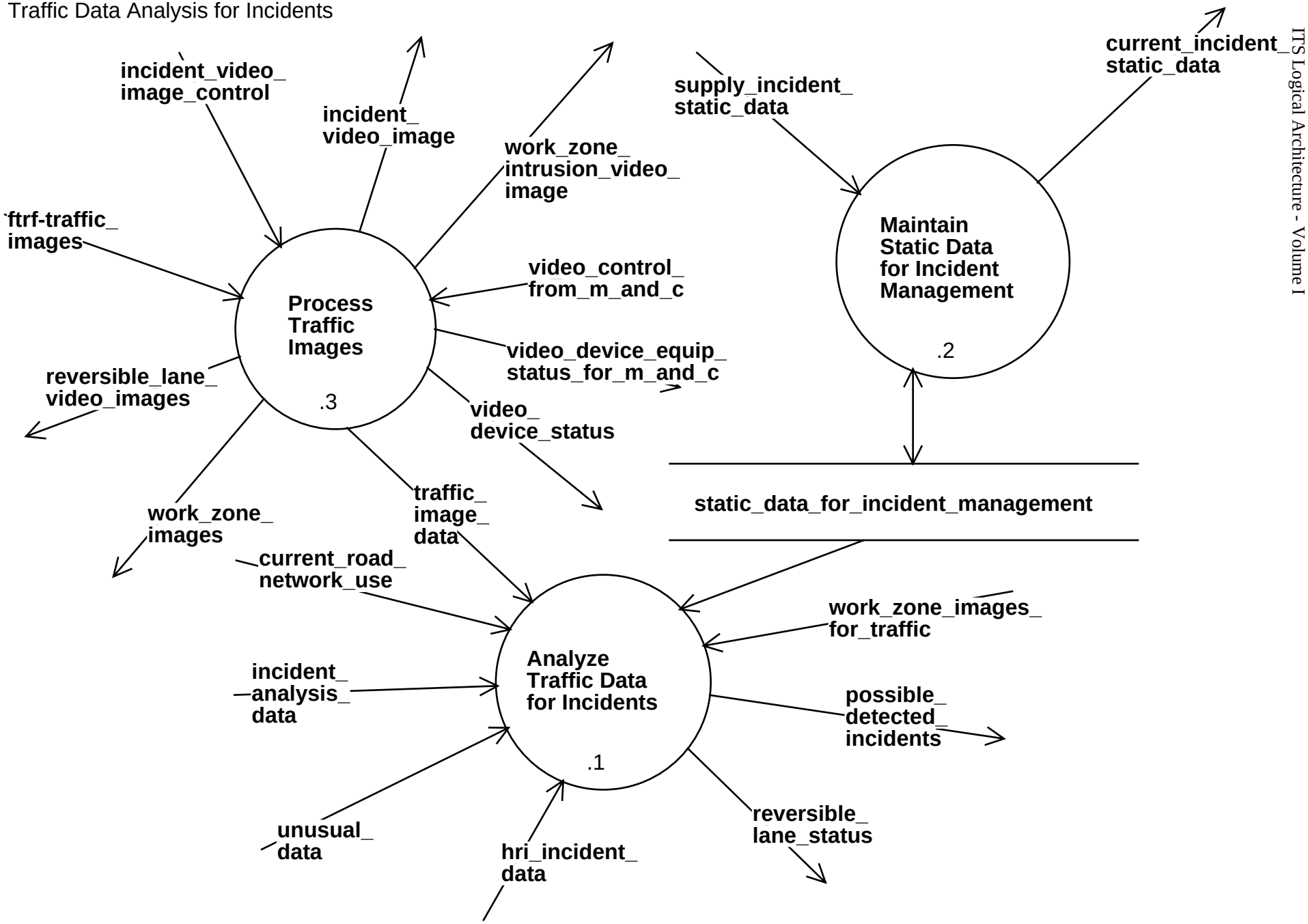
1.2.8
Collect and Process Indicator Fault Data



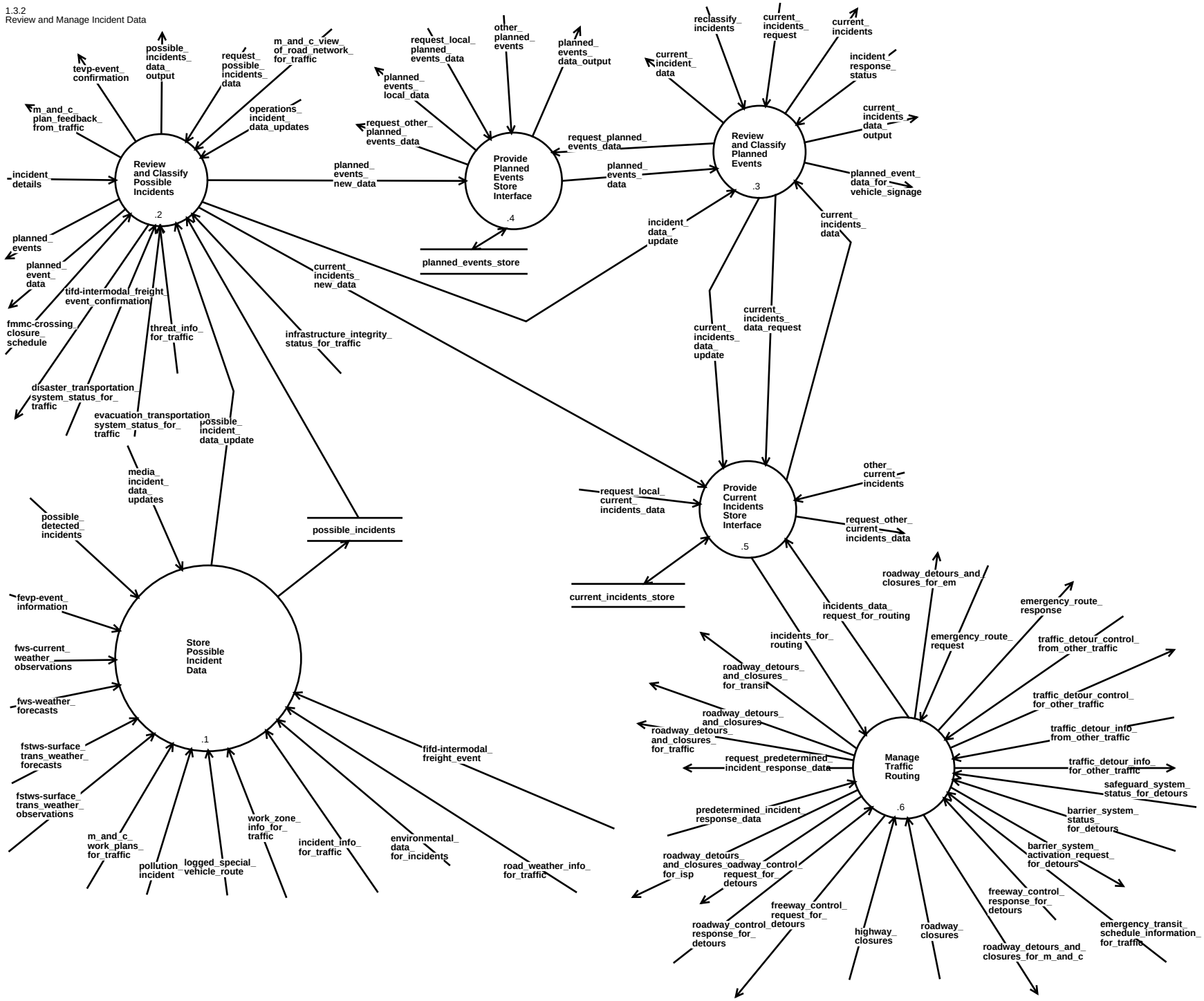
Manage Incidents



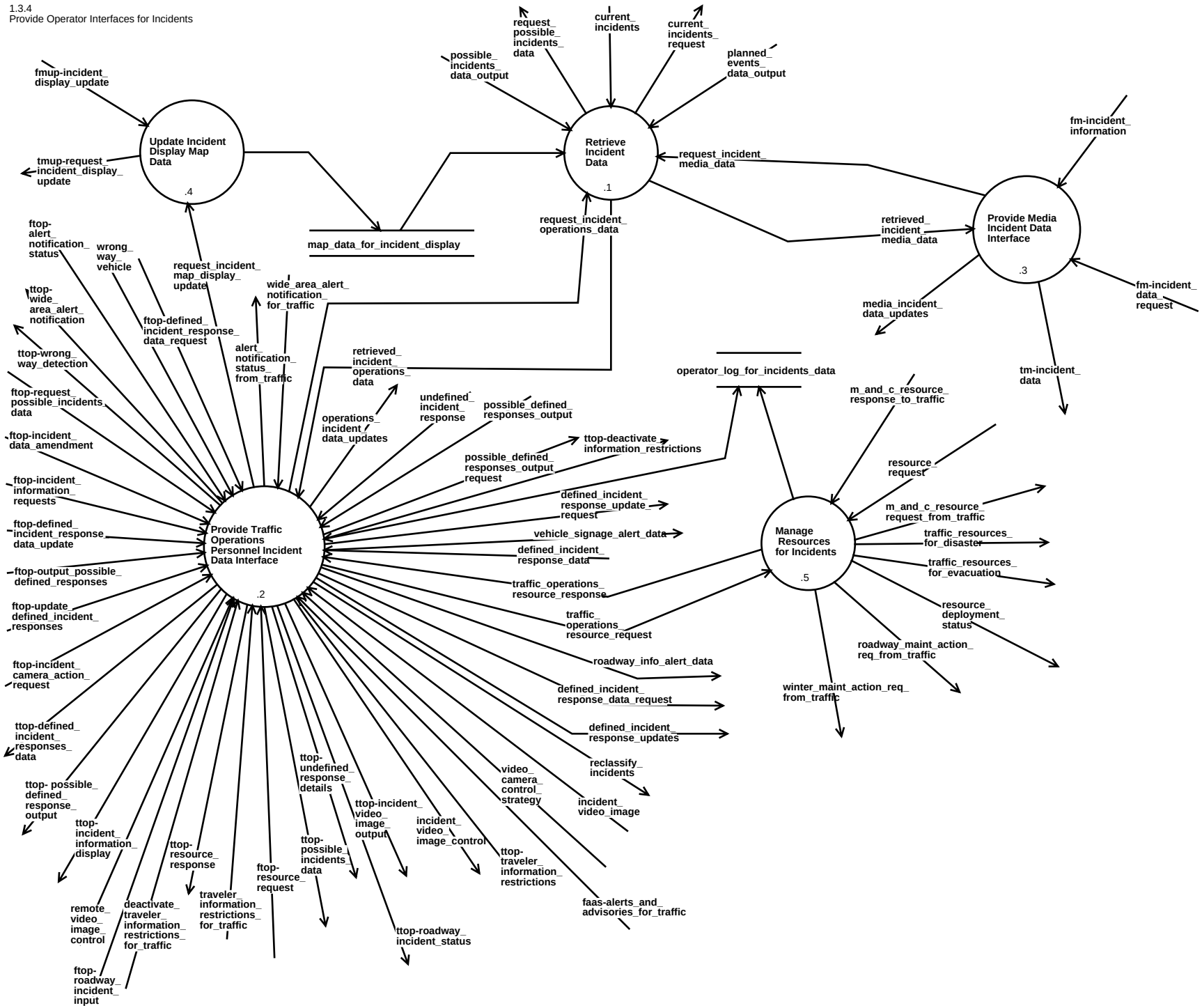
1.3.1
Traffic Data Analysis for Incidents

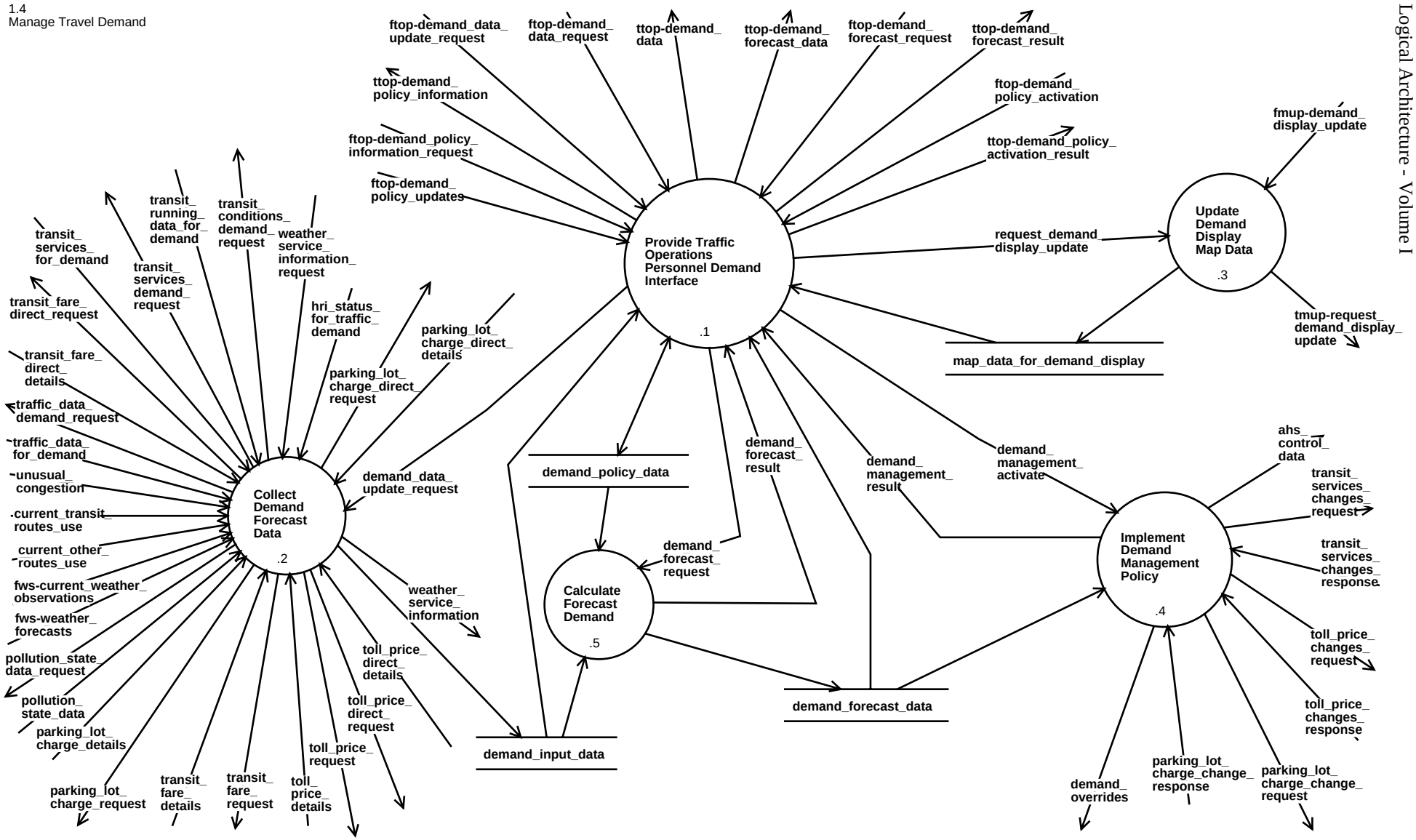


Review and Manage Incident Data



Provide Operator Interfaces for Incidents




1.4
Manage Travel Demand
Provide Traffic Operations Personnel Demand Interface
.1
Collect Demand Forecast Data
.2
Calculate Forecast Demand
.5
Update Demand Display Map Data
.3
Implement Demand Management Policy
.4
ftop-demand_data_update_request
ftop-demand_data_request
ttop-demand_data
ttop-demand_forecast_data
ftop-demand_forecast_request
ttop-demand_forecast_result
ttop-demand_policy_information
ftop-demand_policy_activation
ftop-demand_policy_information_request
ttop-demand_policy_activation_result
ftop-demand_policy_updates
fmup-demand_display_update
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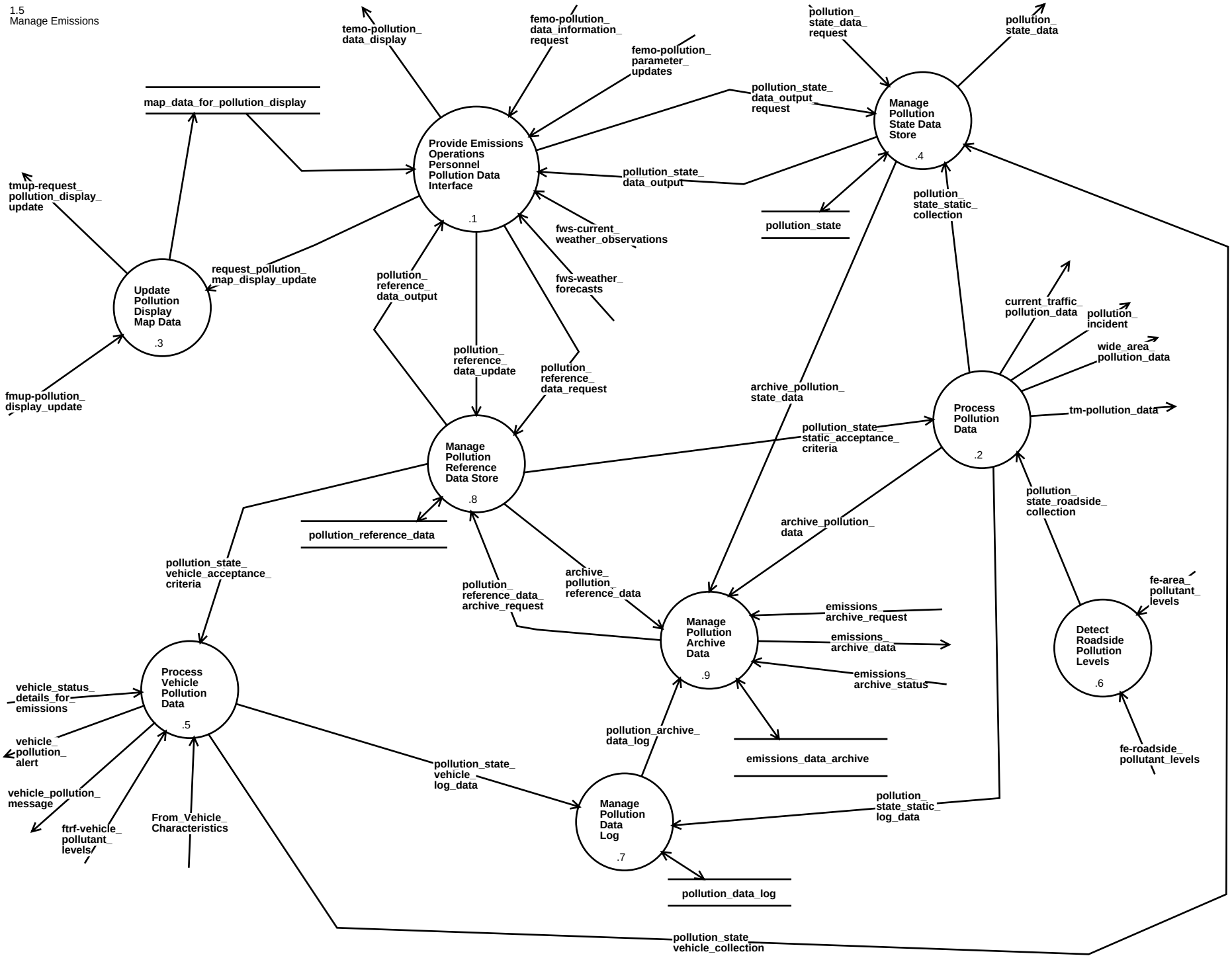
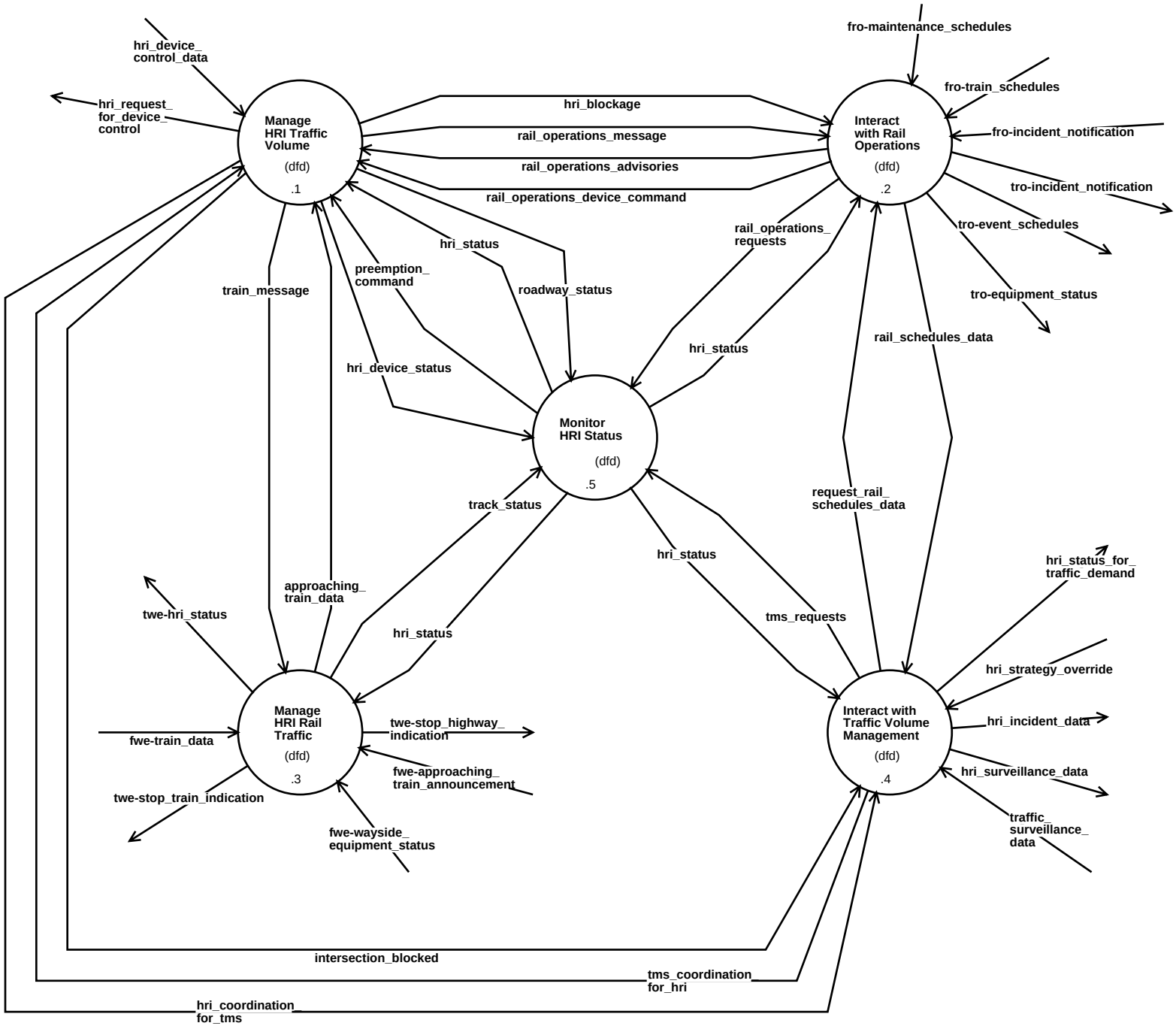
tmup-request_demand_display_update
map_data_for_demand_display
demand_policy_data
demand_forecast_result
demand_management_result
demand_management_activate
demand_forecast_request
demand_forecast_data
demand_input_data
demand_data_update_request
weather_service_information
toll_price_direct_details
toll_price_direct_request
toll_price_request
toll_price_details
transit_fare_details
transit_fare_request
parking_lot_charge_request
parking_lot_charge_details
pollution_state_data
pollution_state_data_request
fws-weather_forecasts
fws-current_weather_observations
current_other_routes_use
current_transit_routes_use
unusual_congestion
traffic_data_for_demand
traffic_data_demand_request
transit_fare_direct_details
transit_fare_direct_request
transit_services_for_demand
transit_services_demand_request
transit_running_data_for_demand
transit_conditions_demand_request
weather_service_information_request
hri_status_for_traffic_demand
parking_lot_charge_direct_request
parking_lot_charge_direct_details
ahs_control_data
transit_services_changes_request
transit_services_changes_response
toll_price_changes_request
toll_price_changes_response
parking_lot_charge_change_request
parking_lot_charge_change_response
demand_overrides

Manage Emissions

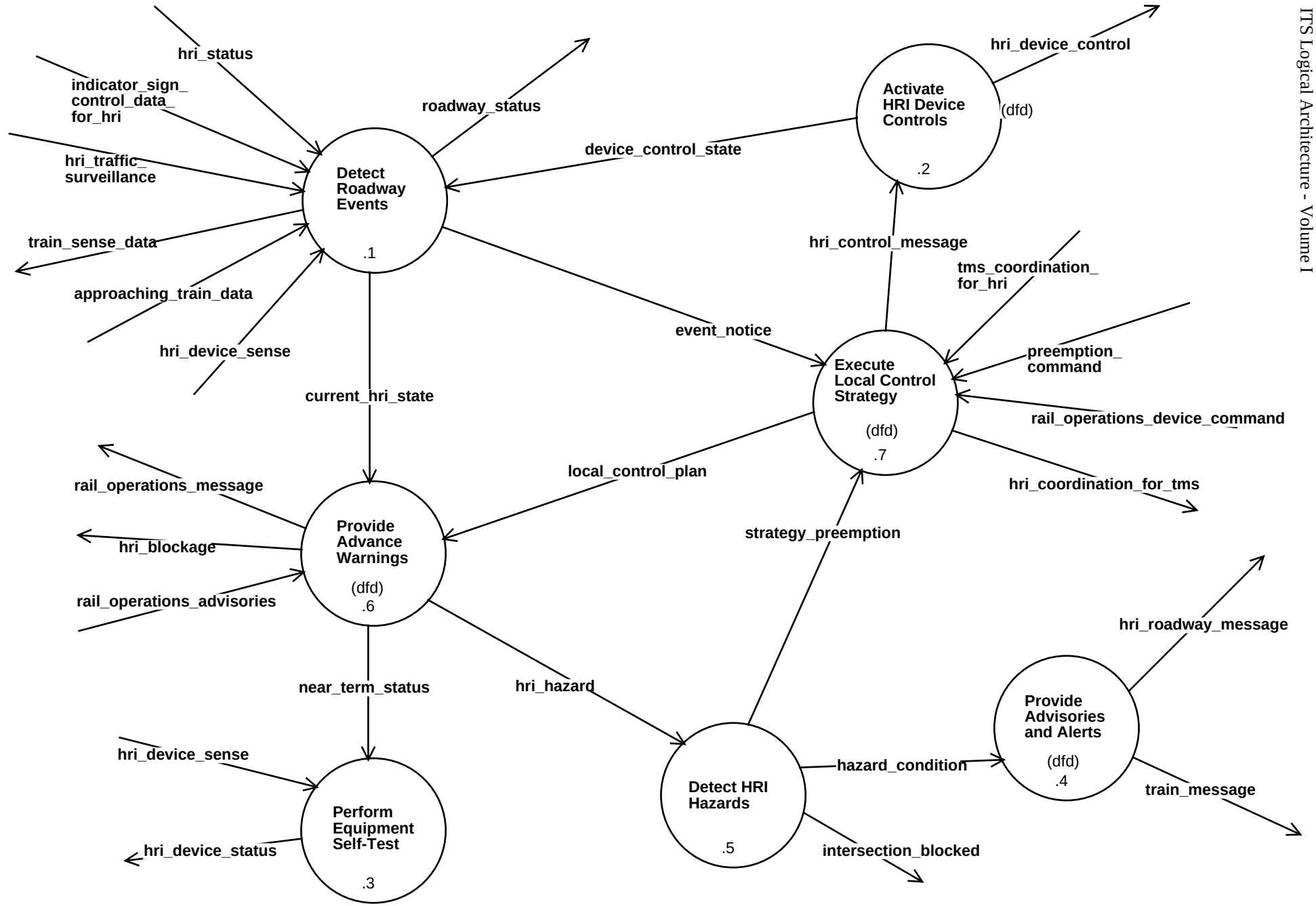


Manage Highway Rail Intersections

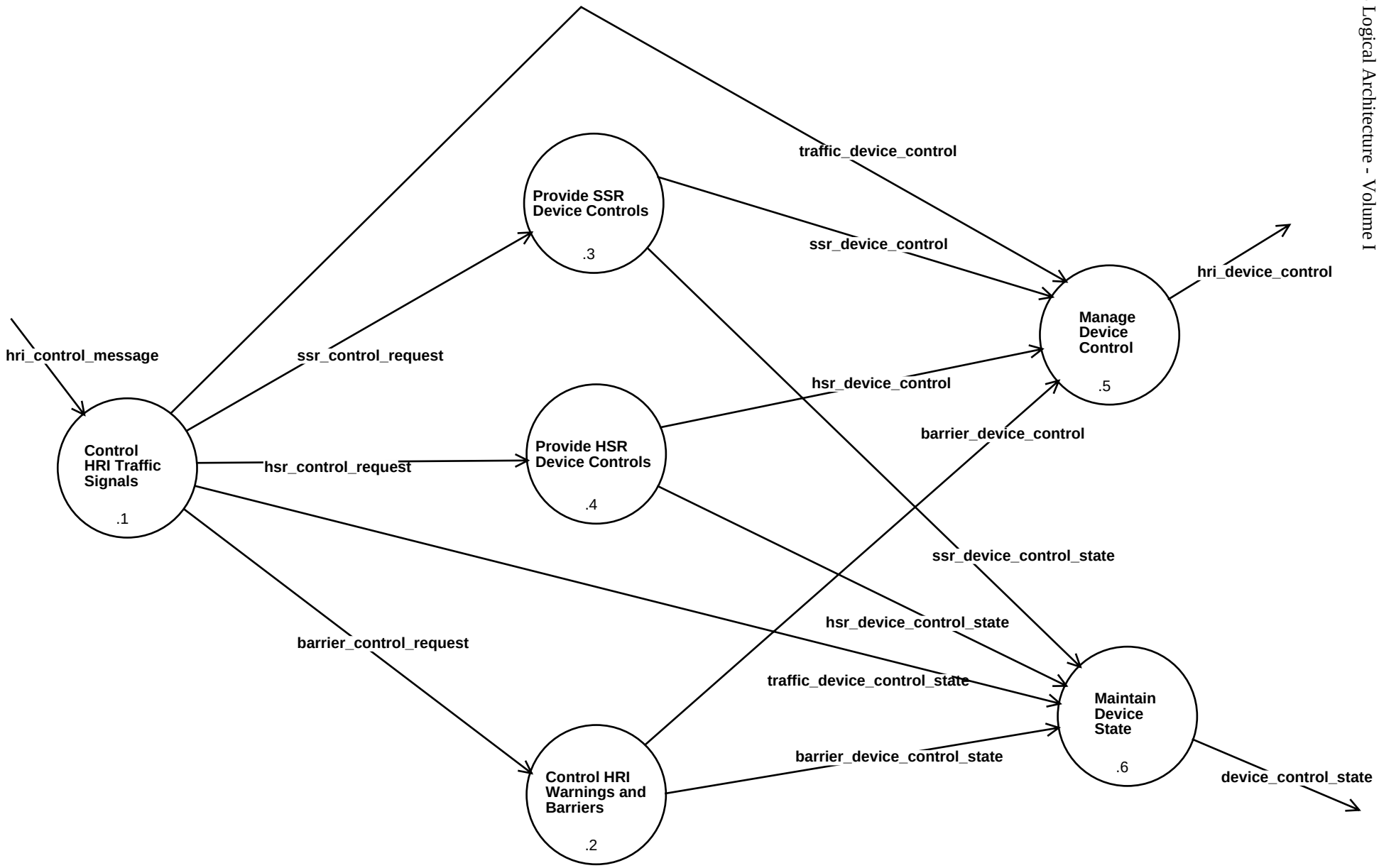
1.6
Manage Highway Rail Intersections



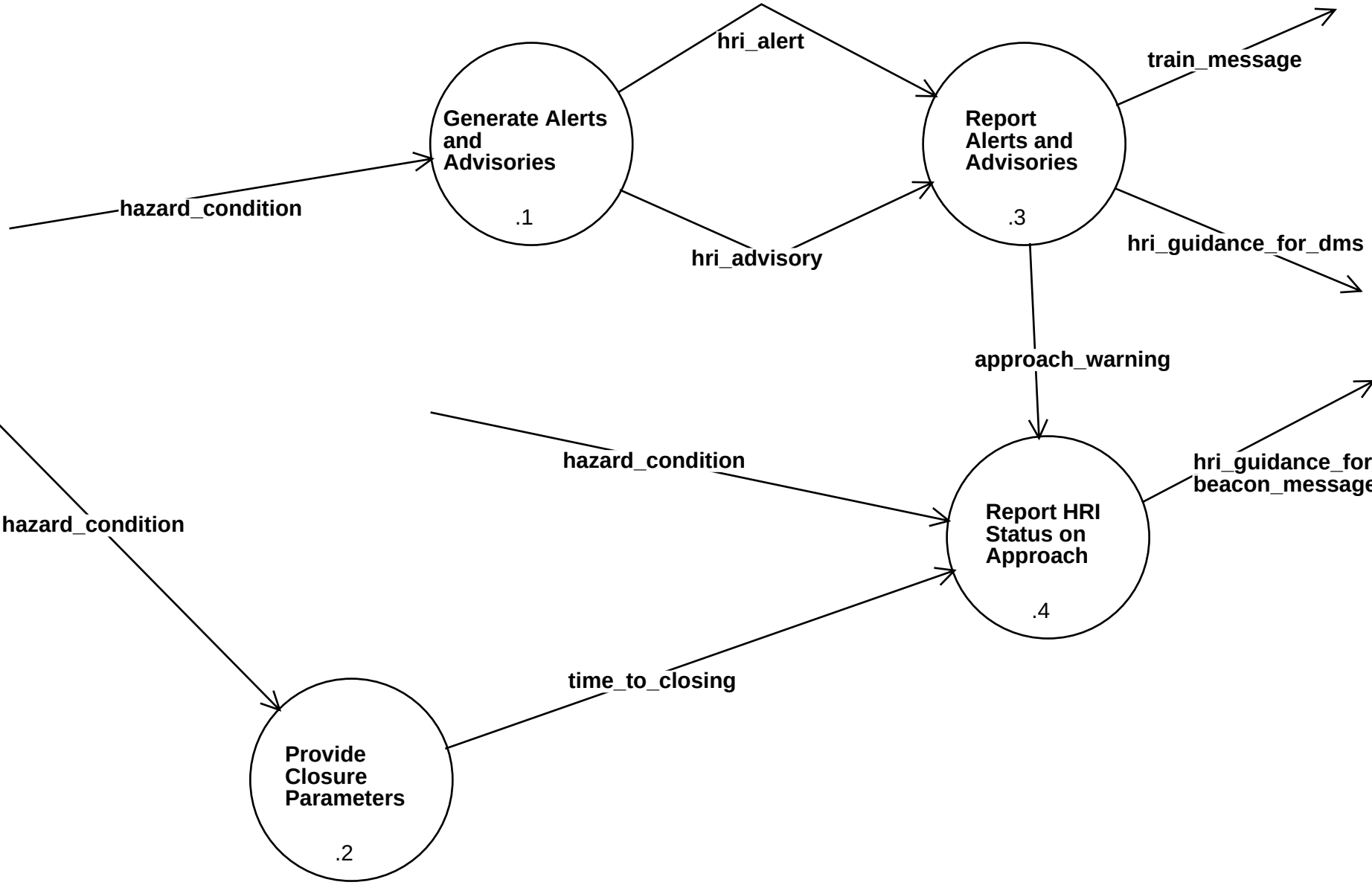
1.6.1
Manage HRI Traffic Volume



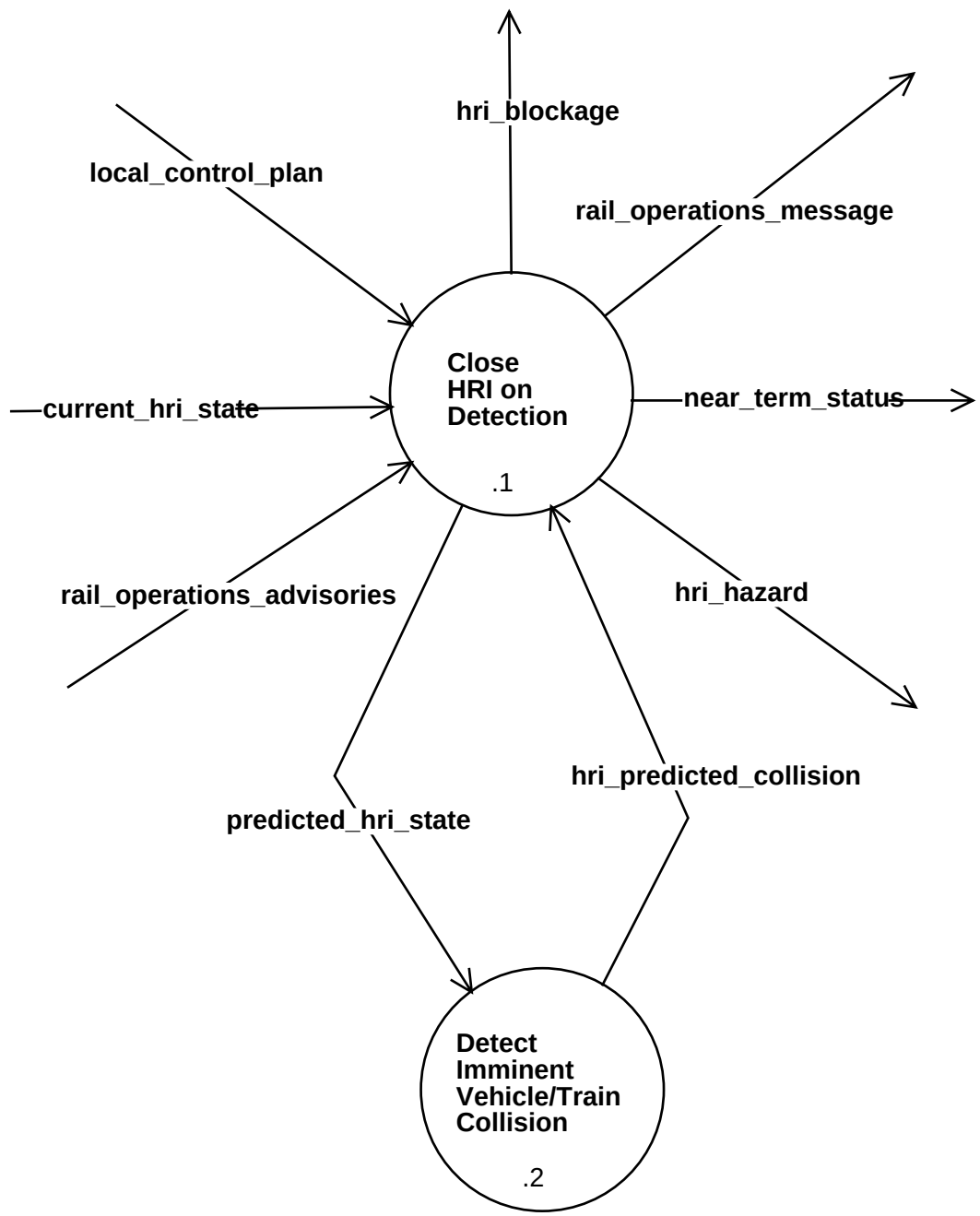
1.6.1.2
Activate HRI Device Controls



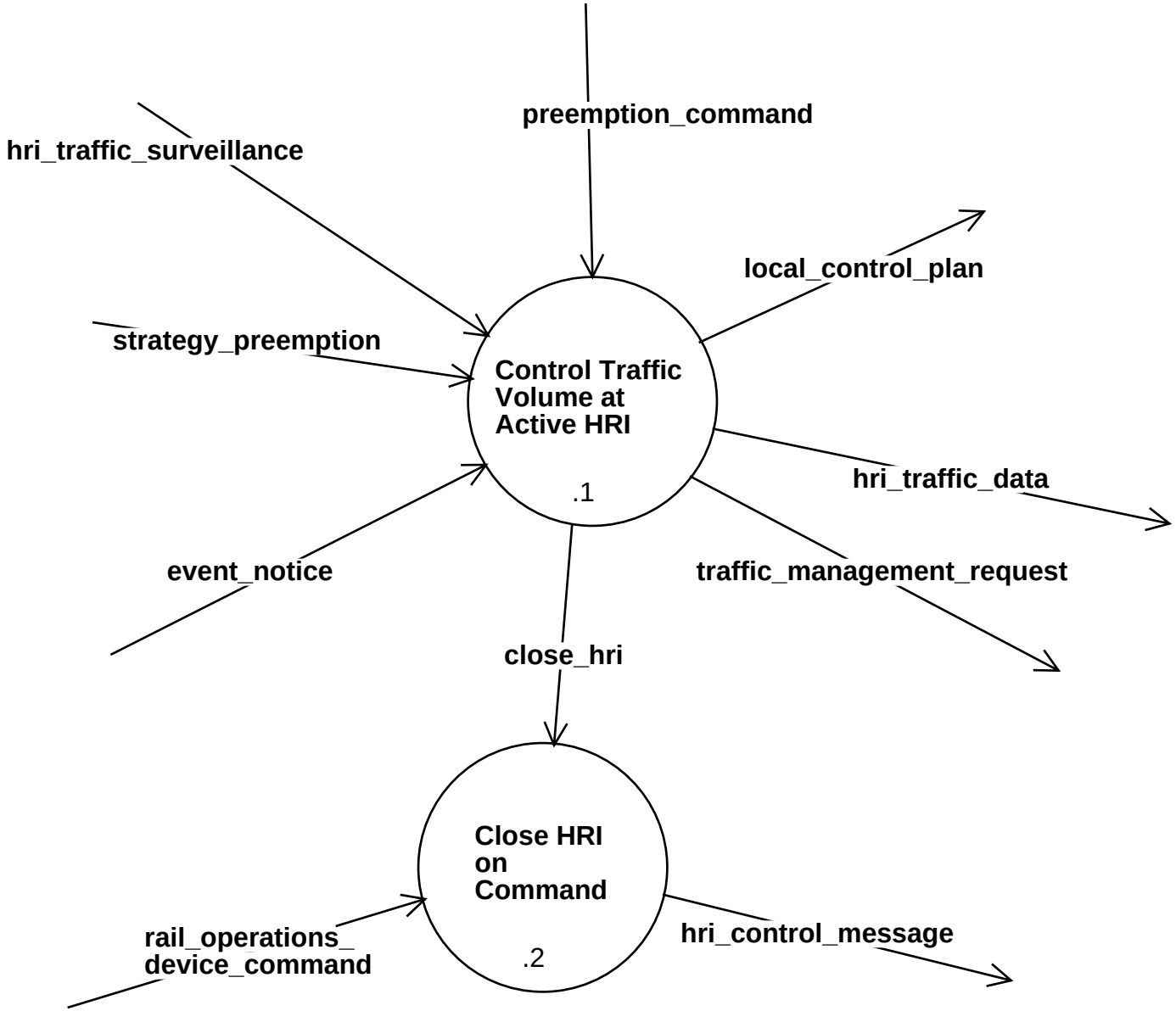
1.6.1.4
Provide Advisories and Alerts



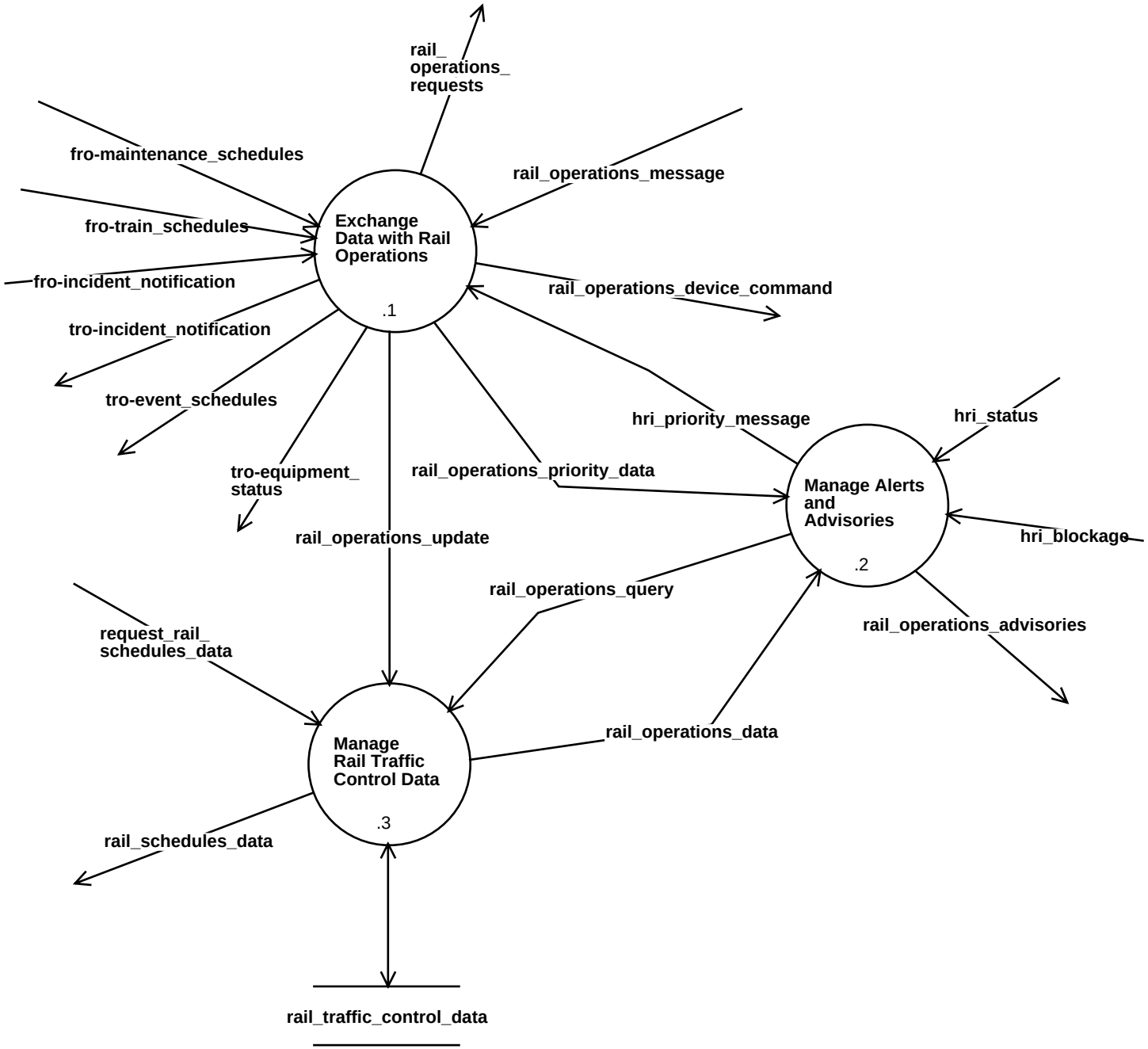
1.6.1.6
Provide Advance Warnings



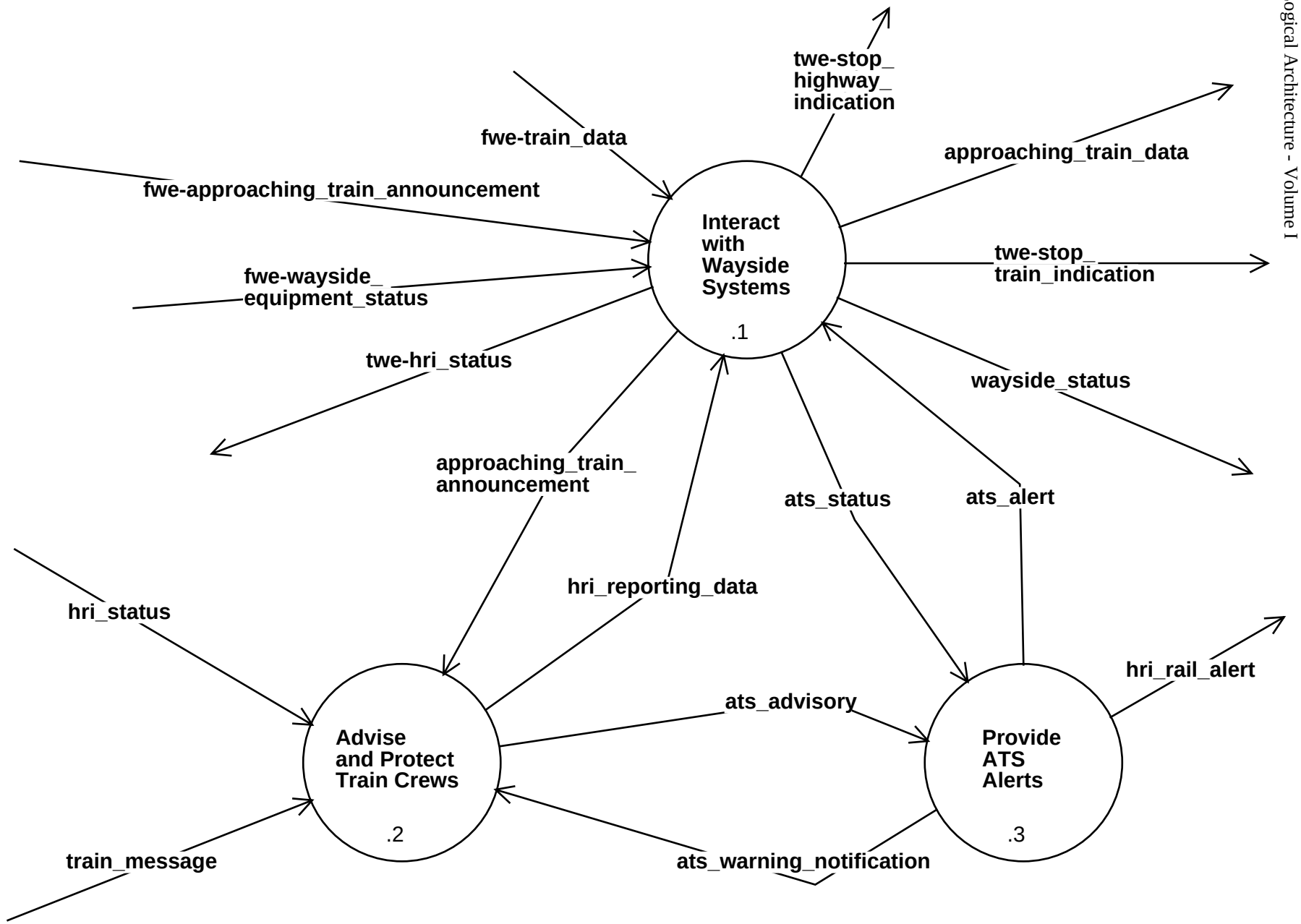
1.6.1.7
Execute Local Control Strategy



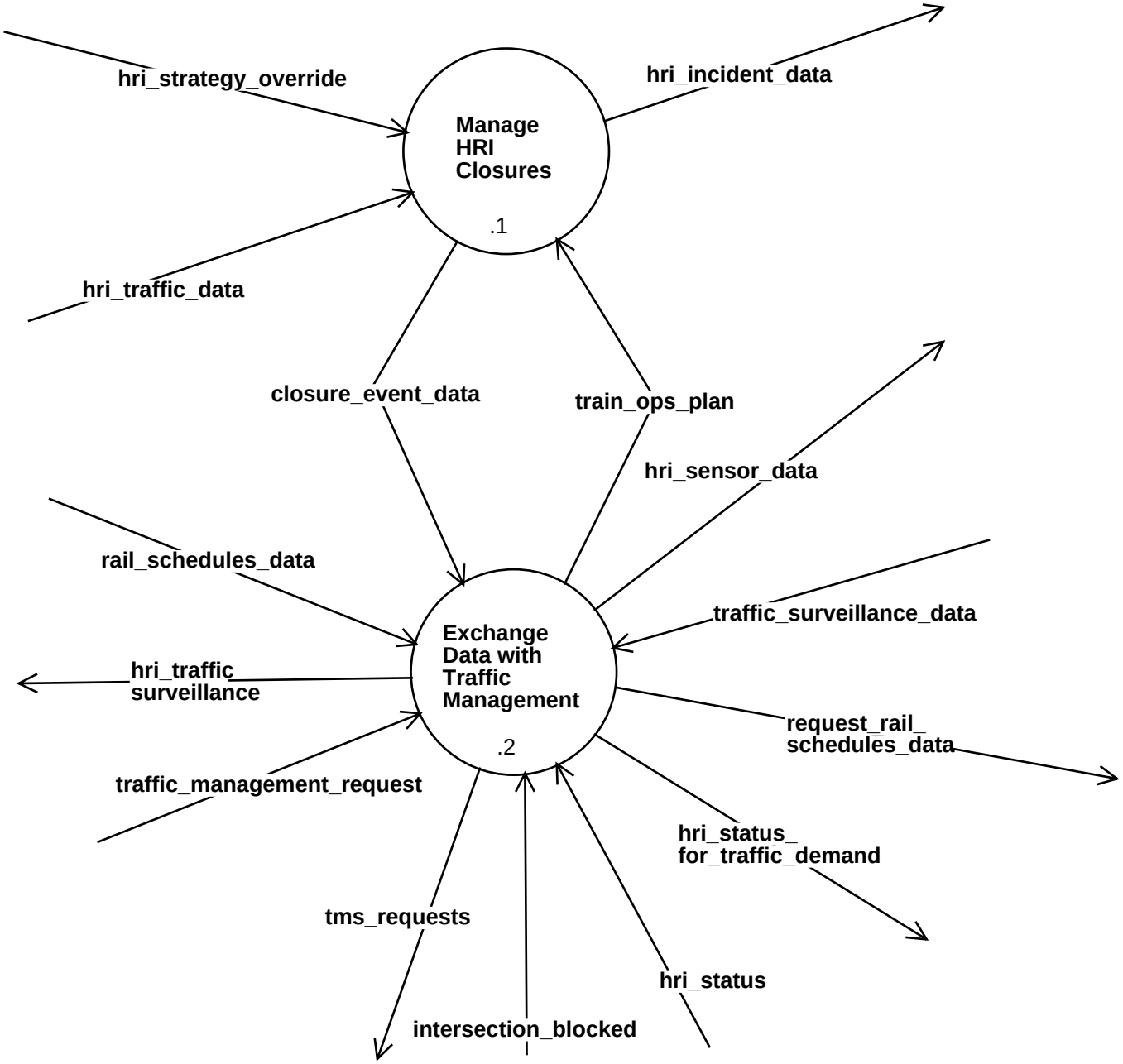
1.6.2
Interact with Rail Operations



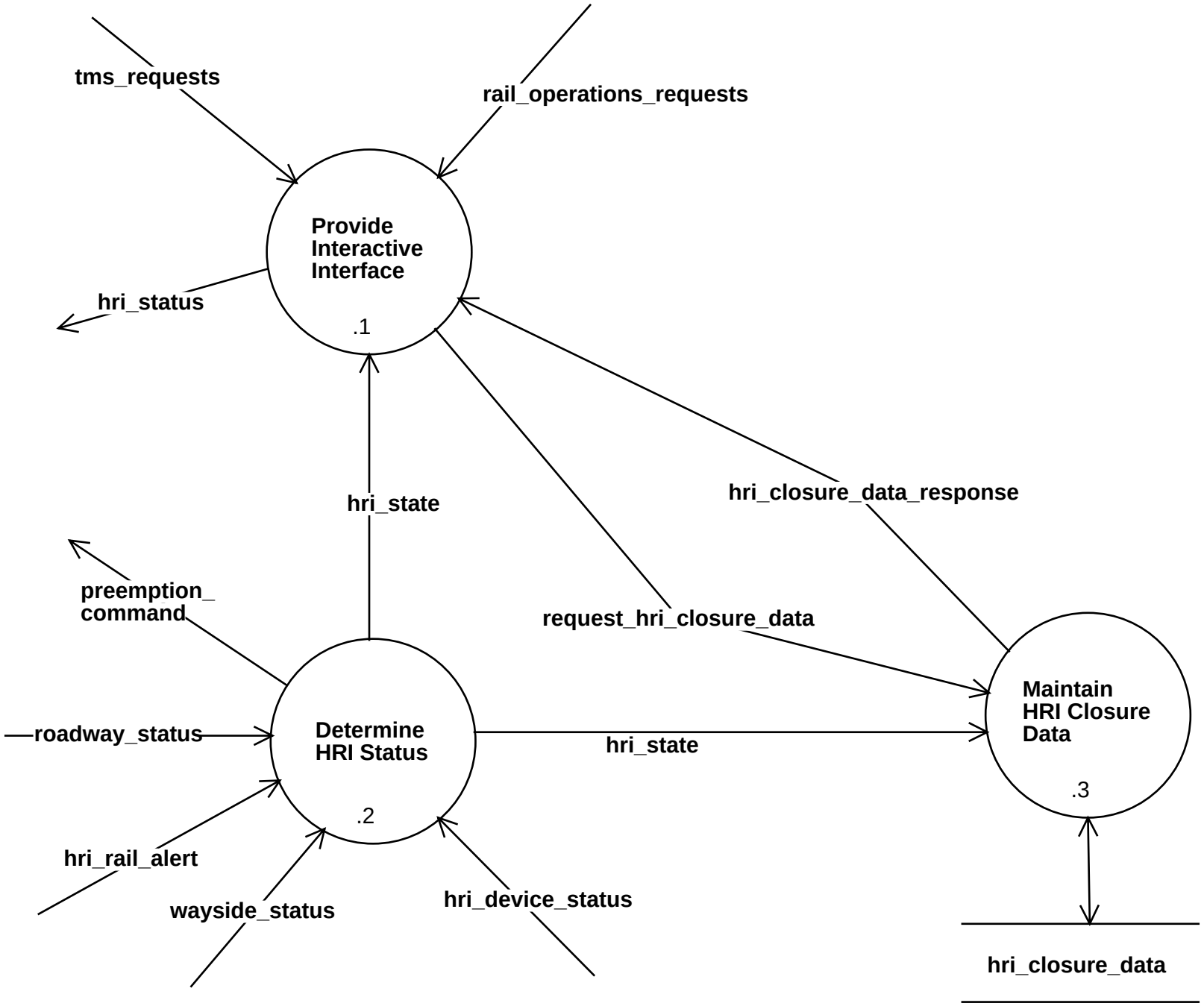
1.6.3
Manage HRI Rail Traffic



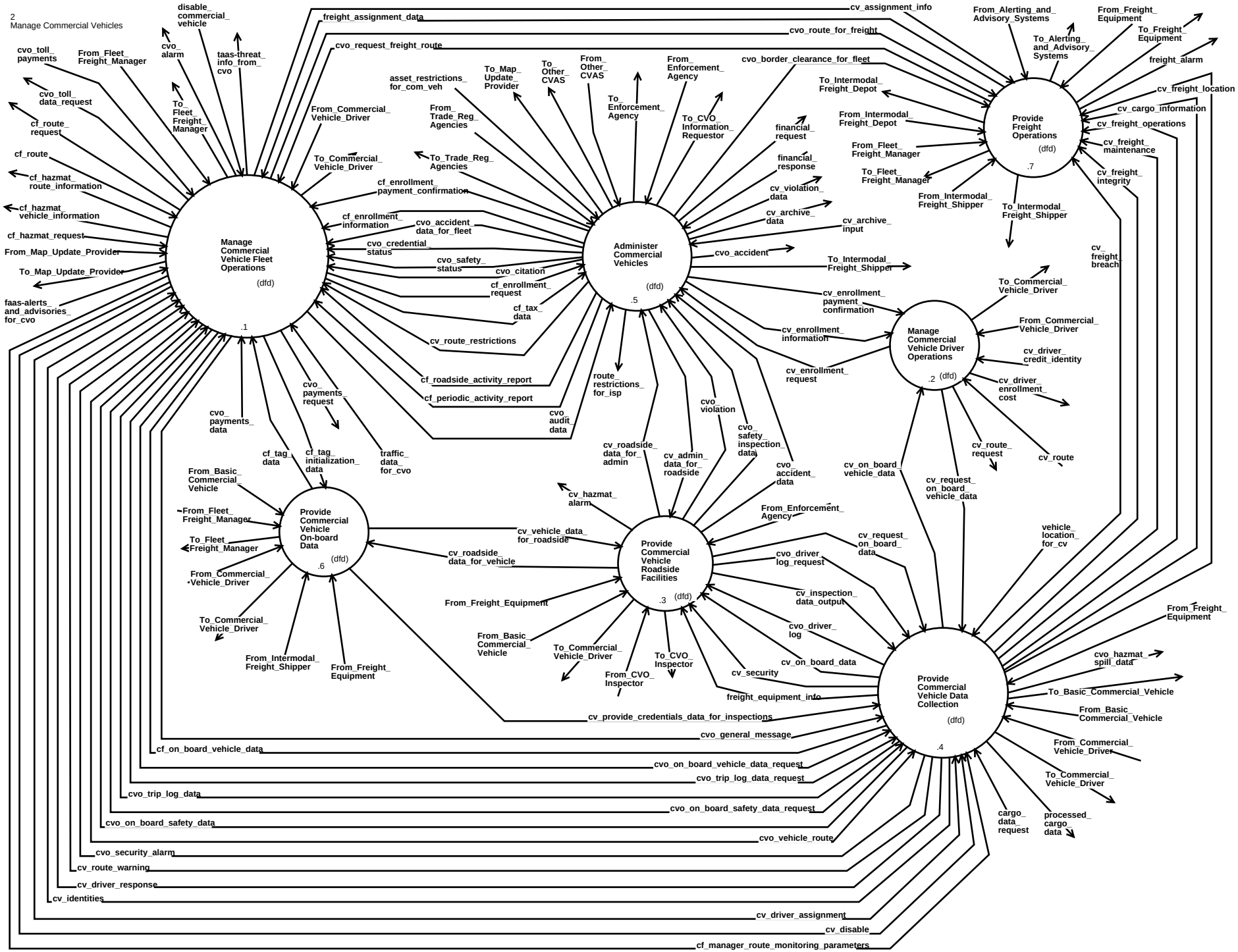
1.6.4
Interact with Traffic Volume Management



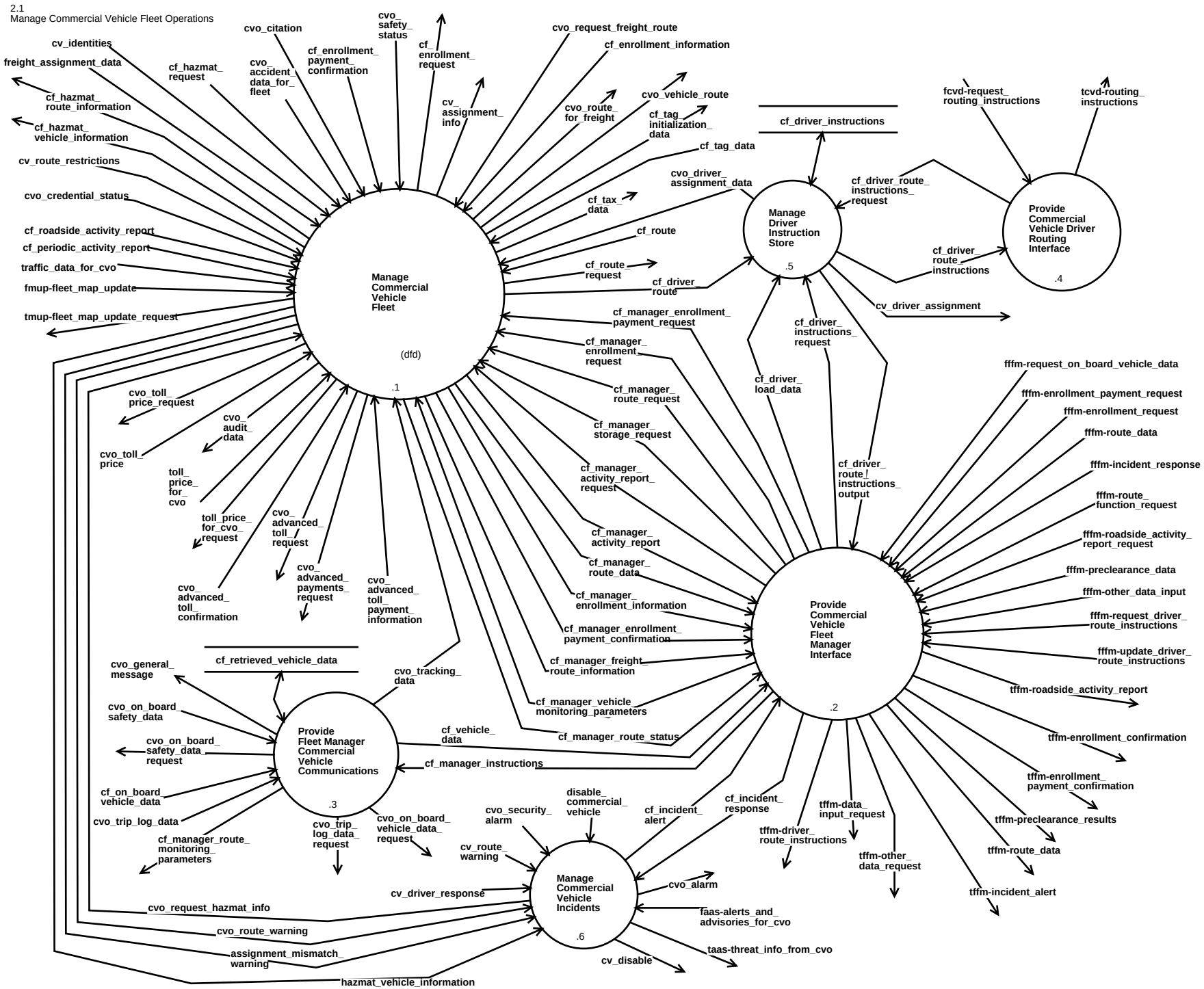
1.6.5
Monitor HRI Status



Manage Commercial Vehicles

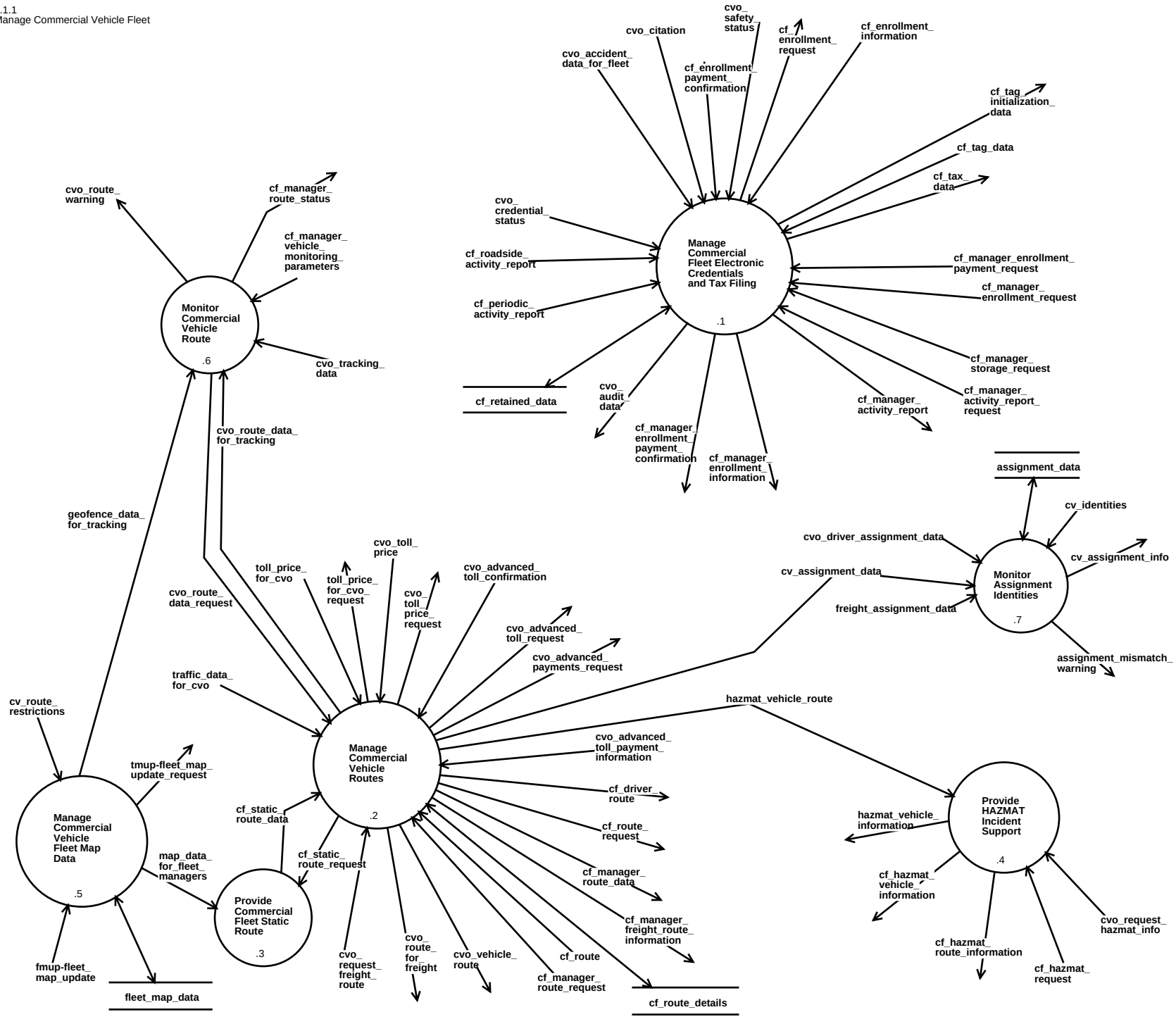


Manage Commercial Vehicle Fleet Operations

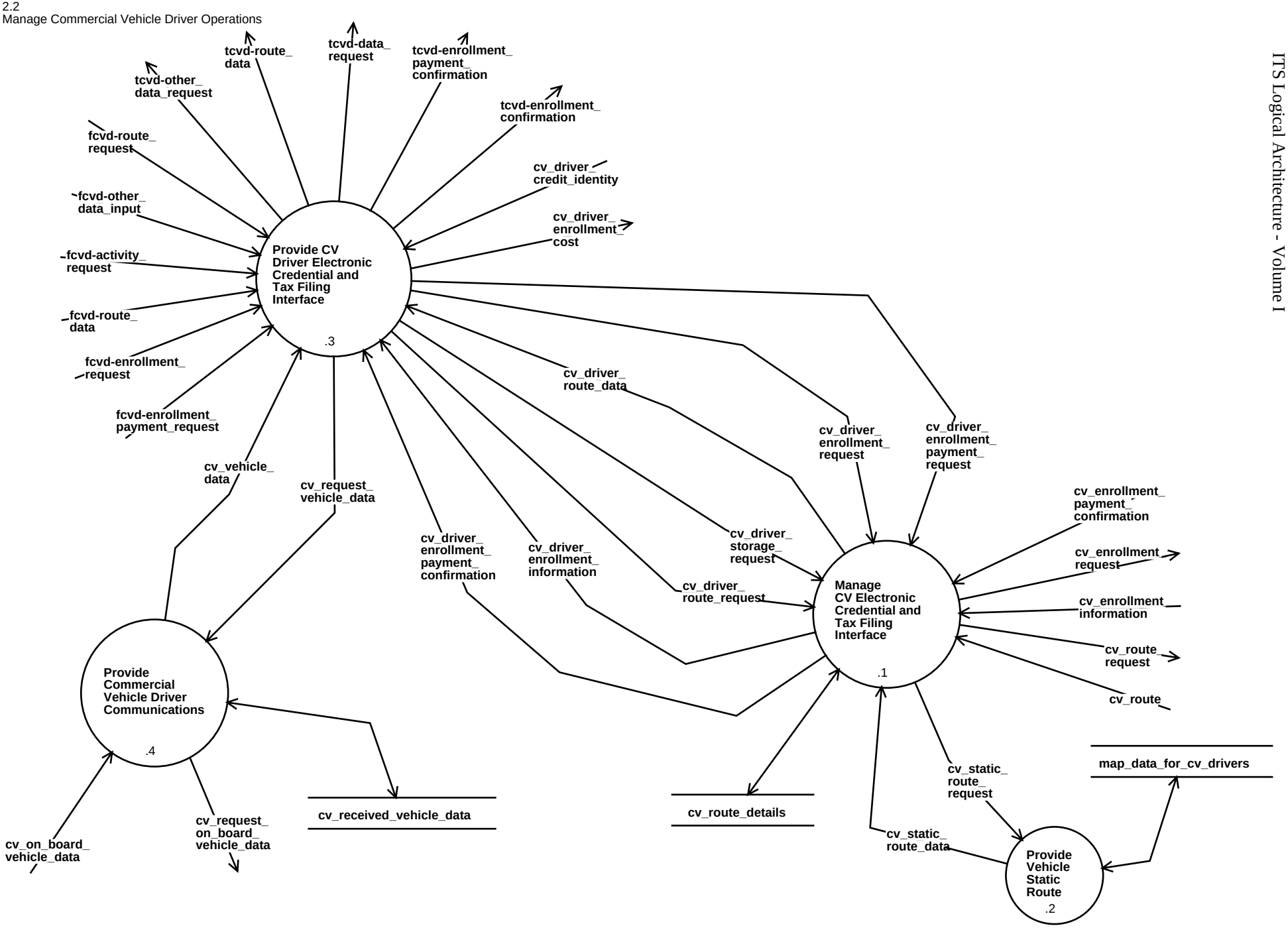


Manage Commercial Vehicle Fleet

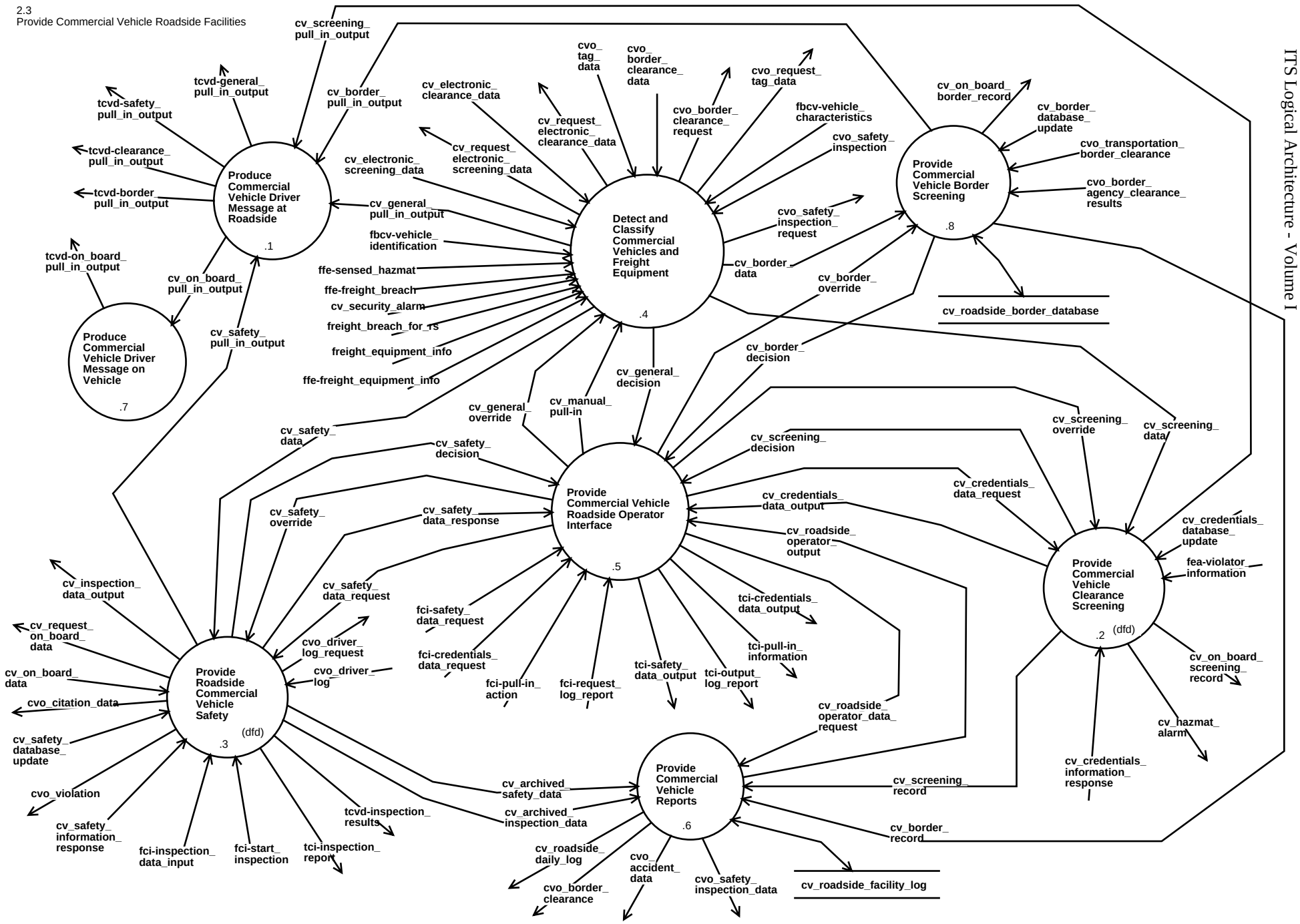
2.1.1
Manage Commercial Vehicle Fleet



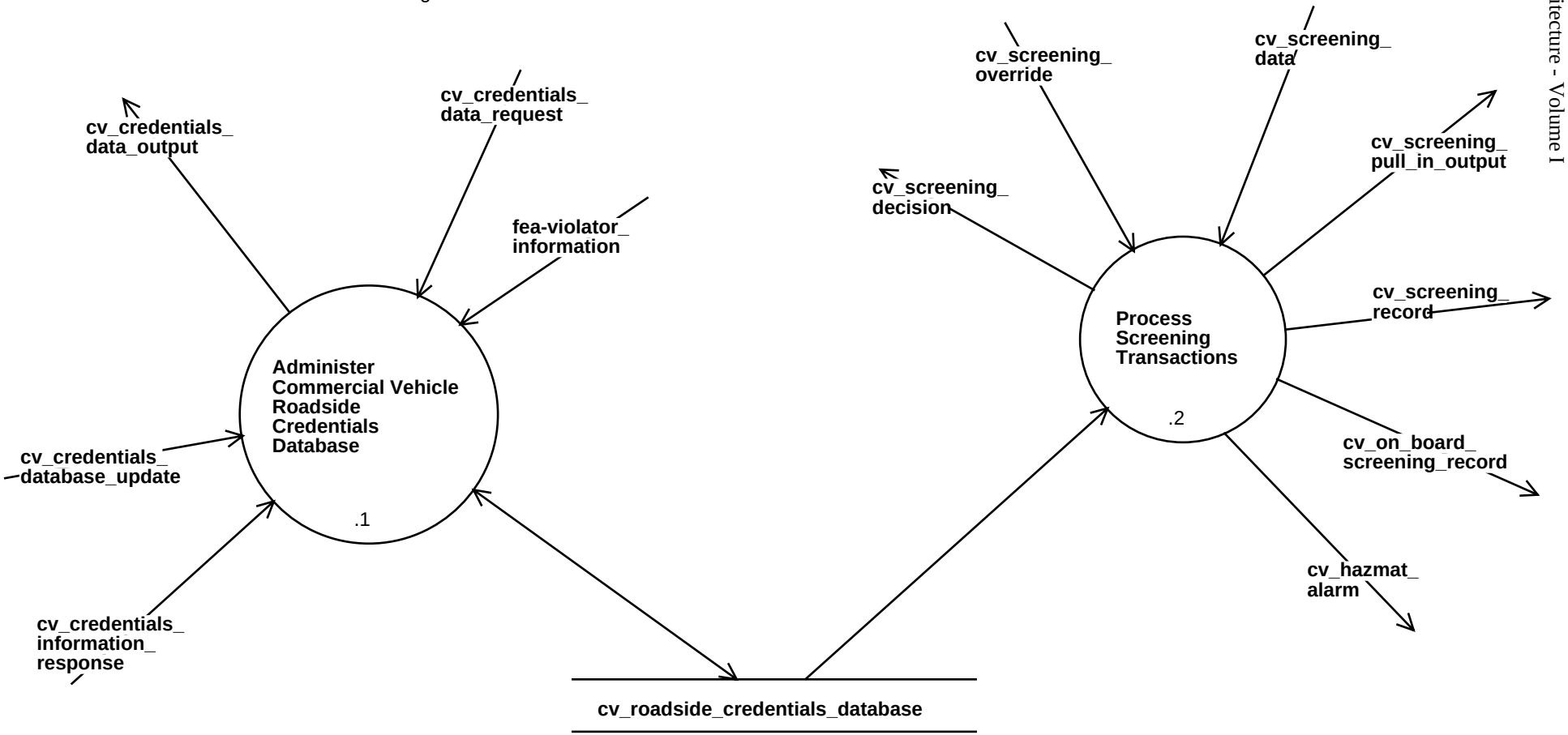
2.2
Manage Commercial Vehicle Driver Operations



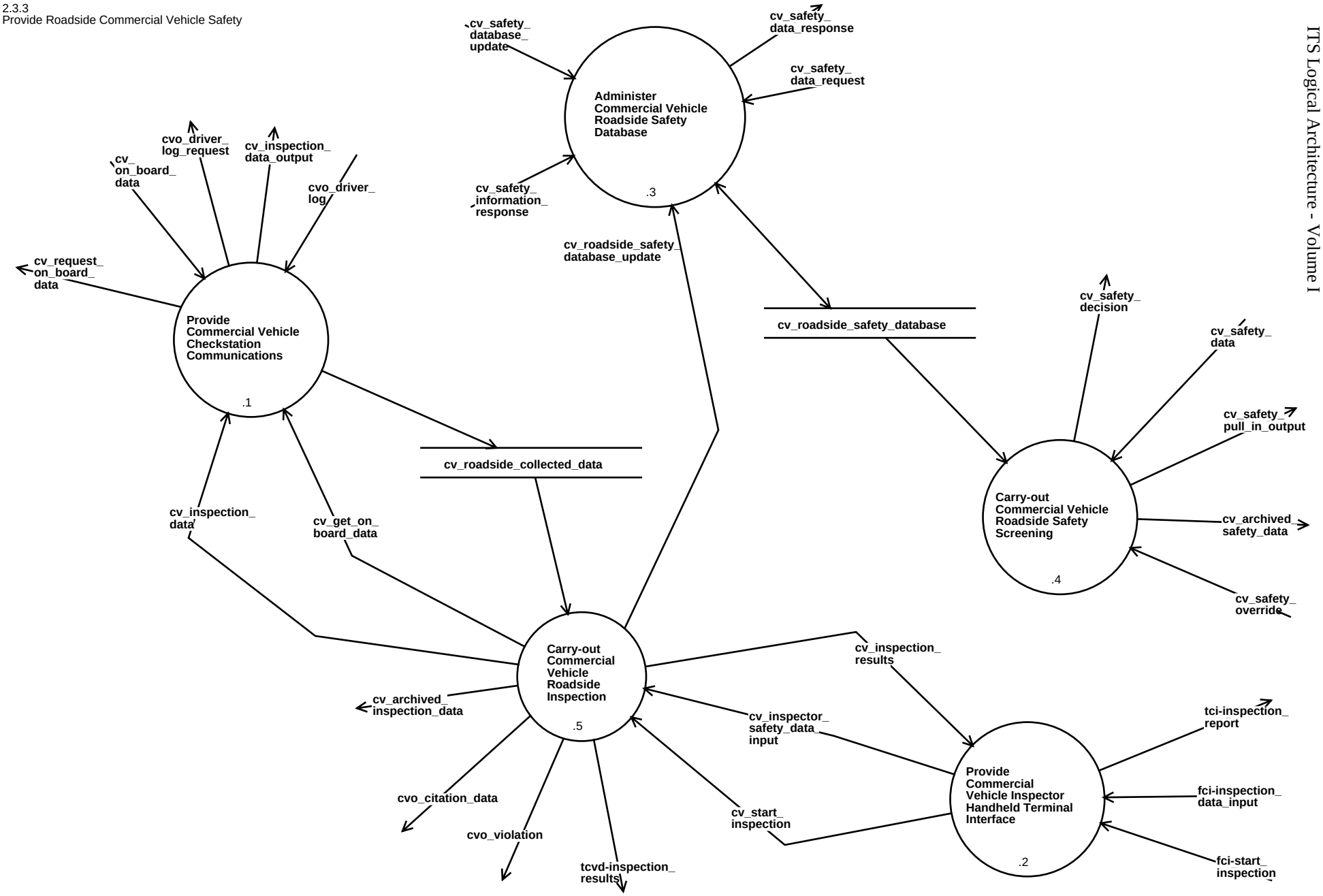
Provide Commercial Vehicle Roadside Facilities

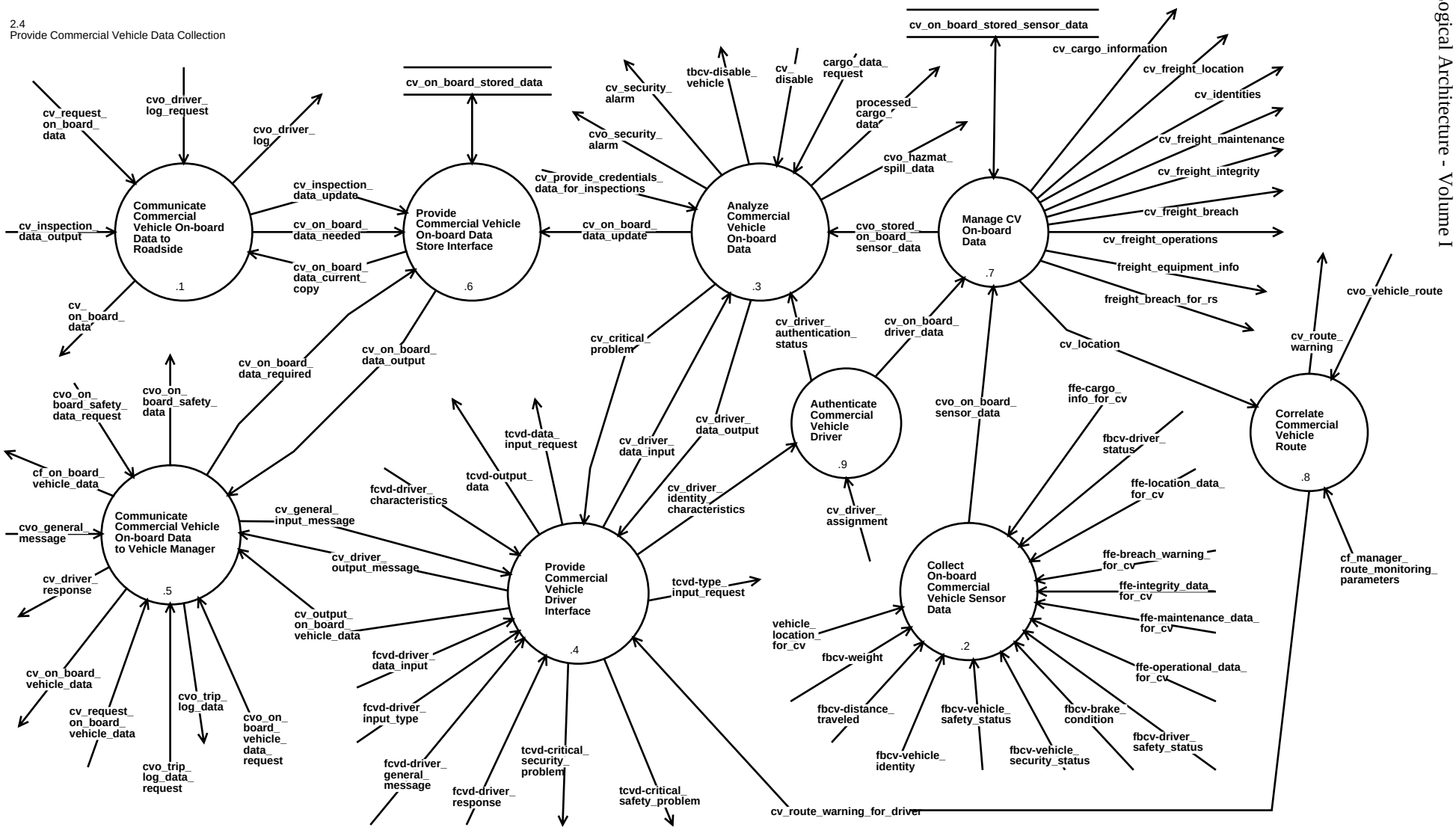


2.3.2
Provide Commercial Vehicle Clearance Screening

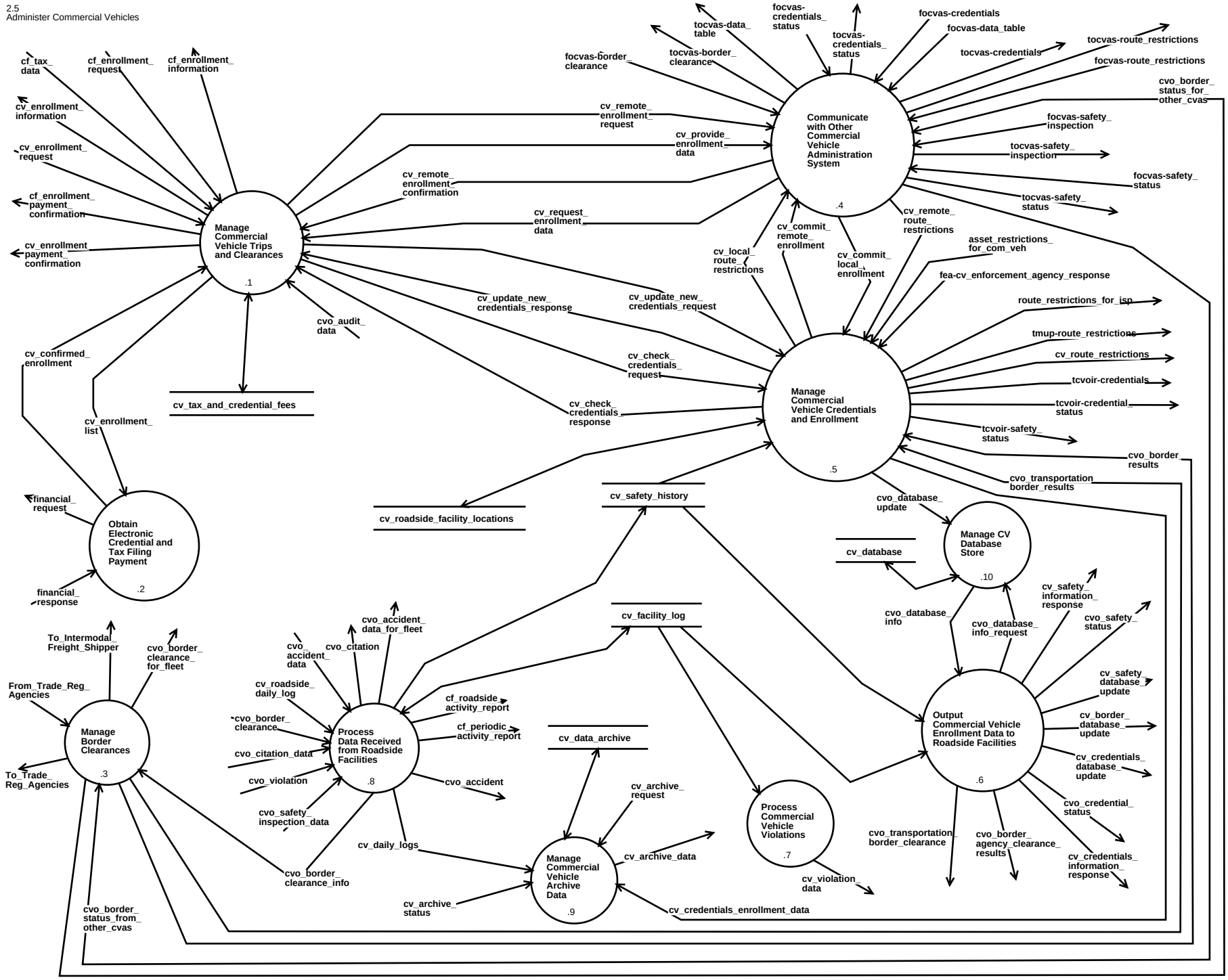


2.3.3
Provide Roadside Commercial Vehicle Safety

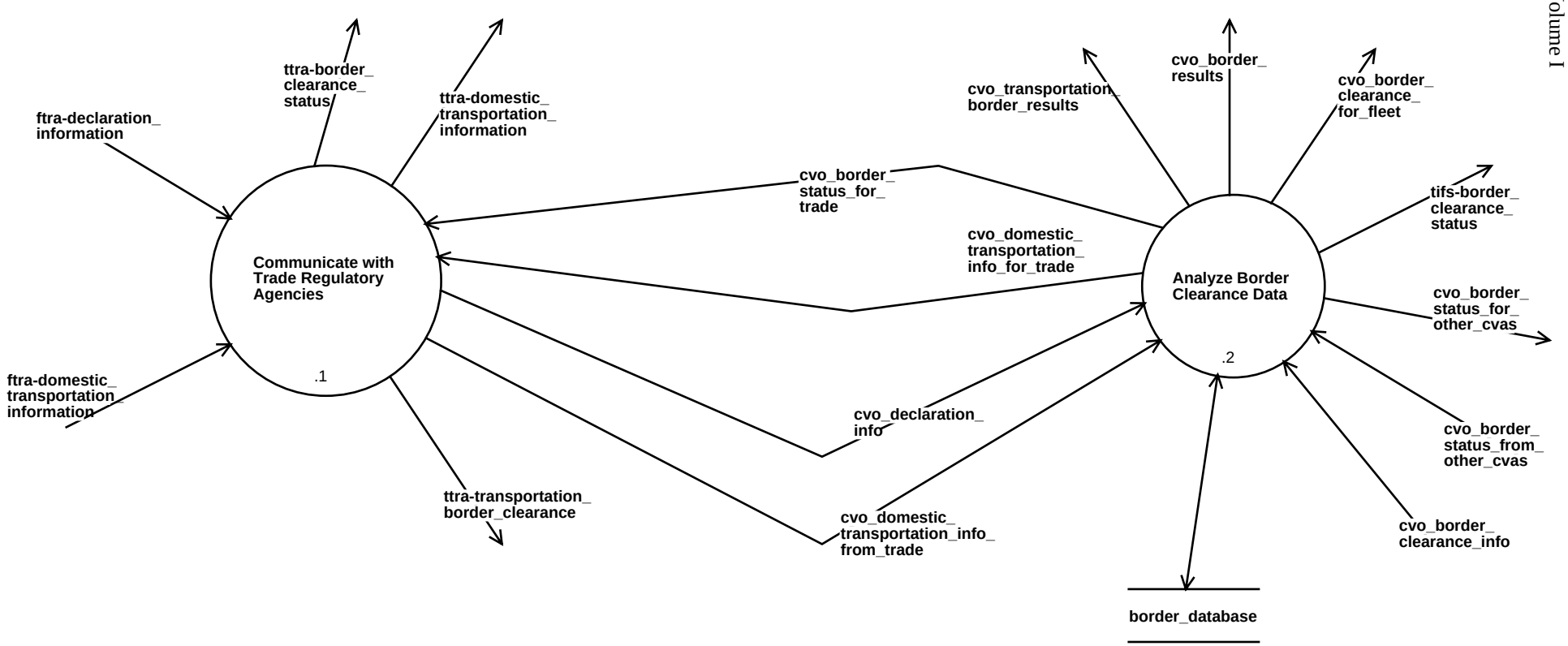



2.4
Provide Commercial Vehicle Data Collection
Communicate Commercial Vehicle On-board Data to Roadside
.1
Provide Commercial Vehicle On-board Data Store Interface
.6
Analyze Commercial Vehicle On-board Data
.3
Manage CV On-board Data
.7
Communicate Commercial Vehicle On-board Data to Vehicle Manager
.5
Provide Commercial Vehicle Driver Interface
.4
Authenticate Commercial Vehicle Driver
.9
Collect On-board Commercial Vehicle Sensor Data
.2
Correlate Commercial Vehicle Route
.8
cv_on_board_stored_data
cv_on_board_stored_sensor_data
cv_request_on_board_data
cvo_driver_log_request
cvo_driver_log
cv_inspection_data_update
cv_on_board_data_needed
cv_on_board_data_current_copy
cv_inspection_data_output
cv_on_board_data
cvo_security_alarm
cv_security_alarm
tbcv-disable_vehicle
cv_disable
cargo_data_request
processed_cargo_data
cvo_hazmat_spill_data
cv_provide_credentials_data_for_inspections
cv_on_board_data_update
cvo_stored_on_board_sensor_data
cv_cargo_information
cv_freight_location
cv_identities
cv_freight_maintenance
cv_freight_integrity
cv_freight_breach
cv_freight_operations
freight_equipment_info
freight_breach_for_rs
cvo_vehicle_route
cv_route_warning
cv_location
cv_on_board_data_required
cv_on_board_data_output
cvo_on_board_safety_data_request
cvo_on_board_safety_data
cf_on_board_vehicle_data
cvo_general_message
cv_driver_response
cv_on_board_vehicle_data
cv_request_on_board_vehicle_data
cvo_trip_log_data_request
cvo_trip_log_data
cvo_on_board_vehicle_data_request
cv_general_input_message
cv_driver_output_message
cv_output_on_board_vehicle_data
tcvd-data_input_request
tcvd-output_data
fcvd-driver_characteristics
fcvd-driver_data_input
fcvd-driver_input_type
fcvd-driver_general_message
fcvd-driver_response
tcvd-critical_security_problem
tcvd-critical_safety_problem
tcvd-type_input_request
cv_critical_problem
cv_driver_data_input
cv_driver_data_output
cv_driver_identity_characteristics
cv_driver_authentication_status
cv_on_board_driver_data
cv_driver_assignment
cvo_on_board_sensor_data
ffe-cargo_info_for_cv
fbcv-driver_status
ffe-location_data_for_cv
ffe-breach_warning_for_cv
ffe-integrity_data_for_cv
ffe-maintenance_data_for_cv
ffe-operational_data_for_cv
vehicle_location_for_cv
fbcv-weight
fbcv-distance_traveled
fbcv-vehicle_identity
fbcv-vehicle_safety_status
fbcv-vehicle_security_status
fbcv-brake_condition
fbcv-driver_safety_status
cv_route_warning_for_driver
cf_manager_route_monitoring_parameters

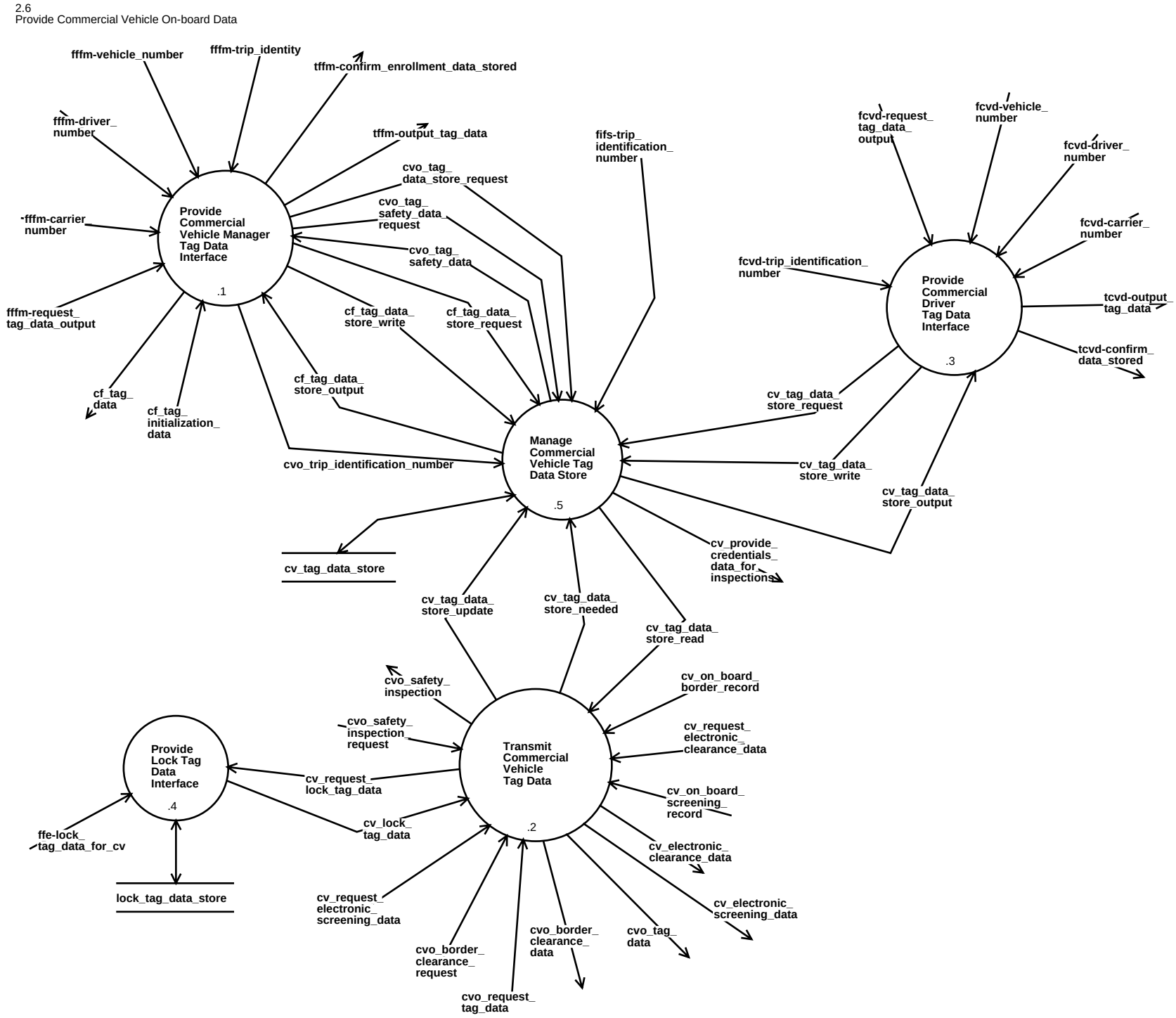
Administer Commercial Vehicles



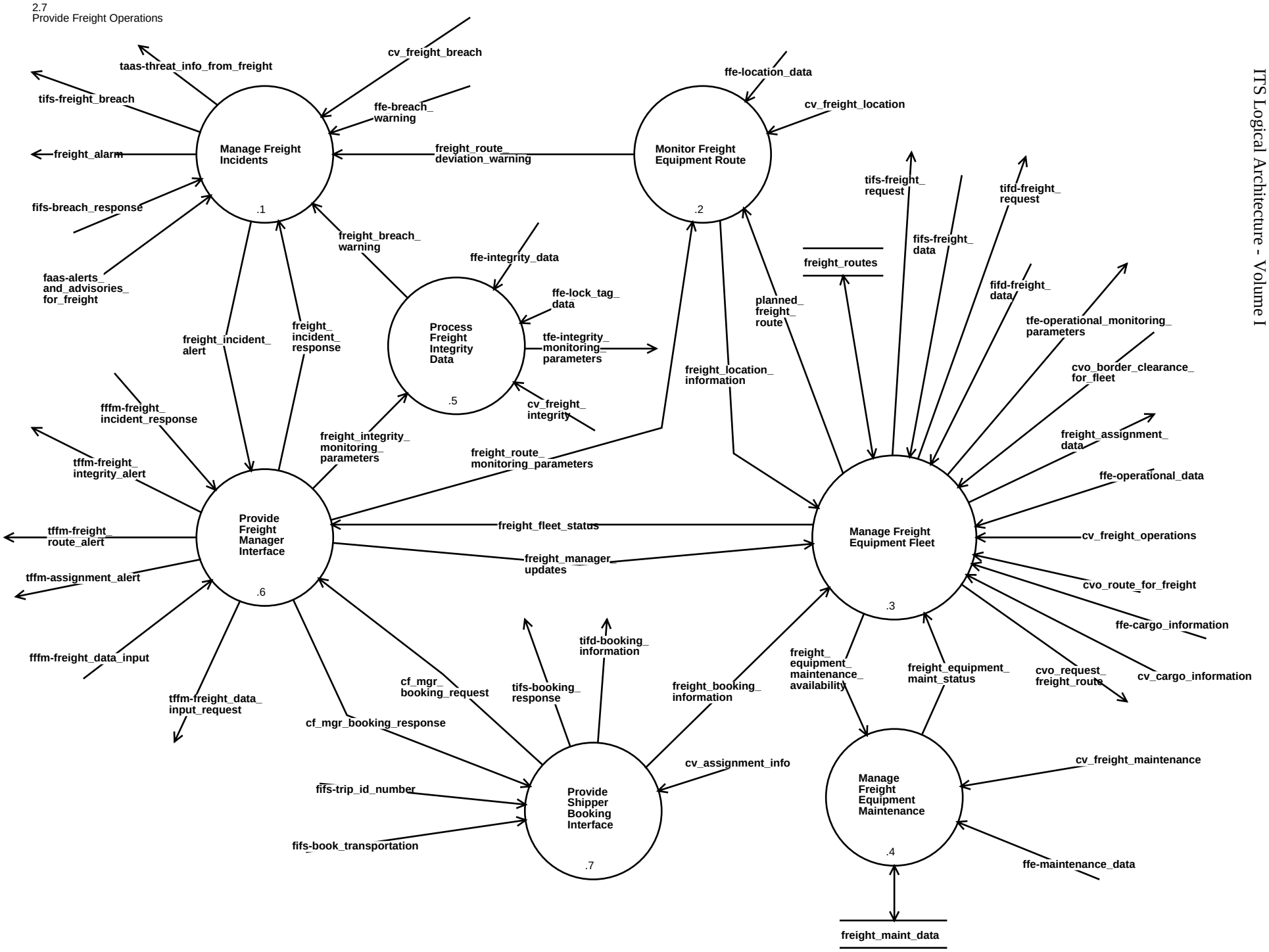
2.5.3
Manage Border Clearances



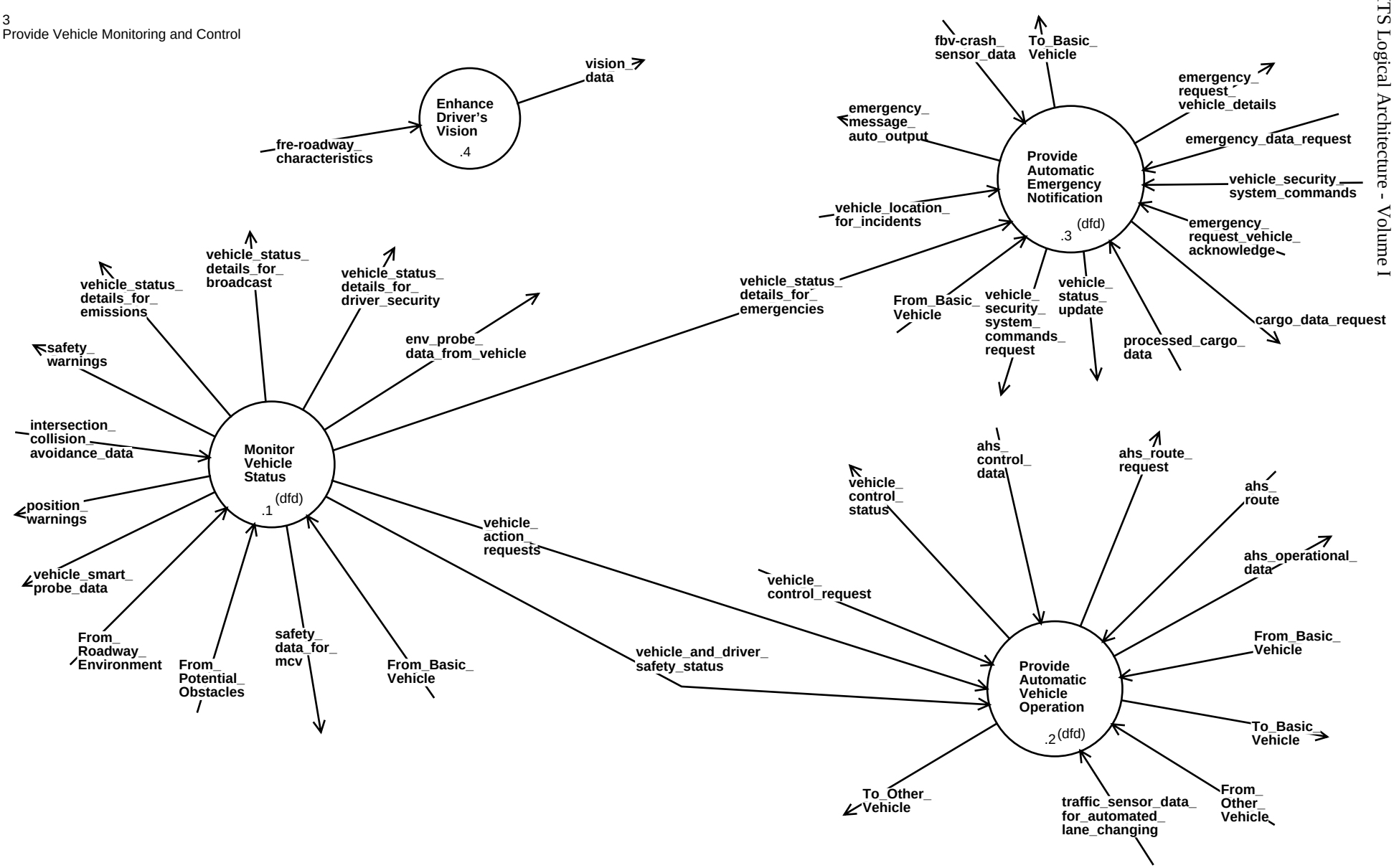
Provide Commercial Vehicle On-board Data



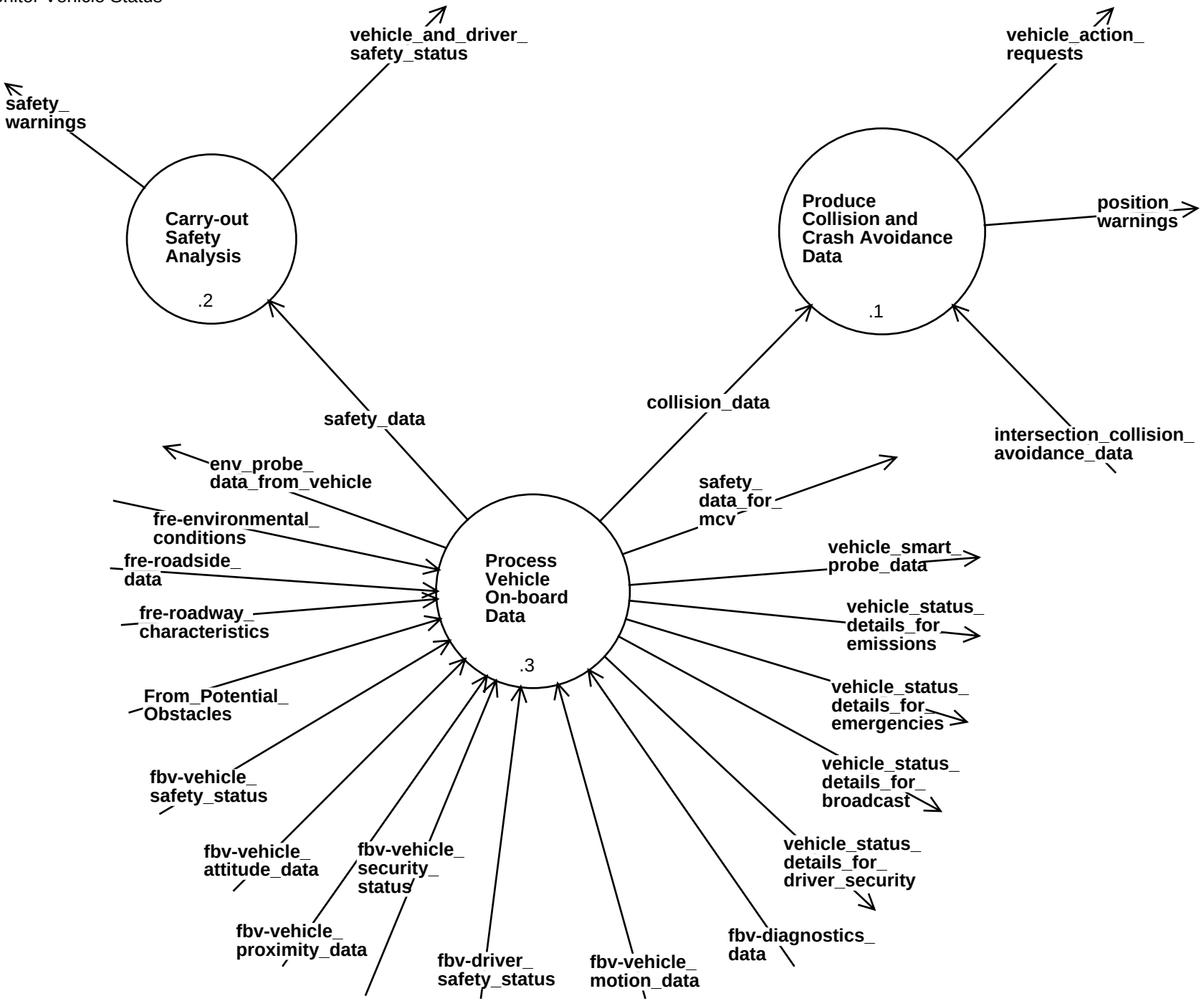
Provide Freight Operations



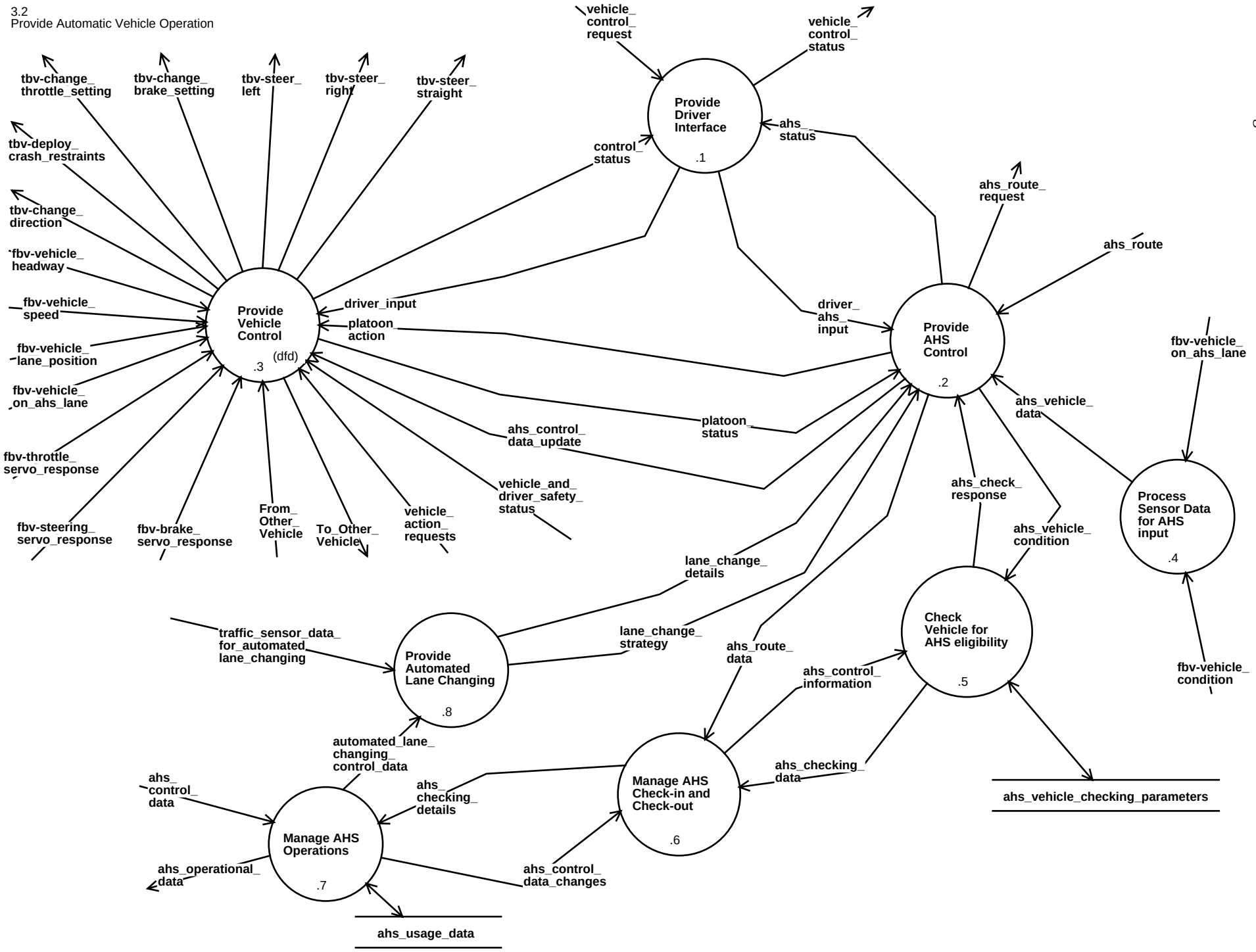
3
Provide Vehicle Monitoring and Control



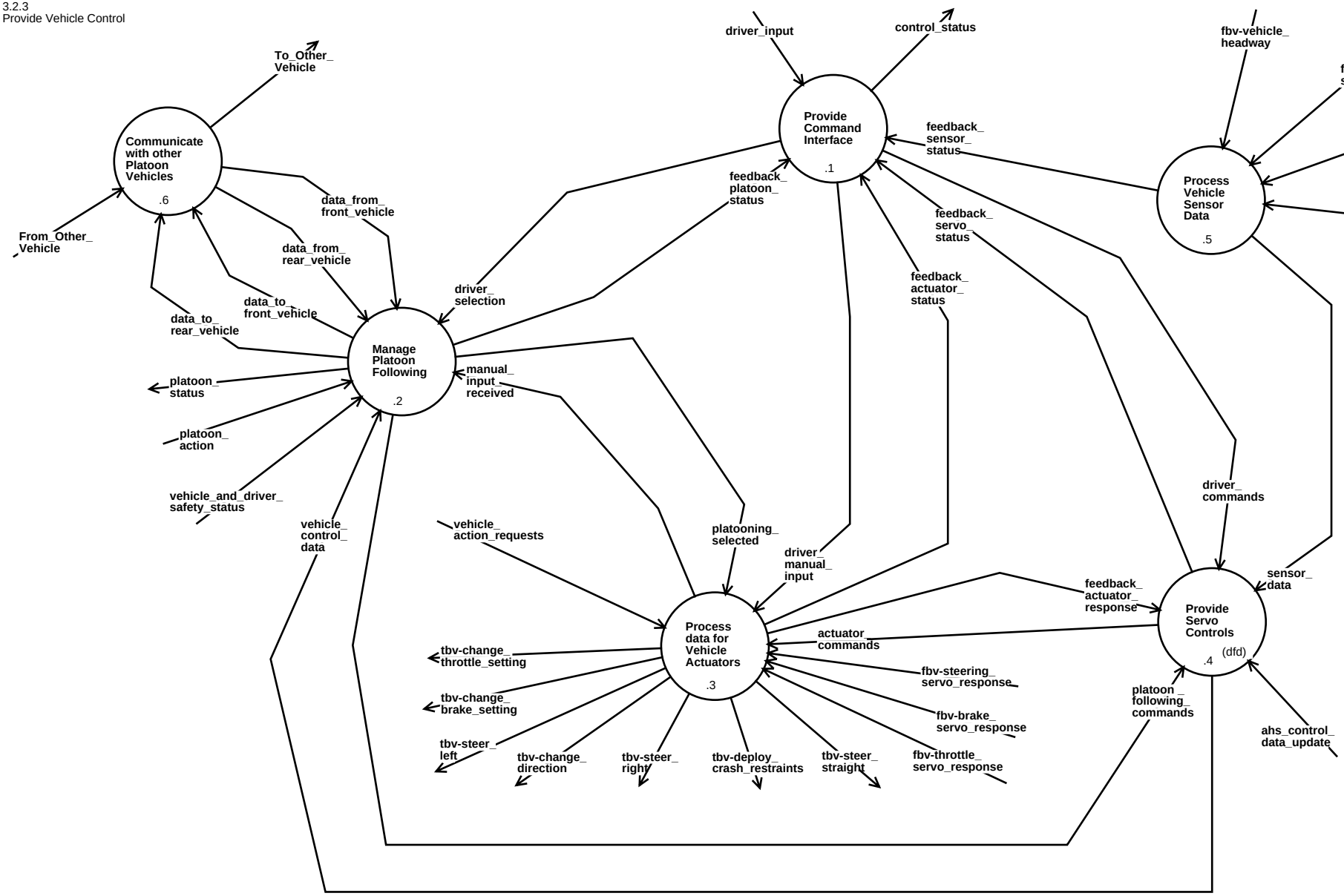
3.1
Monitor Vehicle Status



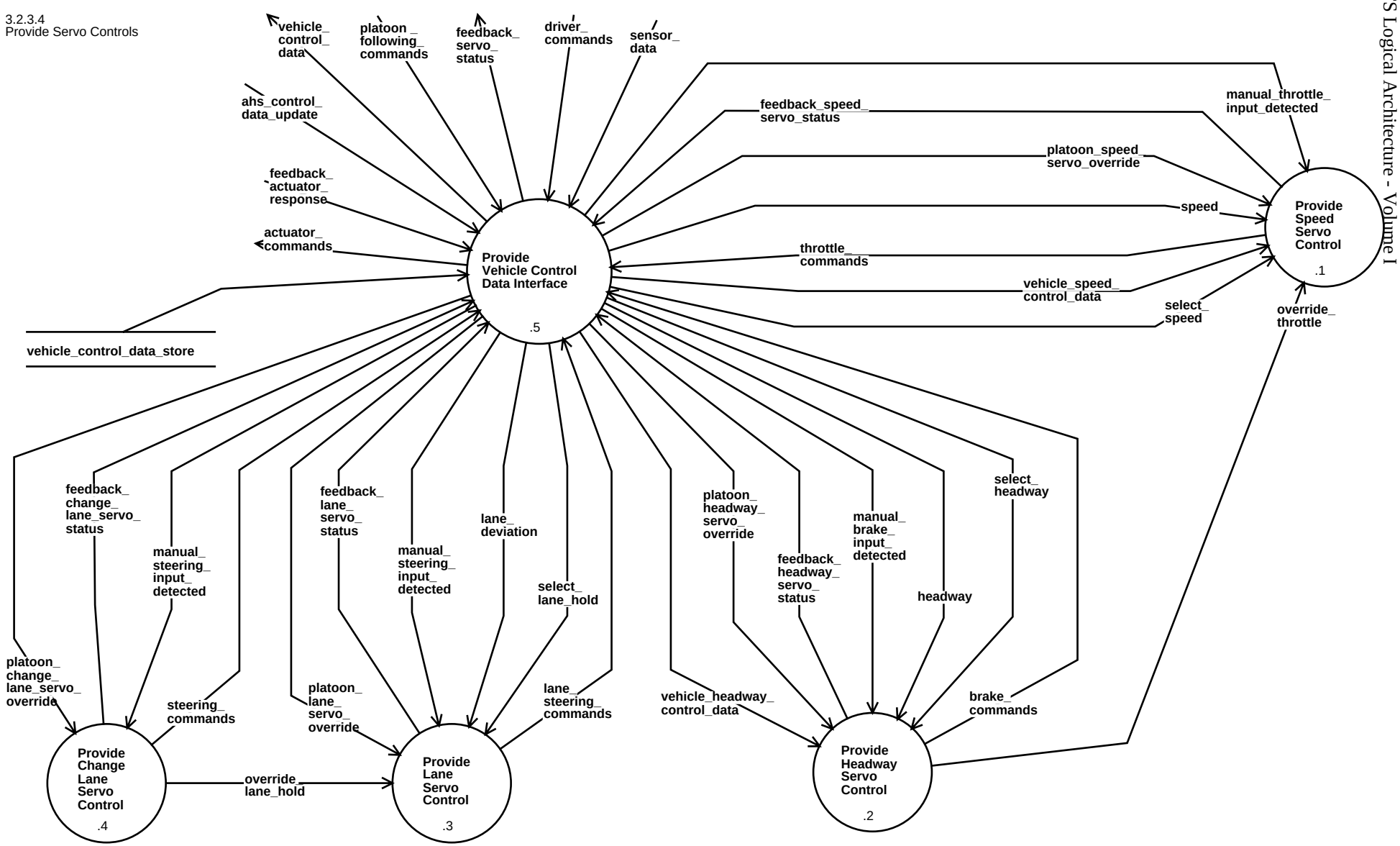
Provide Automatic Vehicle Operation



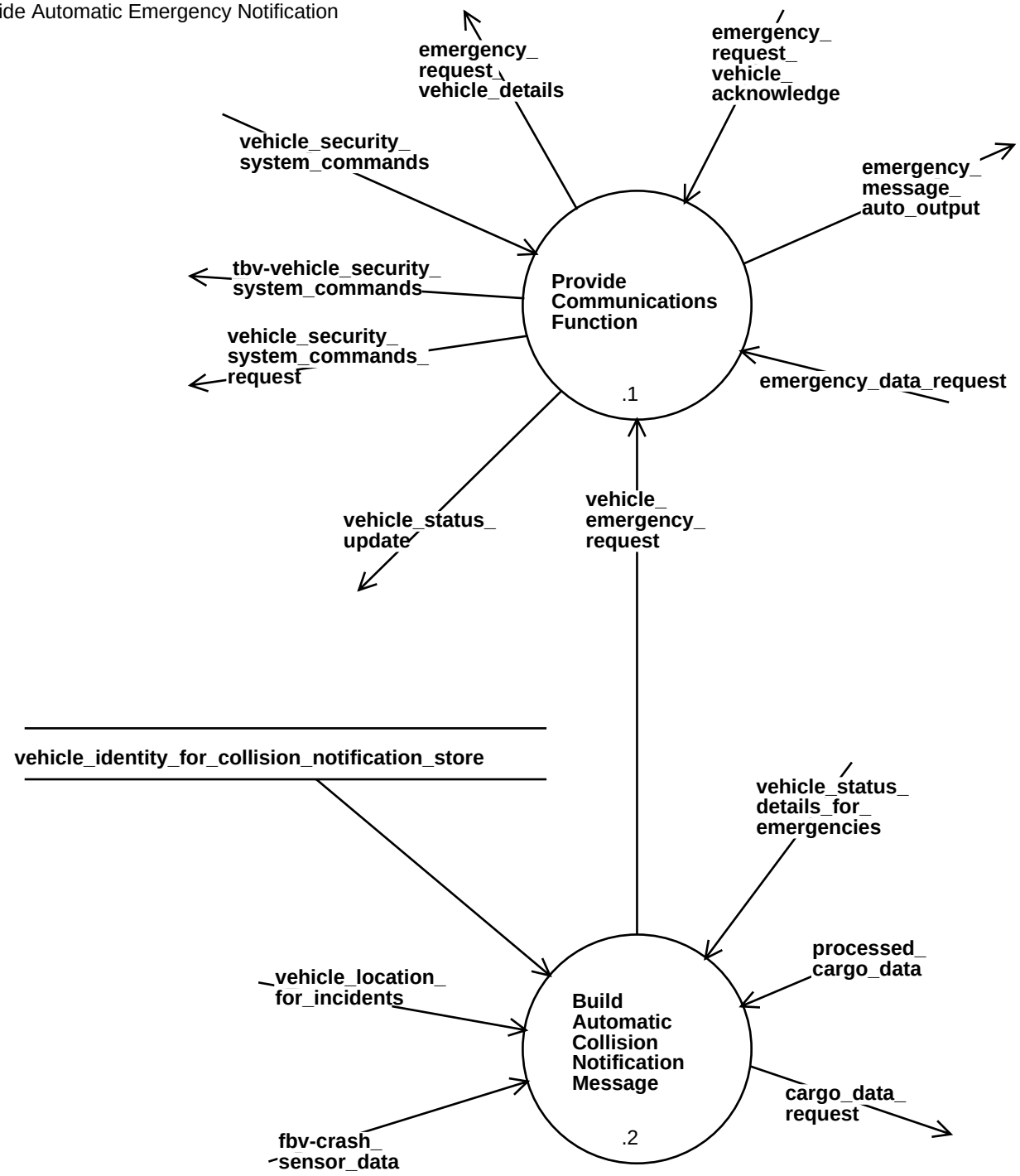
3.2.3
Provide Vehicle Control



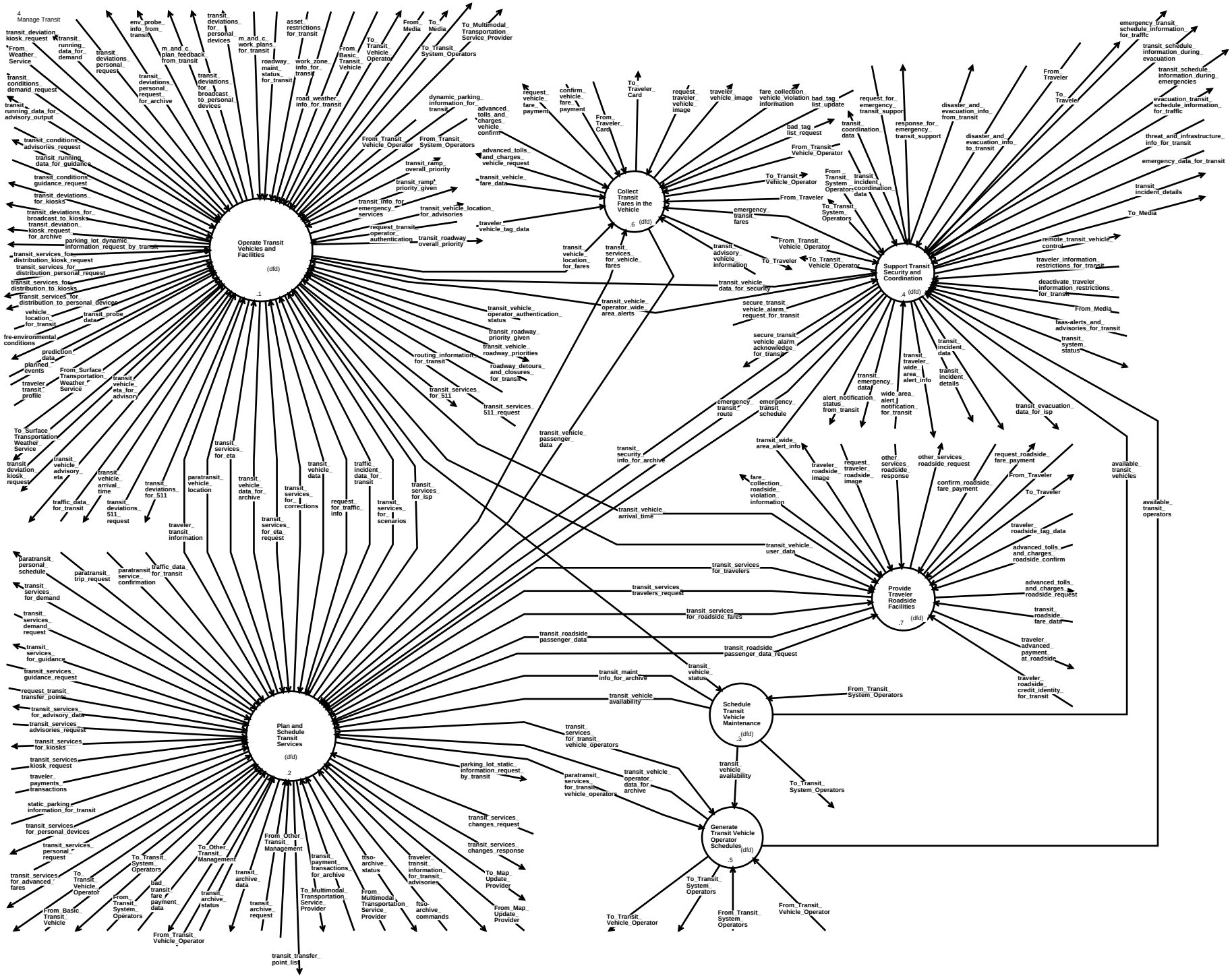
3.2.3.4
Provide Servo Controls



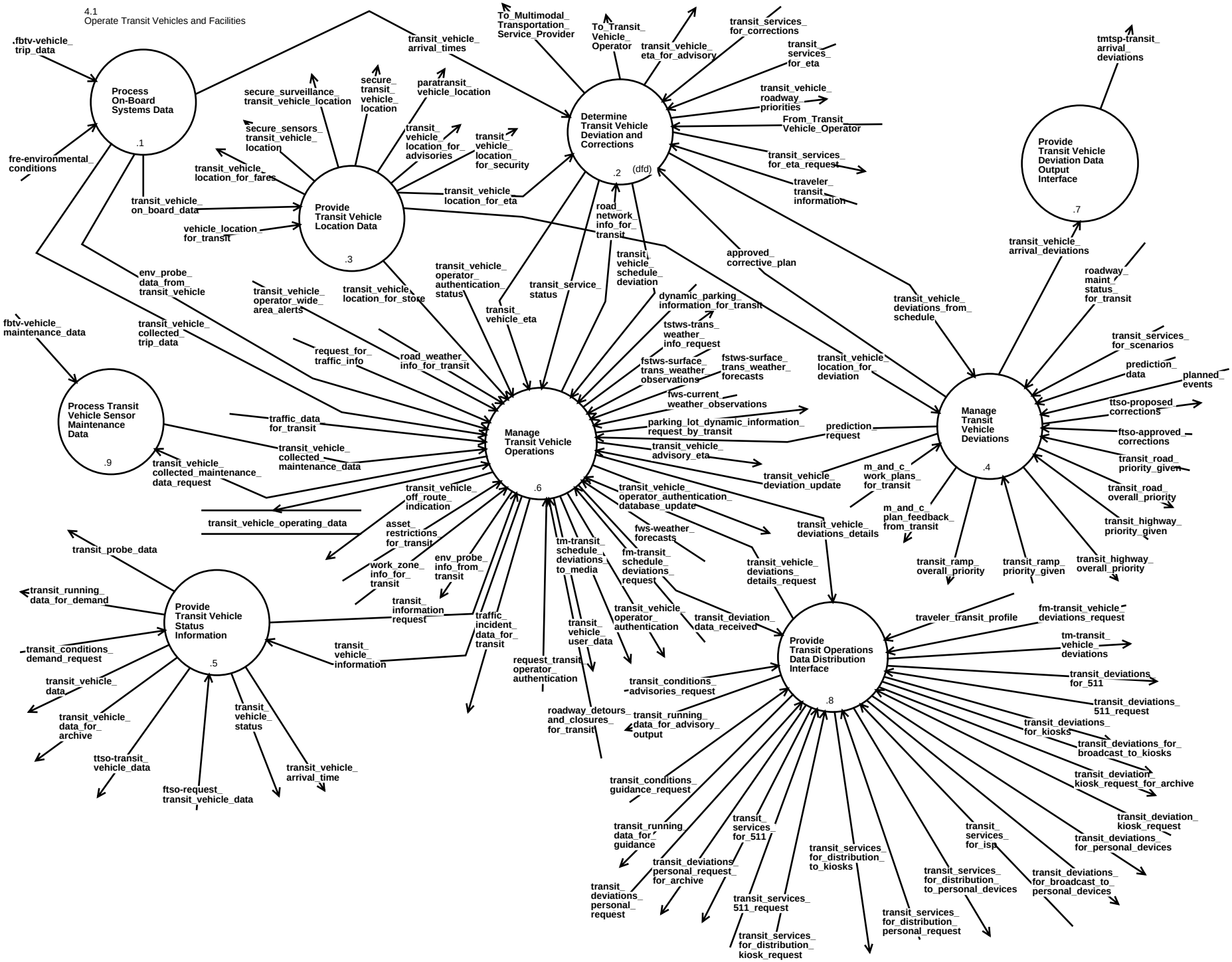
3.3
Provide Automatic Emergency Notification



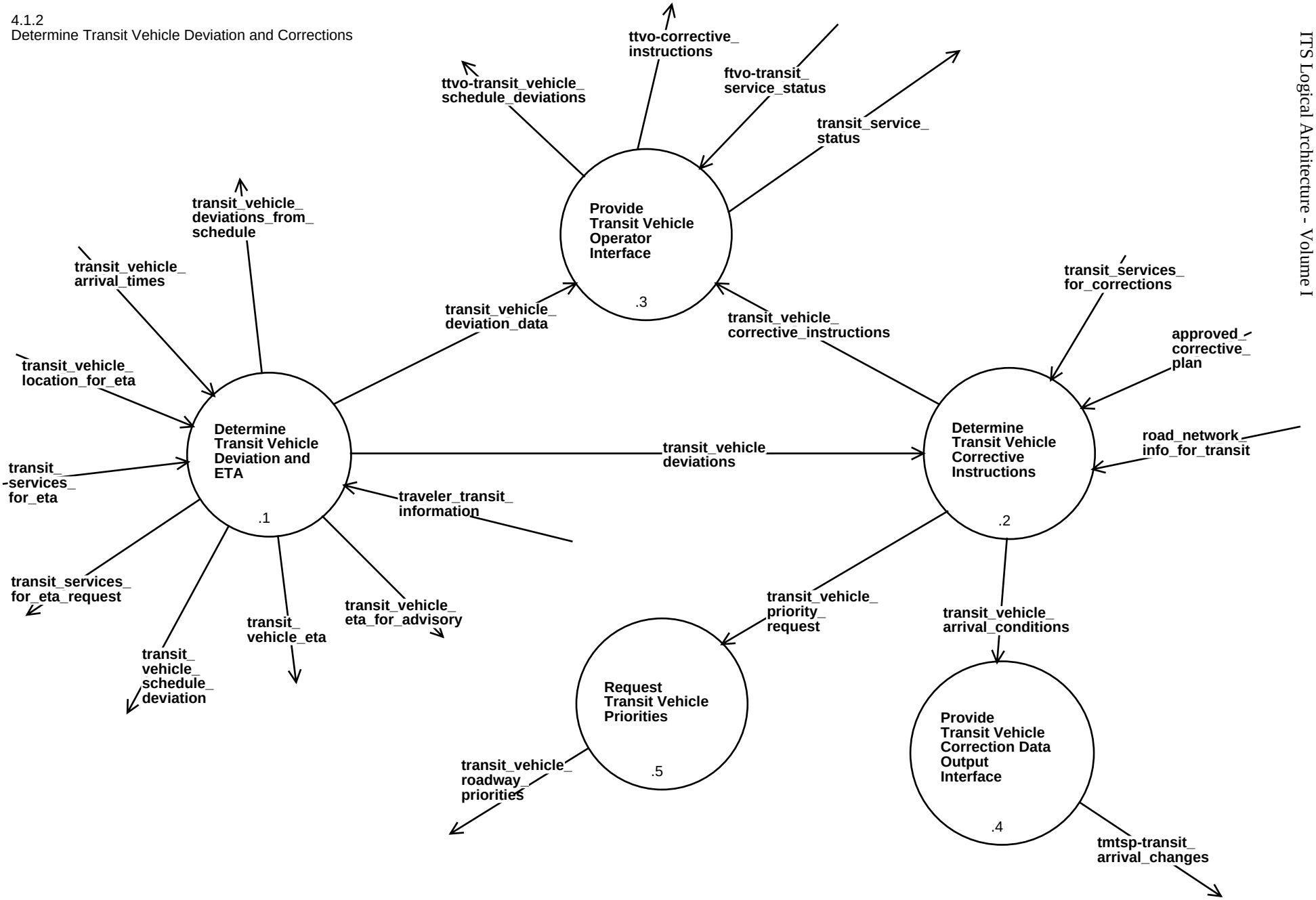
Manage Transit



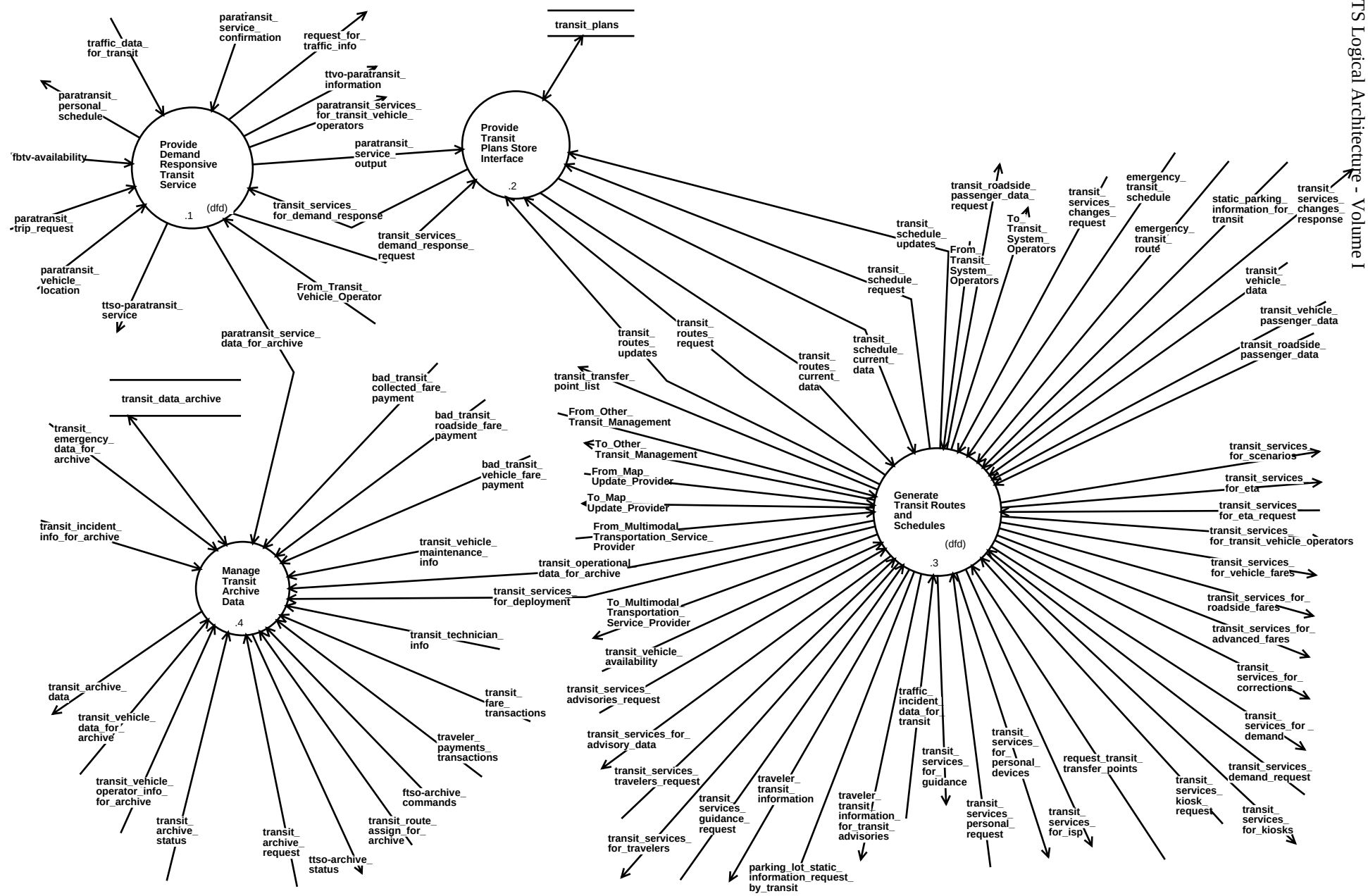
Operate Transit Vehicles and Facilities



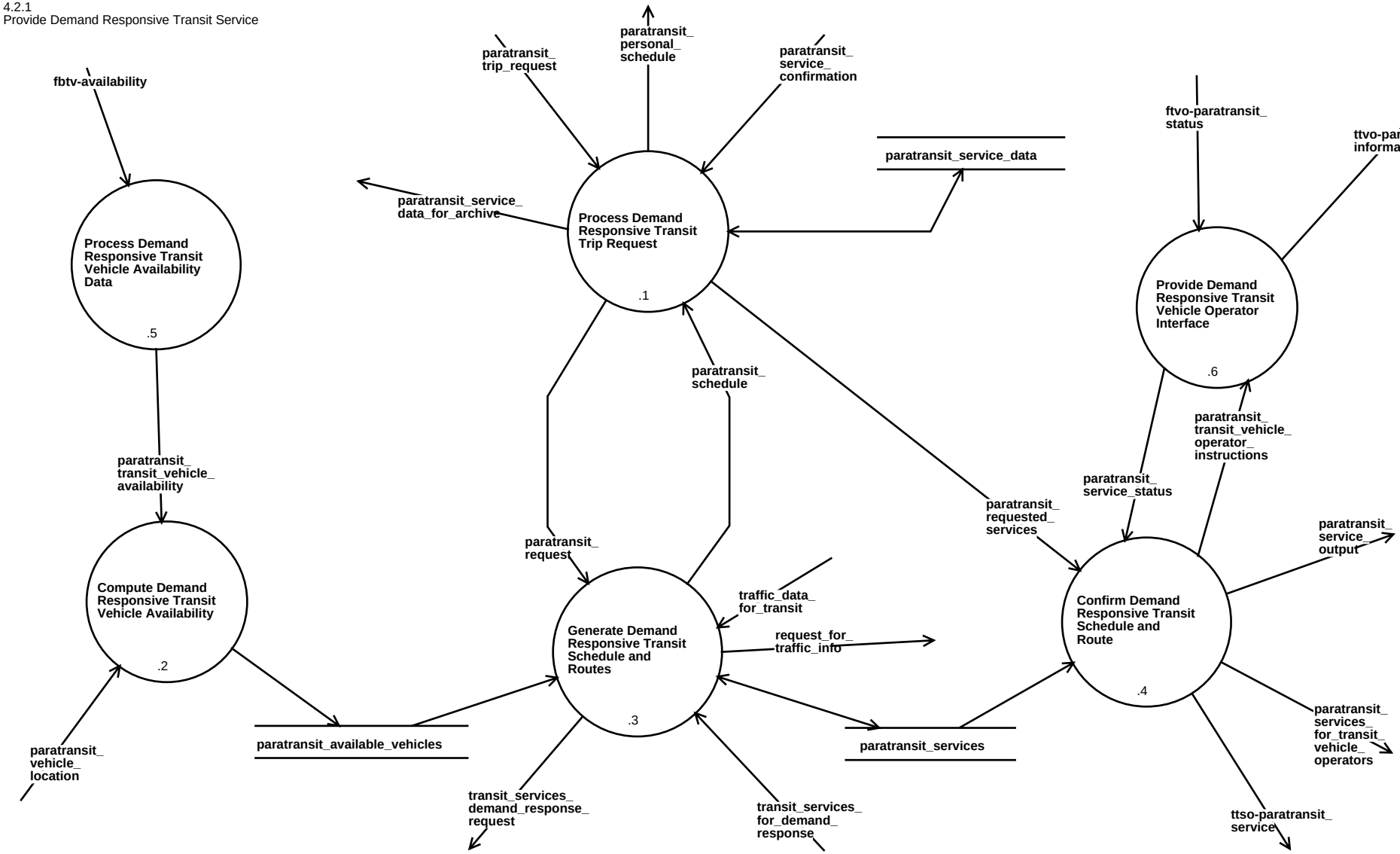
4.1.2
Determine Transit Vehicle Deviation and Corrections



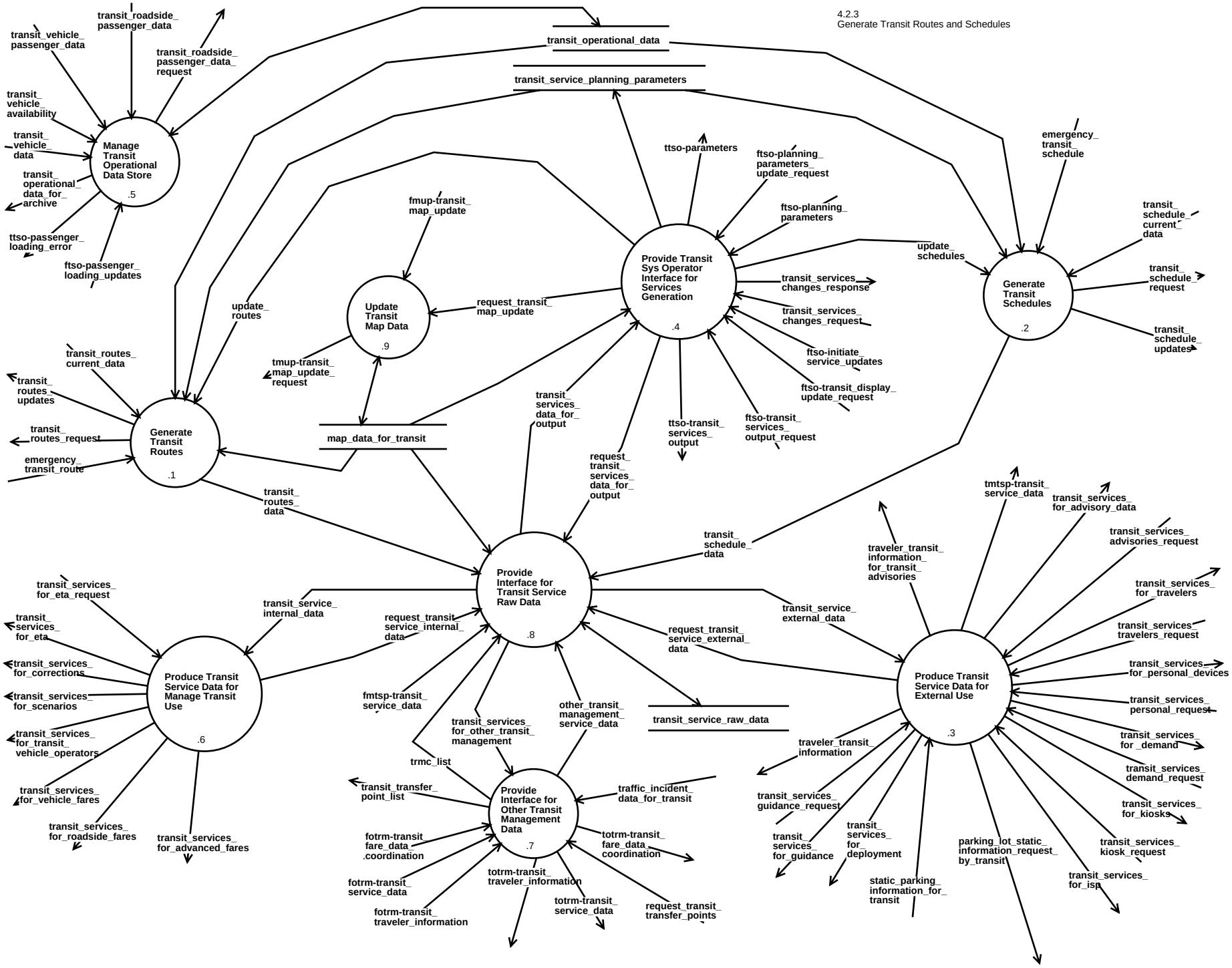
4.2
Plan and Schedule Transit Services

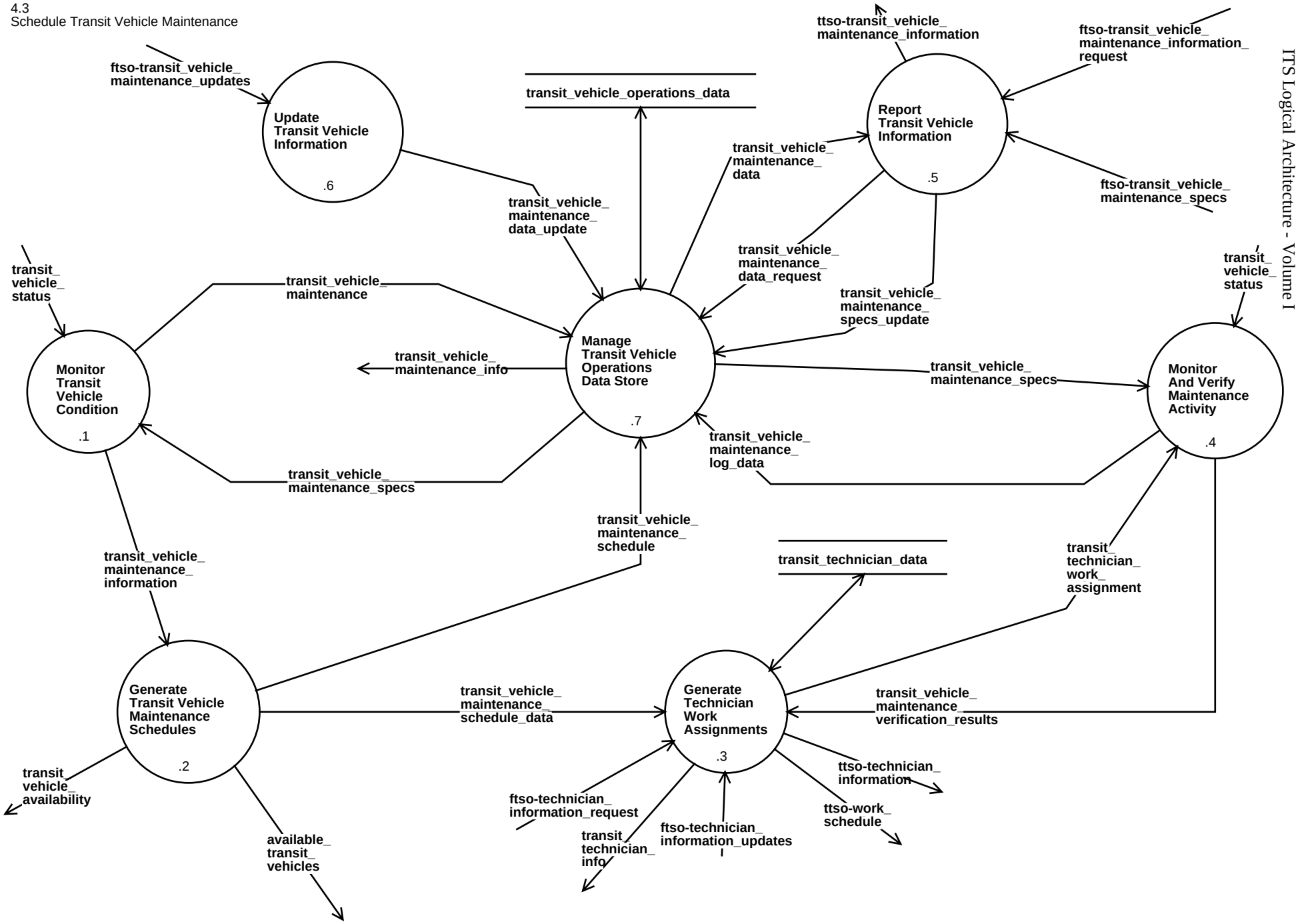


4.2.1
Provide Demand Responsive Transit Service

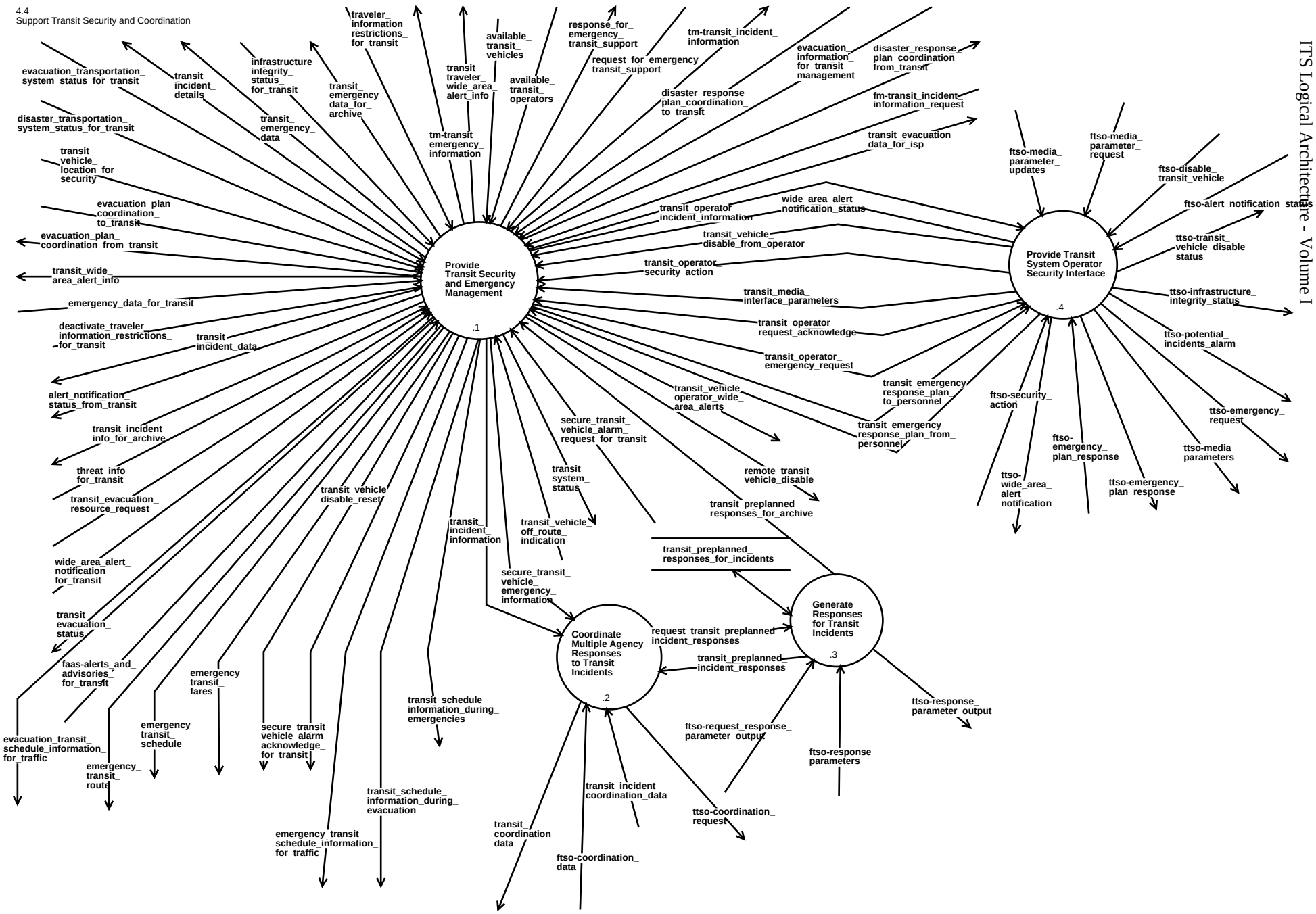


Generate Transit Routes and Schedules

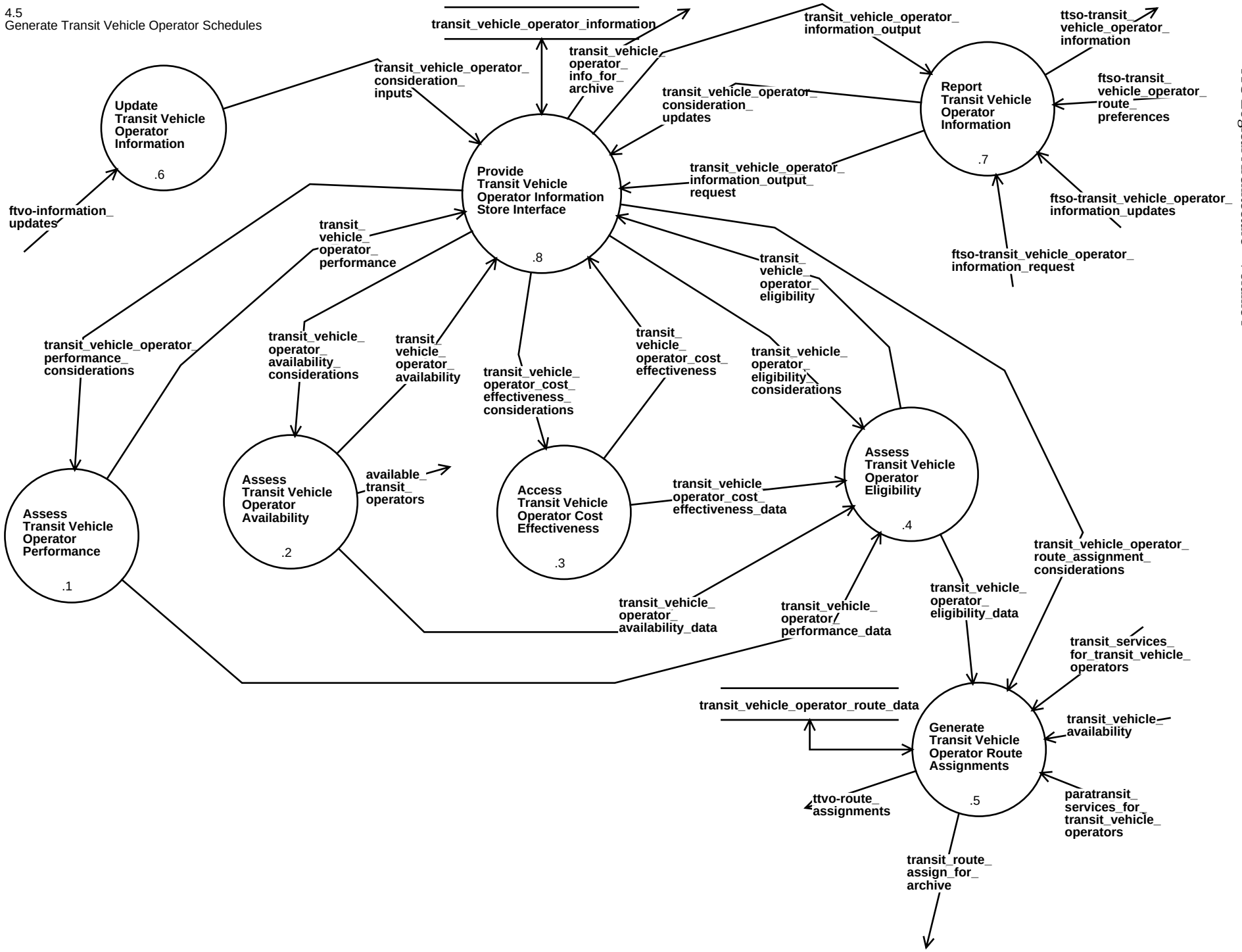



4.3
Schedule Transit Vehicle Maintenance
ftso-transit_vehicle_ maintenance_updates
Update Transit Vehicle Information
.6
transit_vehicle_operations_data
ttso-transit_vehicle_ maintenance_information
ftso-transit_vehicle_ maintenance_information_ request
Report Transit Vehicle Information
.5
transit_vehicle_ maintenance_ data
ftso-transit_vehicle_ maintenance_specs
transit_vehicle_ maintenance_ data_update
transit_vehicle_ maintenance_ data_request
transit_vehicle_ maintenance_ specs_update
transit_ vehicle_ status
transit_vehicle_ maintenance
transit_vehicle_ maintenance_info
Manage Transit Vehicle Operations Data Store
.7
transit_vehicle_ maintenance_specs
transit_ vehicle_ status
Monitor Transit Vehicle Condition
.1
transit_vehicle_ maintenance_specs
transit_vehicle_ maintenance_ log_data
Monitor And Verify Maintenance Activity
.4
transit_vehicle_ maintenance_ schedule
transit_vehicle_ maintenance_ information
transit_technician_data
transit_ technician_ work_ assignment
Generate Transit Vehicle Maintenance Schedules
.2
transit_vehicle_ maintenance_ schedule_data
Generate Technician Work Assignments
.3
transit_vehicle_ maintenance_ verification_results
transit_ vehicle_ availability
ttso-technician_ information
ftso-technician_ information_request
ttso-work_ schedule
transit_ technician_ info
ftso-technician_ information_updates
available_ transit_ vehicles

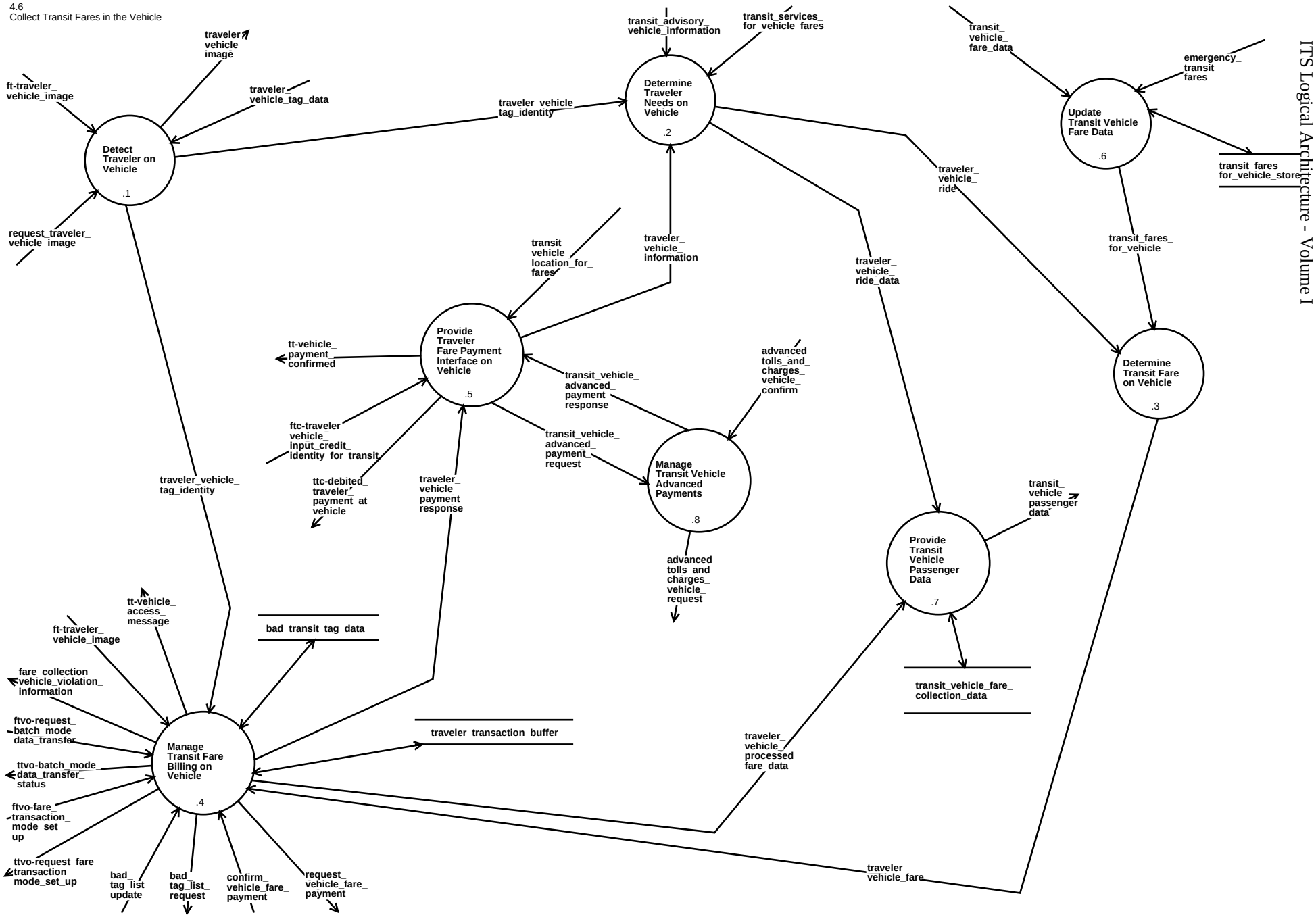
Support Transit Security and Coordination



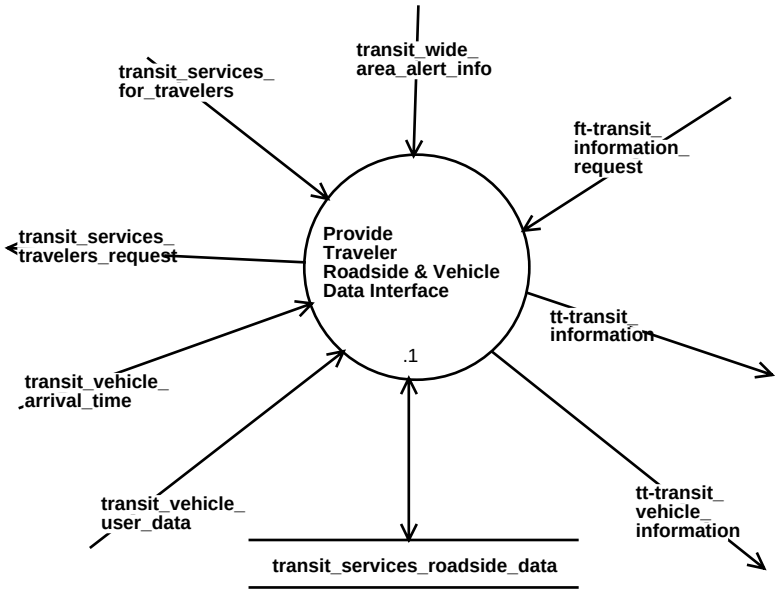
Generate Transit Vehicle Operator Schedules

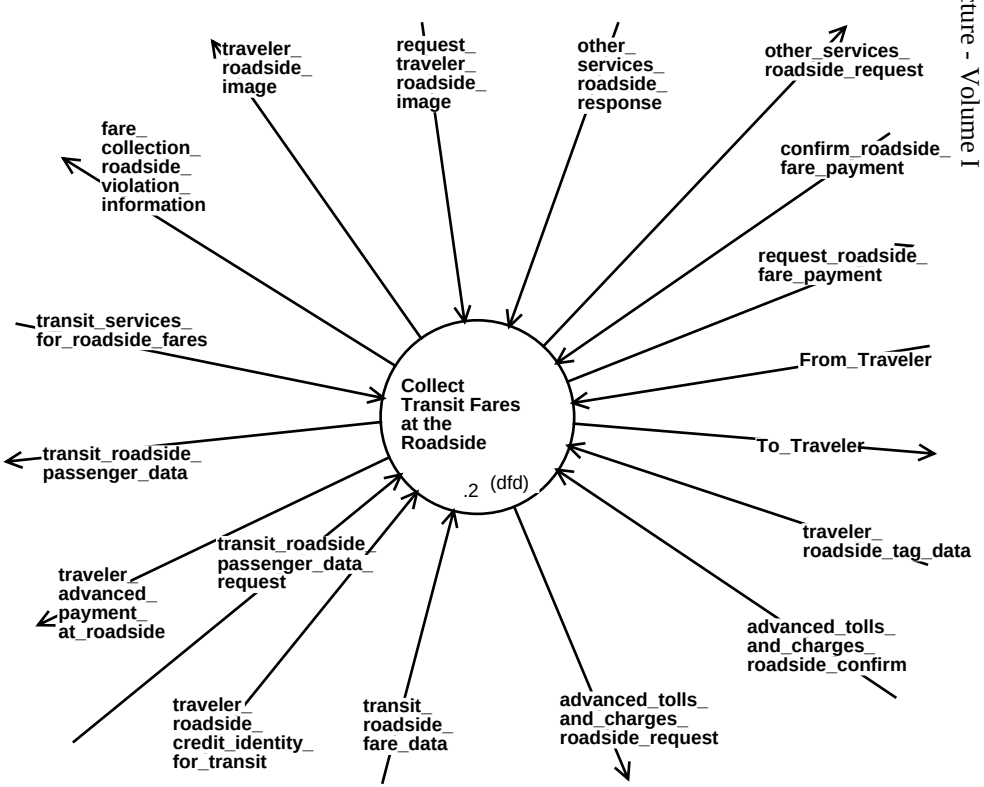


Collect Transit Fares in the Vehicle



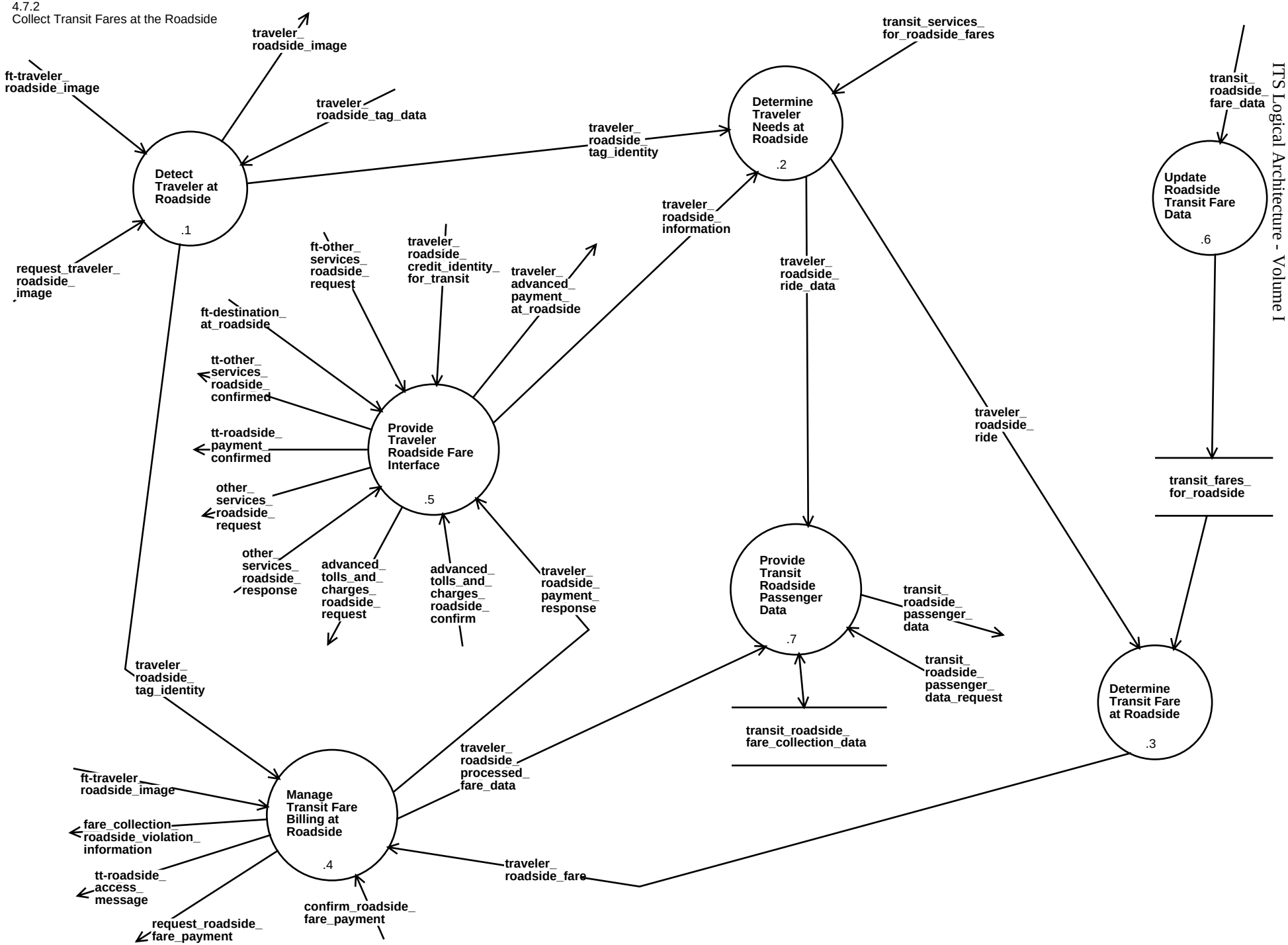
4.7
Provide Traveler Roadside Facilities

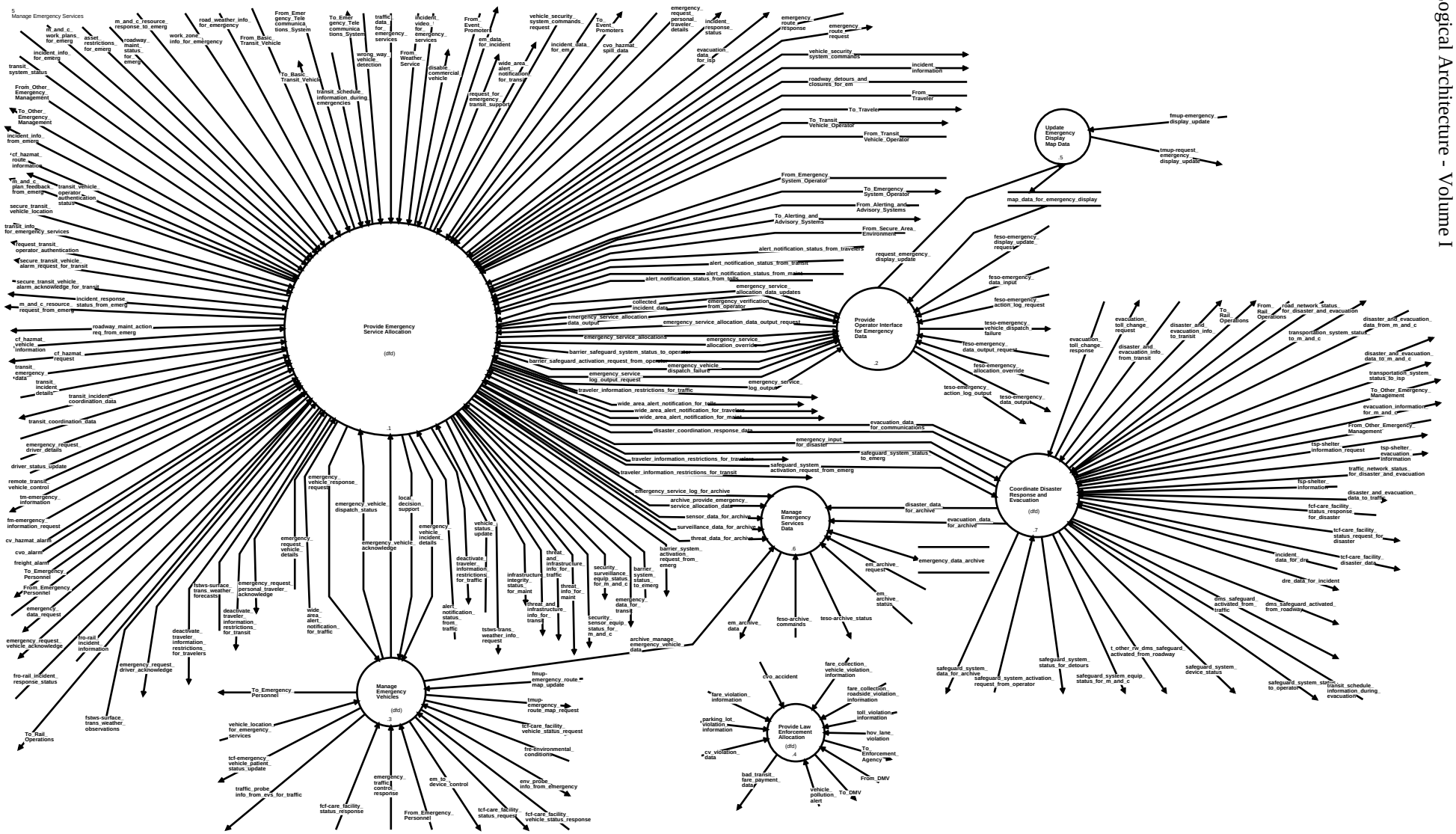




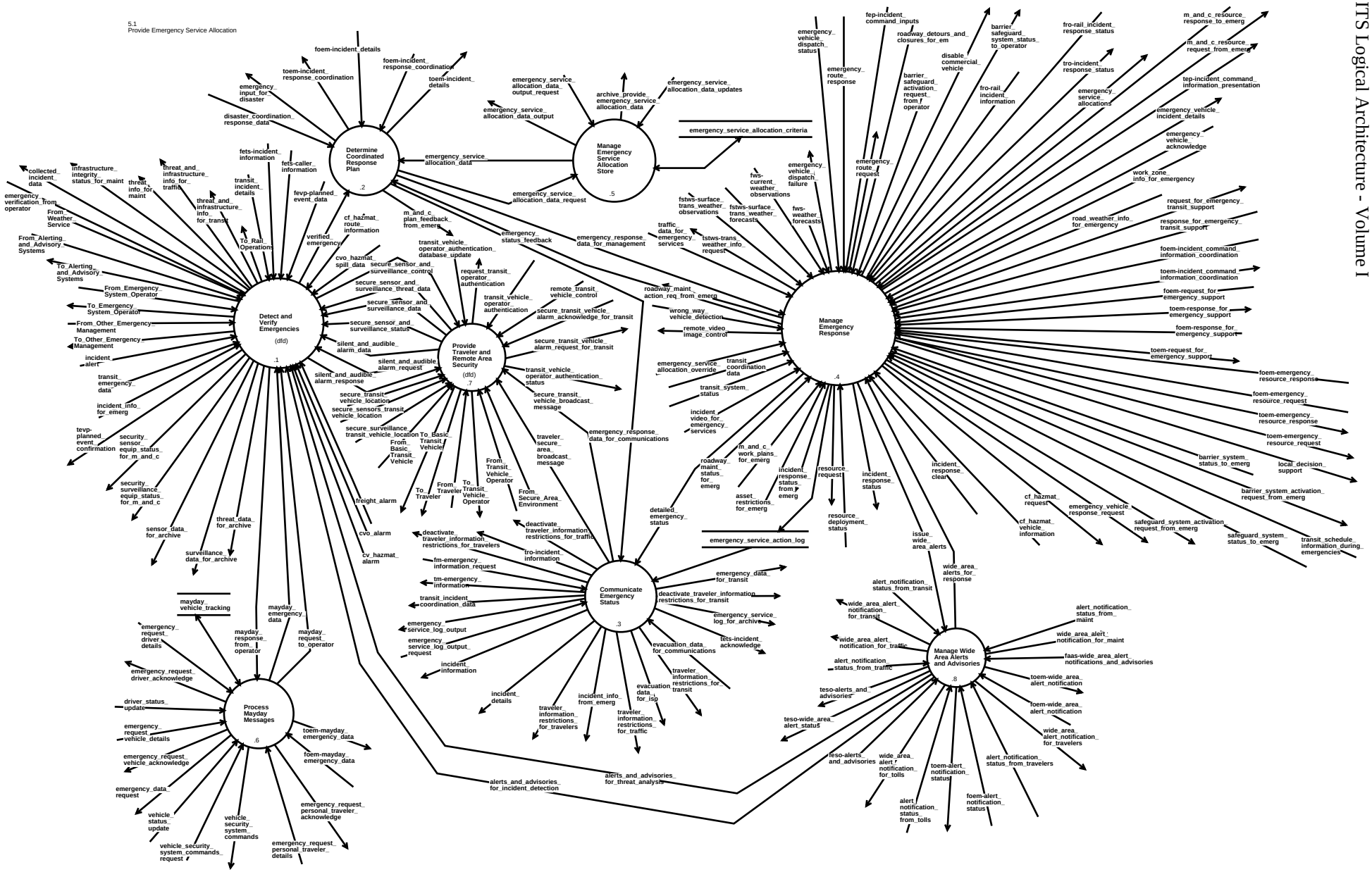
Collect Transit Fares at the Roadside

4.7.2
Collect Transit Fares at the Roadside

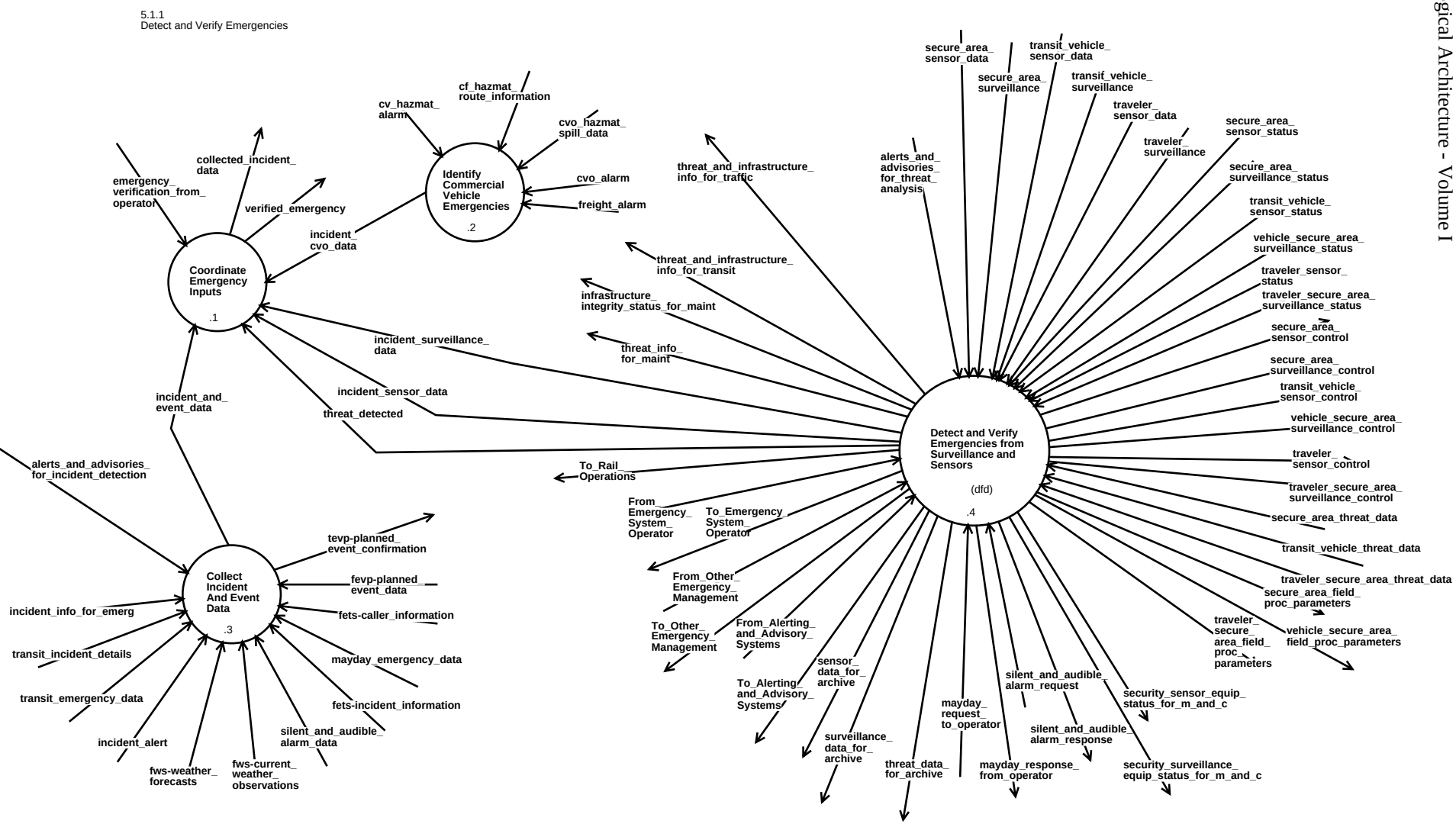



5
Manage Emergency Services
Provide Emergency Service Allocation
(dfd)
.1
Provide Operator Interface for Emergency Data
.2
Manage Emergency Vehicles
(dfd)
.3
Provide Law Enforcement Allocation
(dfd)
.4
Manage Emergency Services Data
.6
Coordinate Disaster Response and Evacuation
(dfd)
.7
Update Emergency Display Map Data
.5
m_and_c_work_plans_for_emerg
asset_restrictions_for_emerg
m_and_c_resource_response_to_emerg
roadway_maint_status_for_emerg
road_weather_info_for_emergency
work_zone_info_for_emergency
From_Basic_Transit_Vehicle
From_Emergency_Telecommunications_System
To_Emergency_Telecommunications_System
traffic_data_for_emergency_services
incident_video_for_emergency_services
From_Event_Promoters
em_data_for_incident
vehicle_security_system_commands_request
To_Event_Promoters
cvo_hazmat_spill_data
emergency_request_personal_traveler_details
incident_response_status
emergency_route_response
emergency_route_request
vehicle_security_system_commands
incident_information
roadway_detours_and_closures_for_em
From_Traveler
To_Traveler
To_Transit_Vehicle_Operator
From_Transit_Vehicle_Operator
fmup-emergency_display_update
tmup-request_emergency_display_update
map_data_for_emergency_display
From_Emergency_System_Operator
To_Emergency_System_Operator
From_Alerting_and_Advisory_Systems
To_Alerting_and_Advisory_Systems
From_Secure_Area_Environment
alert_notification_status_from_travelers
request_emergency_display_update
feso-emergency_display_update_request
feso-emergency_data_input
feso-emergency_action_log_request
teso-emergency_vehicle_dispatch_failure
feso-emergency_data_output_request
feso-emergency_allocation_override
teso-emergency_action_log_output
teso-emergency_data_output
evacuation_toll_change_response
evacuation_toll_change_request
disaster_and_evacuation_info_to_transit
disaster_and_evacuation_info_from_transit
To_Rail_Operations
From_Rail_Operations
road_network_status_for_disaster_and_evacuation
transportation_system_status_to_m_and_c
disaster_and_evacuation_data_from_m_and_c
disaster_and_evacuation_data_to_m_and_c
transportation_system_status_to_isp
To_Other_Emergency_Management
evacuation_information_for_m_and_c
From_Other_Emergency_Management
tsp-shelter_information_request
tsp-shelter_evacuation_information
traffic_network_status_for_disaster_and_evacuation
fsp-shelter_information
disaster_and_evacuation_data_to_traffic
fcf-care_facility_status_response_for_disaster
tcf-care_facility_status_request_for_disaster
incident_data_for_dre
tcf-care_facility_disaster_data
dre_data_for_incident
dms_safeguard_activated_from_traffic
dms_safeguard_activated_from_roadway
t_other_rw_dms_safeguard_activated_from_roadway
safeguard_system_device_status
safeguard_system_status_to_operator
transit_schedule_information_during_evacuation
safeguard_system_data_for_archive
safeguard_system_activation_request_from_operator
safeguard_system_status_for_detours
safeguard_system_equip_status_for_m_and_c
m_and_c_plan_feedback_from_emerg
incident_info_for_emerg
transit_system_status
From_Other_Emergency_Management
To_Other_Emergency_Management
incident_info_from_emerg
cf_hazmat_route_information
transit_vehicle_operator_authentication_status
secure_transit_vehicle_location
transit_info_for_emergency_services
request_transit_operator_authentication
secure_transit_vehicle_alarm_request_for_transit
secure_transit_vehicle_alarm_acknowledge_for_transit
incident_response_status_from_emerg
m_and_c_resource_request_from_emerg
roadway_maint_action_req_from_emerg
cf_hazmat_vehicle_information
cf_hazmat_request
transit_emergency_data
transit_incident_details
transit_incident_coordination_data
transit_coordination_data
emergency_request_driver_details
driver_status_update
remote_transit_vehicle_control
tm-emergency_information
fm-emergency_information_request
cv_hazmat_alarm
cvo_alarm
freight_alarm
To_Emergency_Personnel
From_Emergency_Personnel
emergency_data_request
emergency_request_vehicle_acknowledge
fro-rail_incident_information
fro-rail_incident_response_status
To_Rail_Operations
fstws-surface_trans_weather_observations
emergency_request_driver_acknowledge
deactivate_traveler_information_restrictions_for_travelers
fstws-surface_trans_weather_forecasts
emergency_request_personal_traveler_acknowledge
deactivate_traveler_information_restrictions_for_transit
emergency_vehicle_response_request
emergency_vehicle_details
wide_area_alert_notification_for_traffic
emergency_vehicle_dispatch_status
emergency_vehicle_acknowledge
local_decision_support
emergency_vehicle_incident_details
deactivate_traveler_information_restrictions_for_traffic
alert_notification_status_from_traffic
vehicle_status_update
tstws-trans_weather_info_request
infrastructure_integrity_status_for_maint
threat_and_infrastructure_info_for_transit
threat_and_infrastructure_info_for_traffic
threat_info_for_maint
security_surveillance_equip_status_for_m_and_c
security_sensor_equip_status_for_m_and_c
barrier_system_status_to_emerg
emergency_data_for_transit
barrier_system_activation_request_from_emerg
archive_manage_emergency_vehicle_data
To_Emergency_Personnel
vehicle_location_for_emergency_services
tcf-emergency_vehicle_patient_status_update
traffic_probe_info_from_evs_for_traffic
fcf-care_facility_status_response
emergency_traffic_control_response
em_to_device_control
From_Emergency_Personnel
tcf-care_facility_status_request
fcf-care_facility_vehicle_status_response
fmup-emergency_route_map_update
tmup-emergency_route_map_request
tcf-care_facility_vehicle_status_request
fro-environmental_conditions
env_probe_info_from_emergency
cvo_accident
fare_violation_information
parking_lot_violation_information
cv_violation_data
bad_transit_fare_payment_data
vehicle_pollution_alert
To_DMV
From_DMV
To_Enforcement_Agency
hov_lane_violation
toll_violation_information
fare_collection_roadside_violation_information
fare_collection_vehicle_violation_information
emergency_service_log_for_archive
archive_provide_emergency_service_allocation_data
sensor_data_for_archive
surveillance_data_for_archive
threat_data_for_archive
emergency_service_allocations
emergency_service_allocation_override
barrier_safeguard_system_status_to_operator
barrier_safeguard_activation_request_from_operator
emergency_service_log_output_request
traveler_information_restrictions_for_traffic
wide_area_alert_notification_for_tolls
wide_area_alert_notification_for_travelers
wide_area_alert_notification_for_maint
disaster_coordination_response_data
traveler_information_restrictions_for_travelers
traveler_information_restrictions_for_transit
emergency_service_log_output
emergency_input_for_disaster
safeguard_system_status_to_emerg
safeguard_system_activation_request_from_emerg
disaster_data_for_archive
evacuation_data_for_archive
emergency_data_archive
em_archive_request
em_archive_status
em_archive_data
feso-archive_commands
teso-archive_status
collected_incident_data
emergency_service_allocation_data_output
emergency_service_allocation_data_output_request
emergency_service_allocation_data_updates
emergency_verification_from_operator
emergency_vehicle_dispatch_failure
alert_notification_status_from_transit
alert_notification_status_from_maint
alert_notification_status_from_tolls
evacuation_data_for_communications

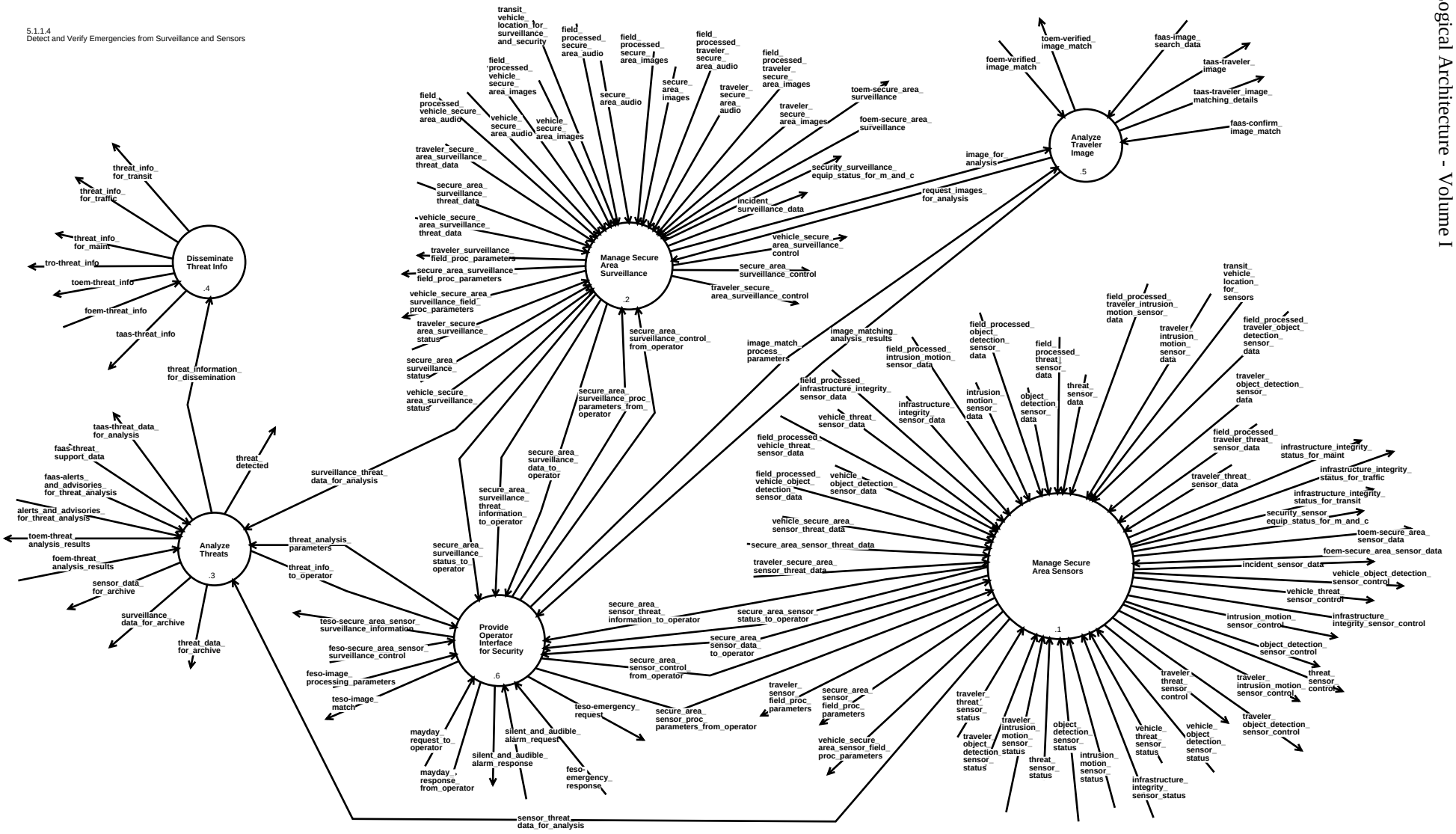
Provide Emergency Service Allocation



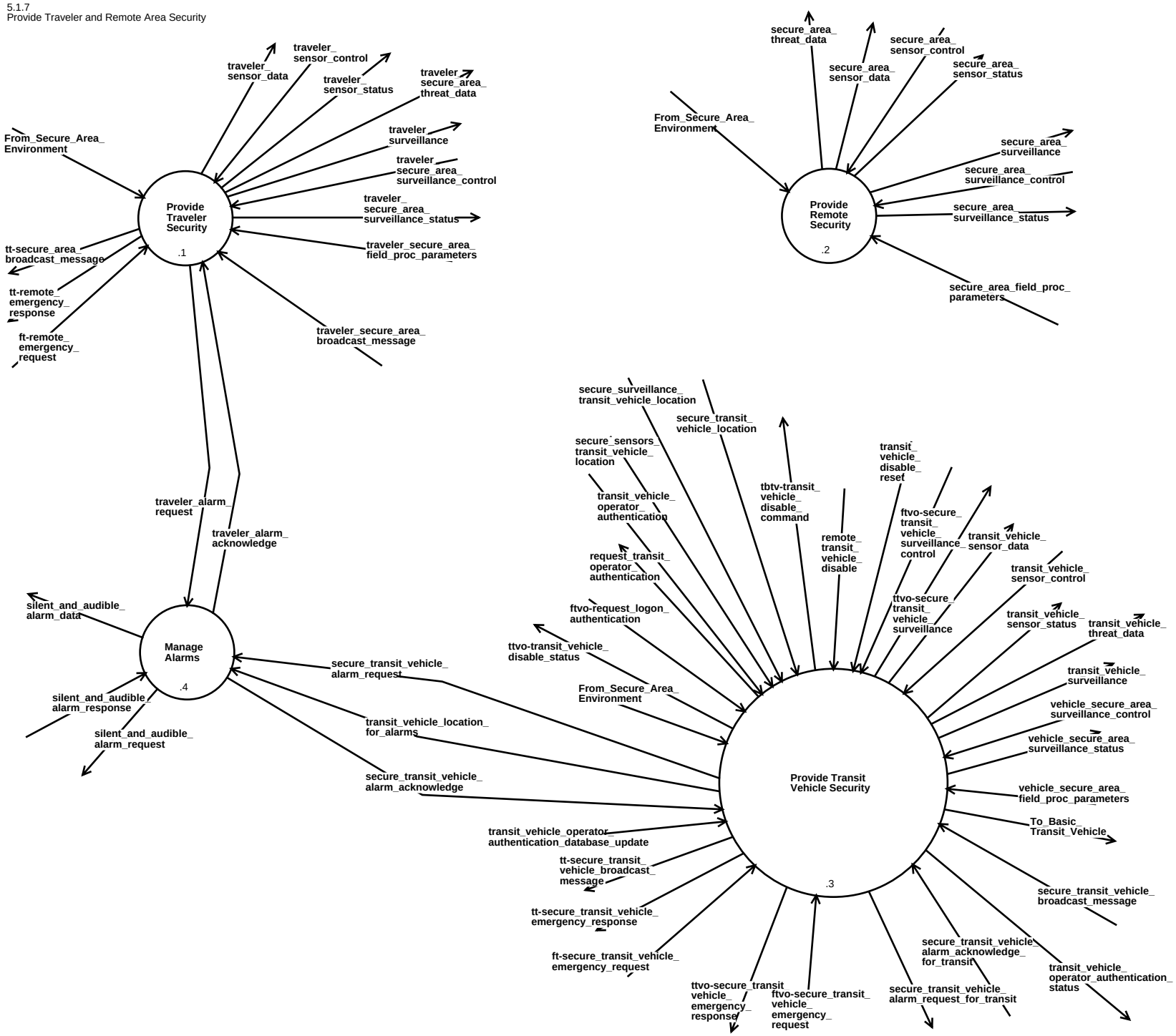
Detect and Verify Emergencies



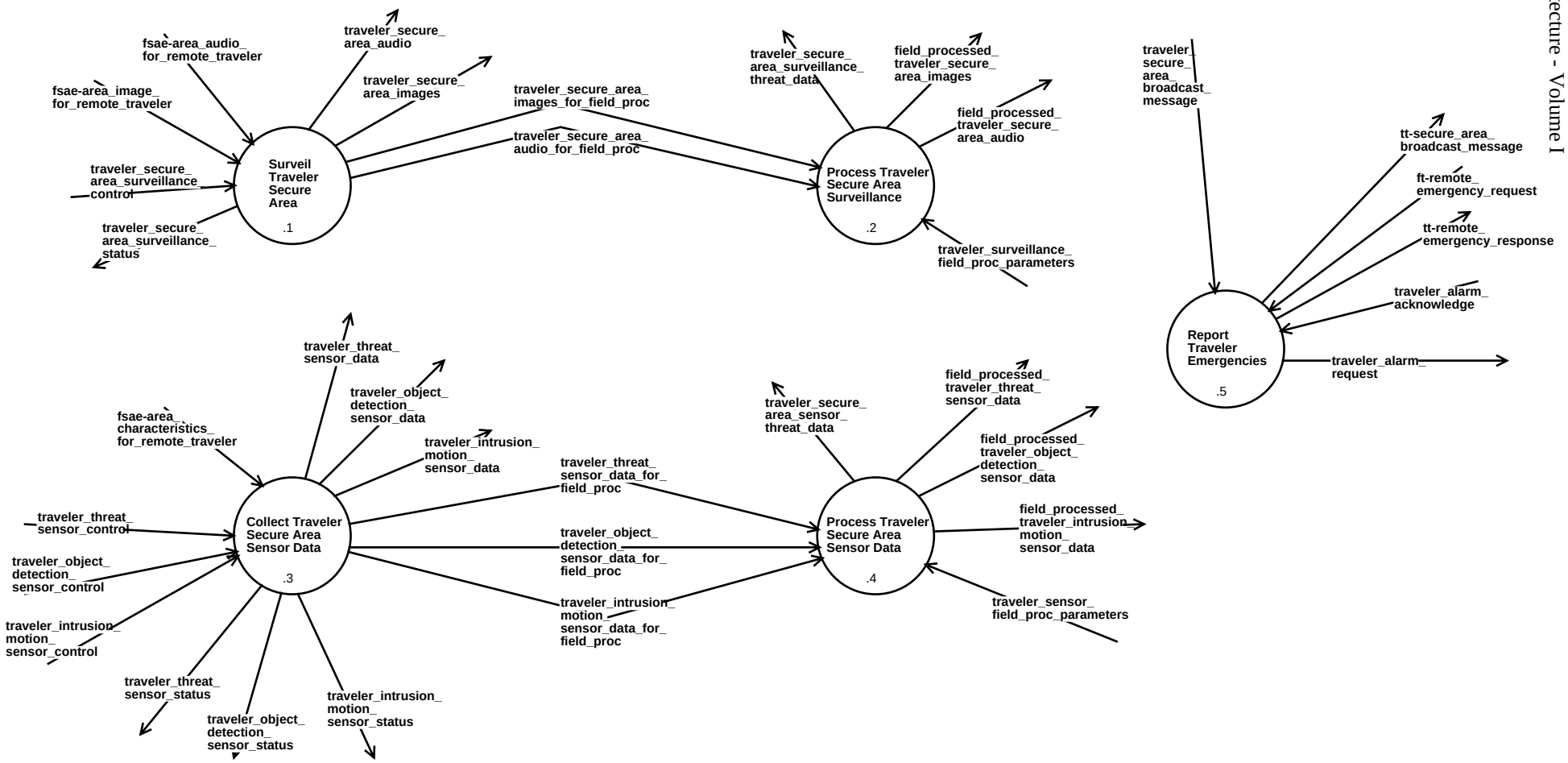
5.1.1.4
Detect and Verify Emergencies from Surveillance and Sensors



Provide Traveler and Remote Area Security

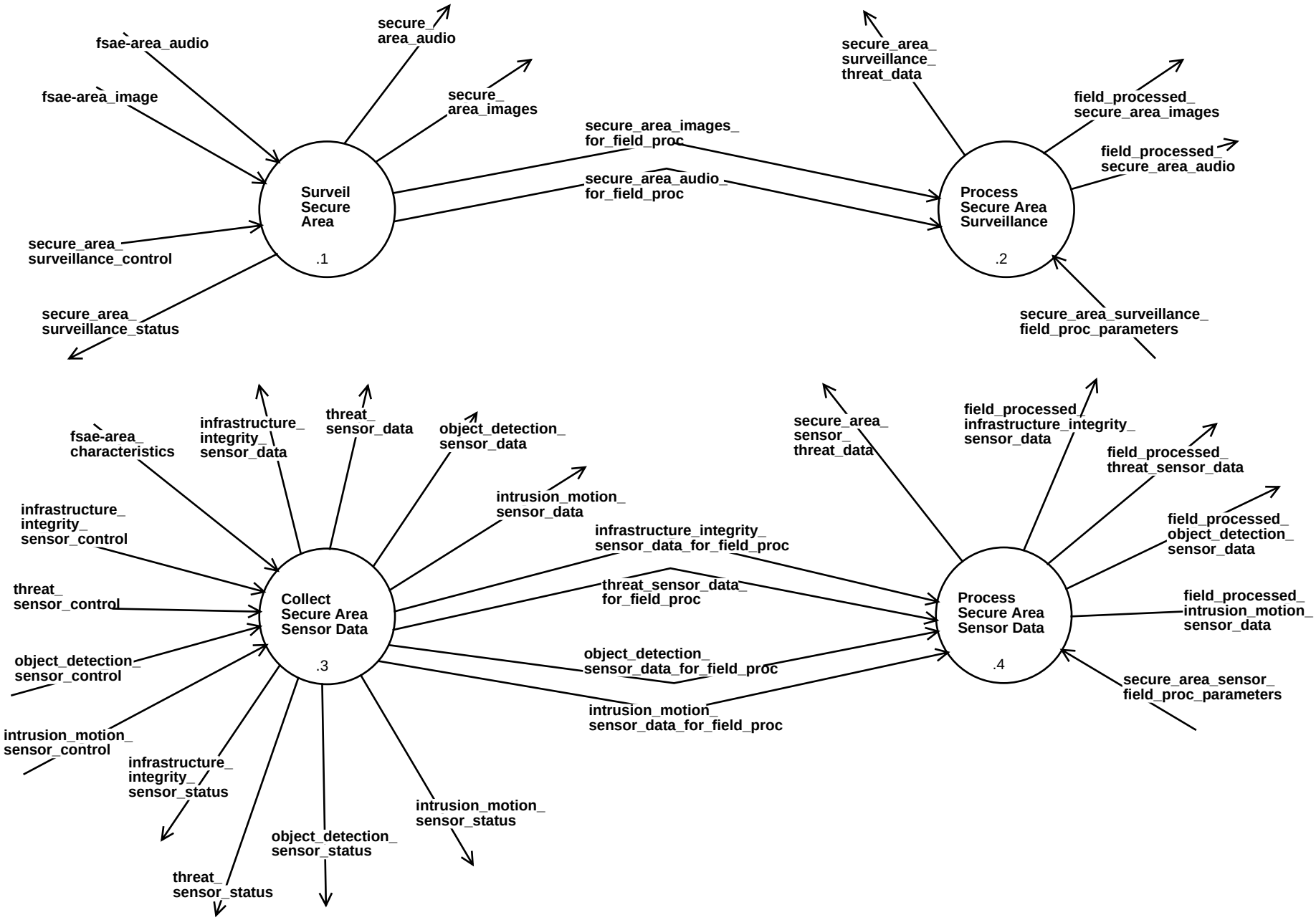


5.1.7.1
Provide Traveler Security



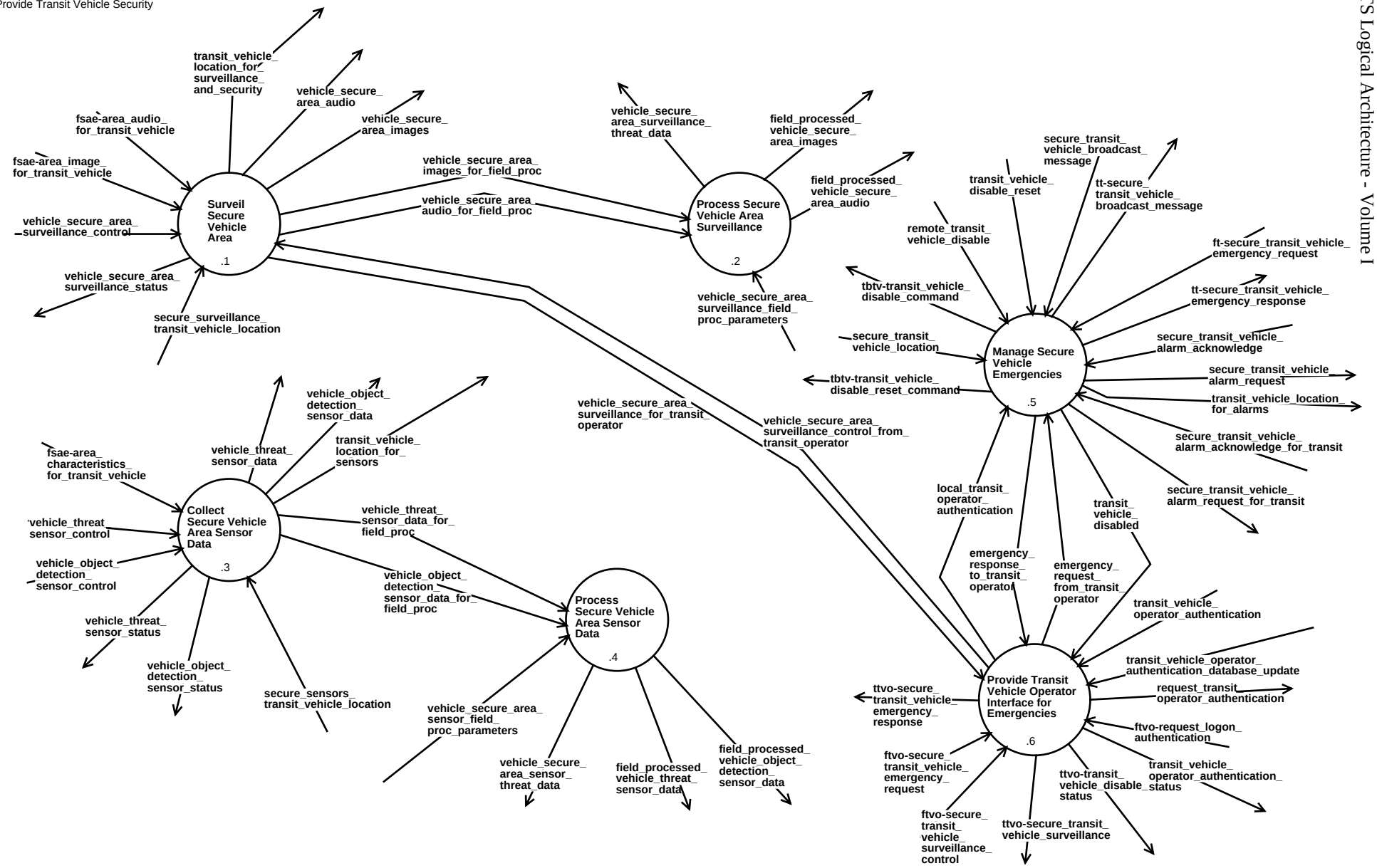
Provide Remote Security

5.1.7.2
Provide Remote Security

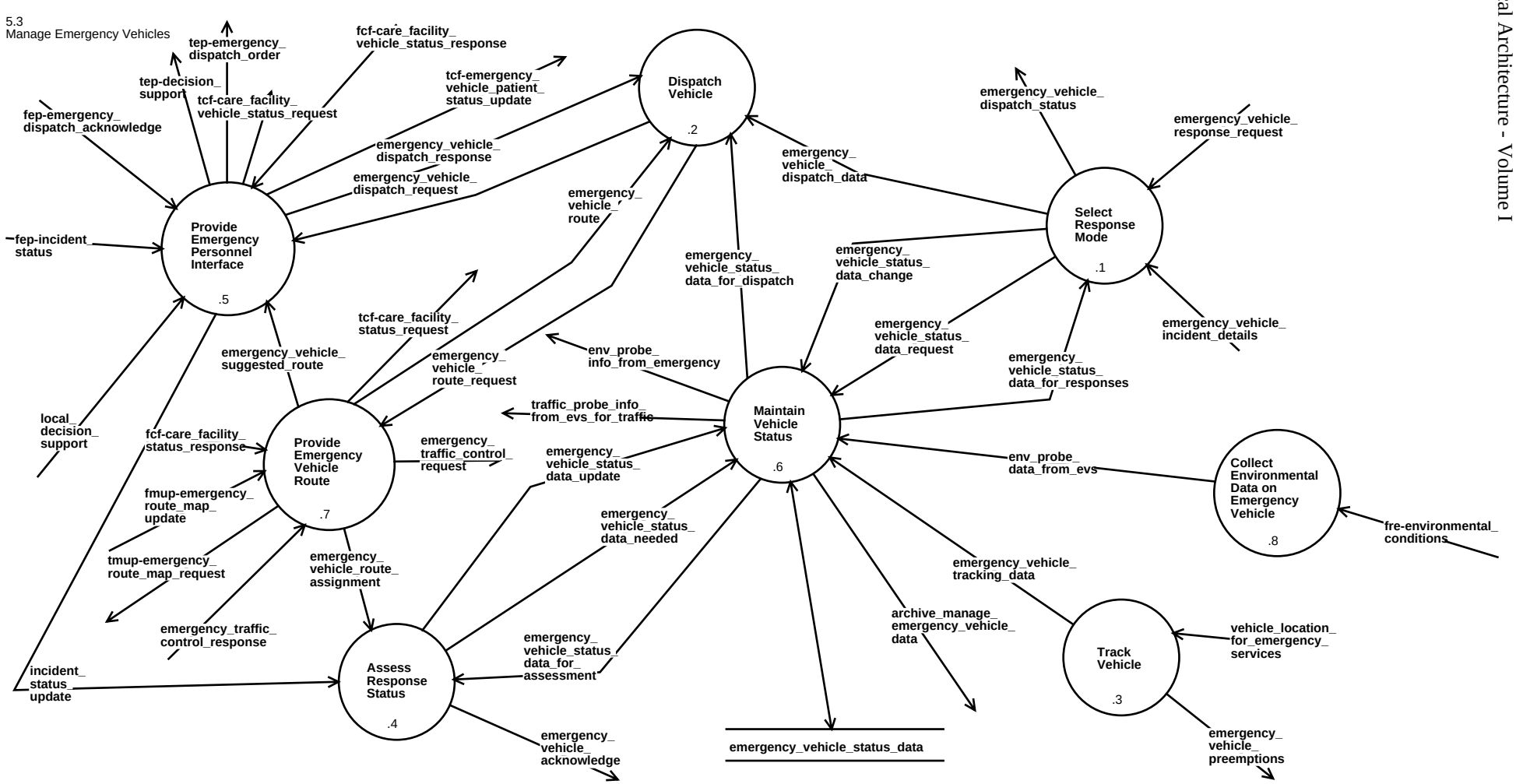


Provide Transit Vehicle Security

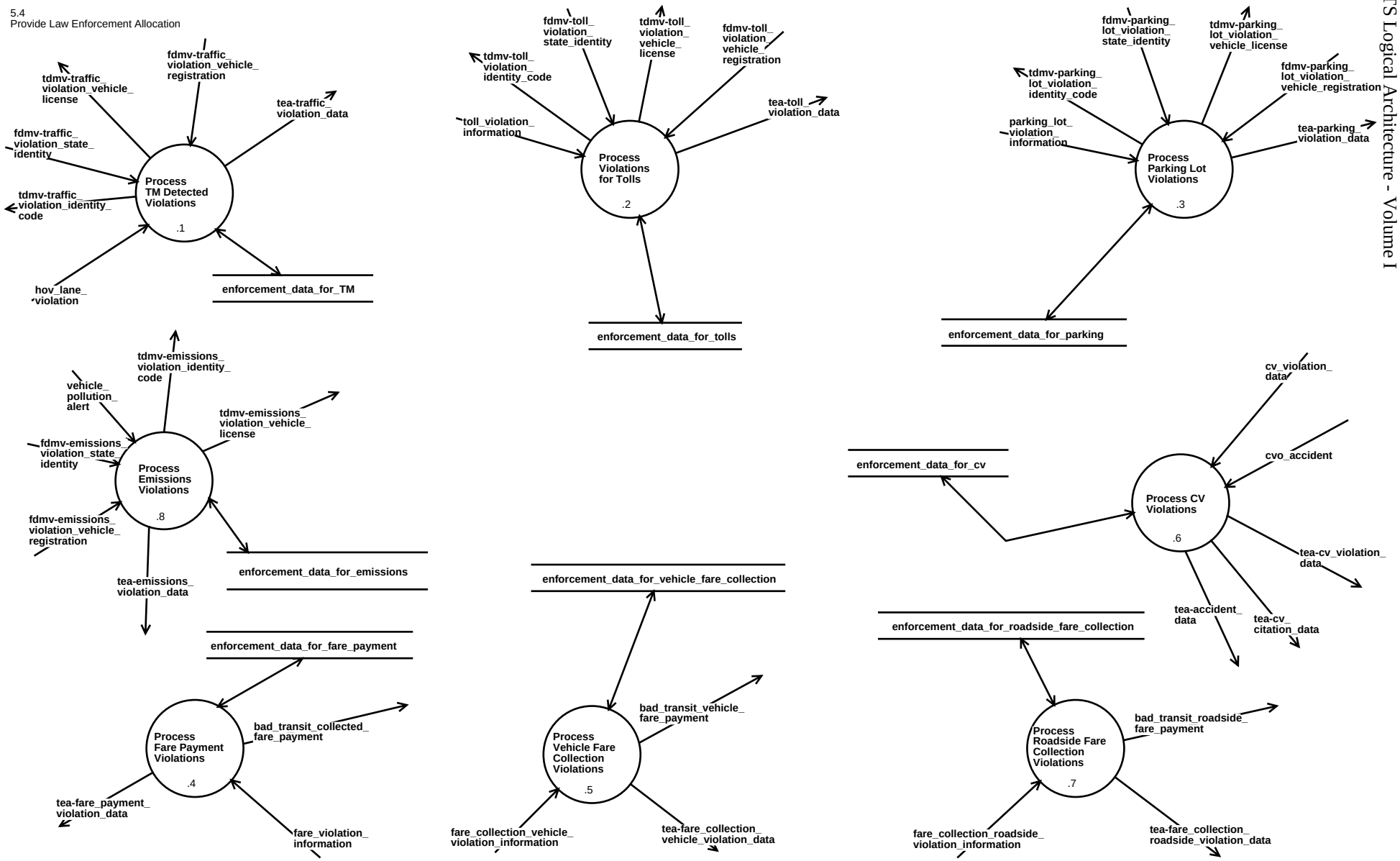
5.1.7.3
Provide Transit Vehicle Security



Manage Emergency Vehicles

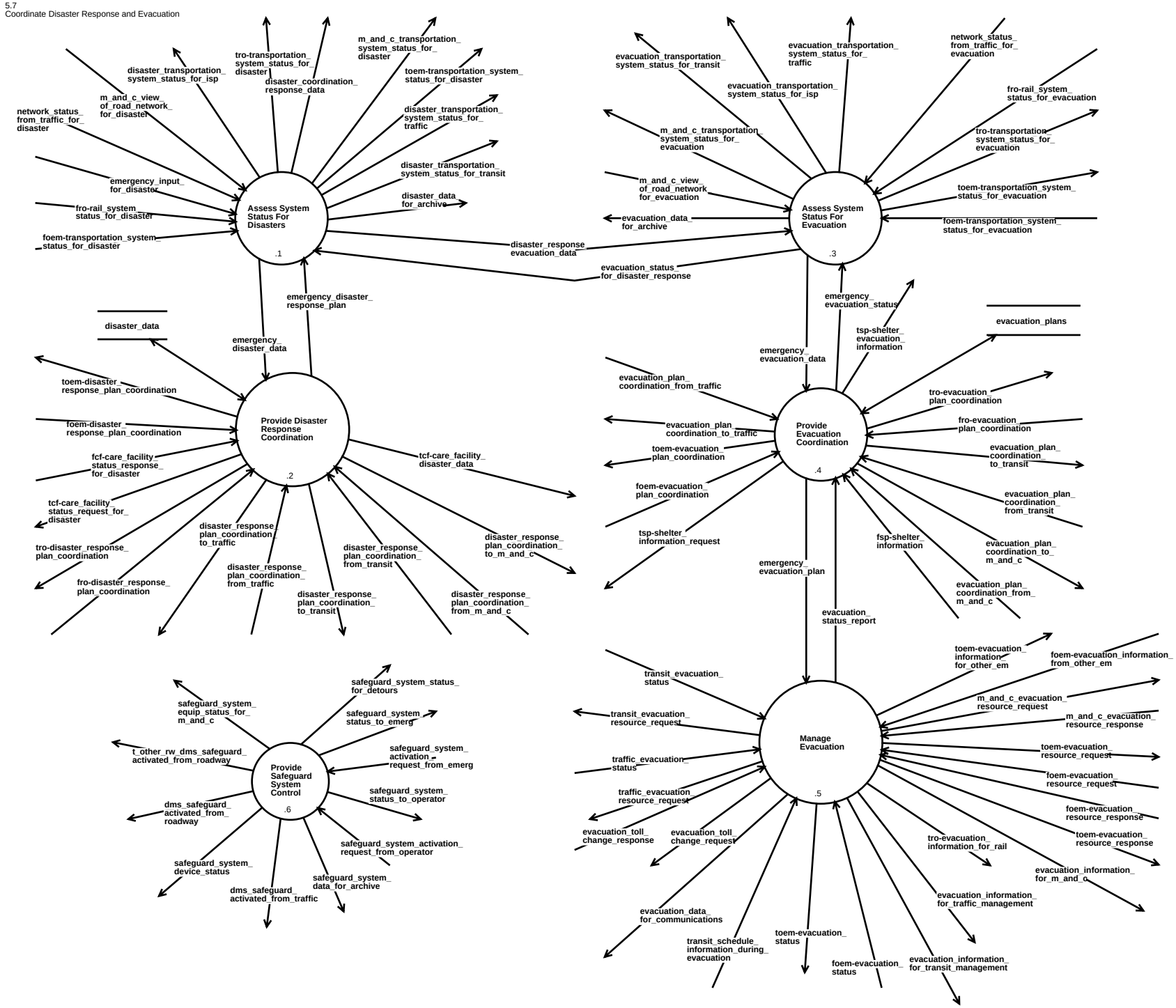


5.4
Provide Law Enforcement Allocation

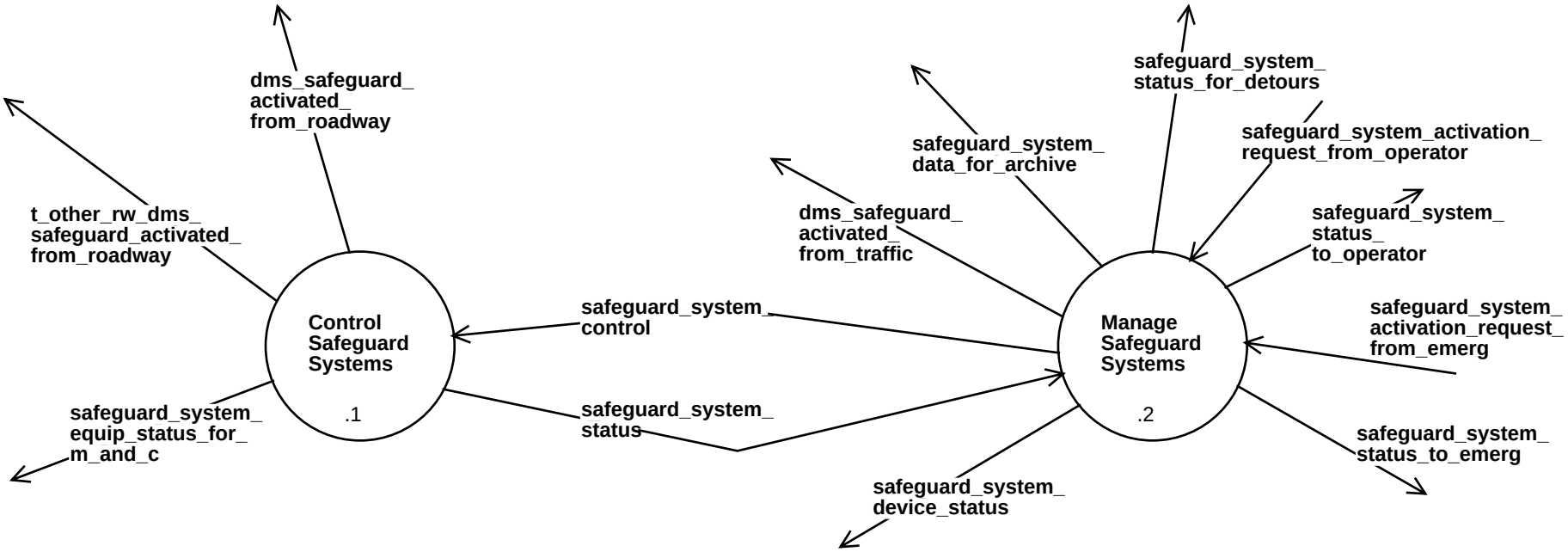


Coordinate Disaster Response and Evacuation

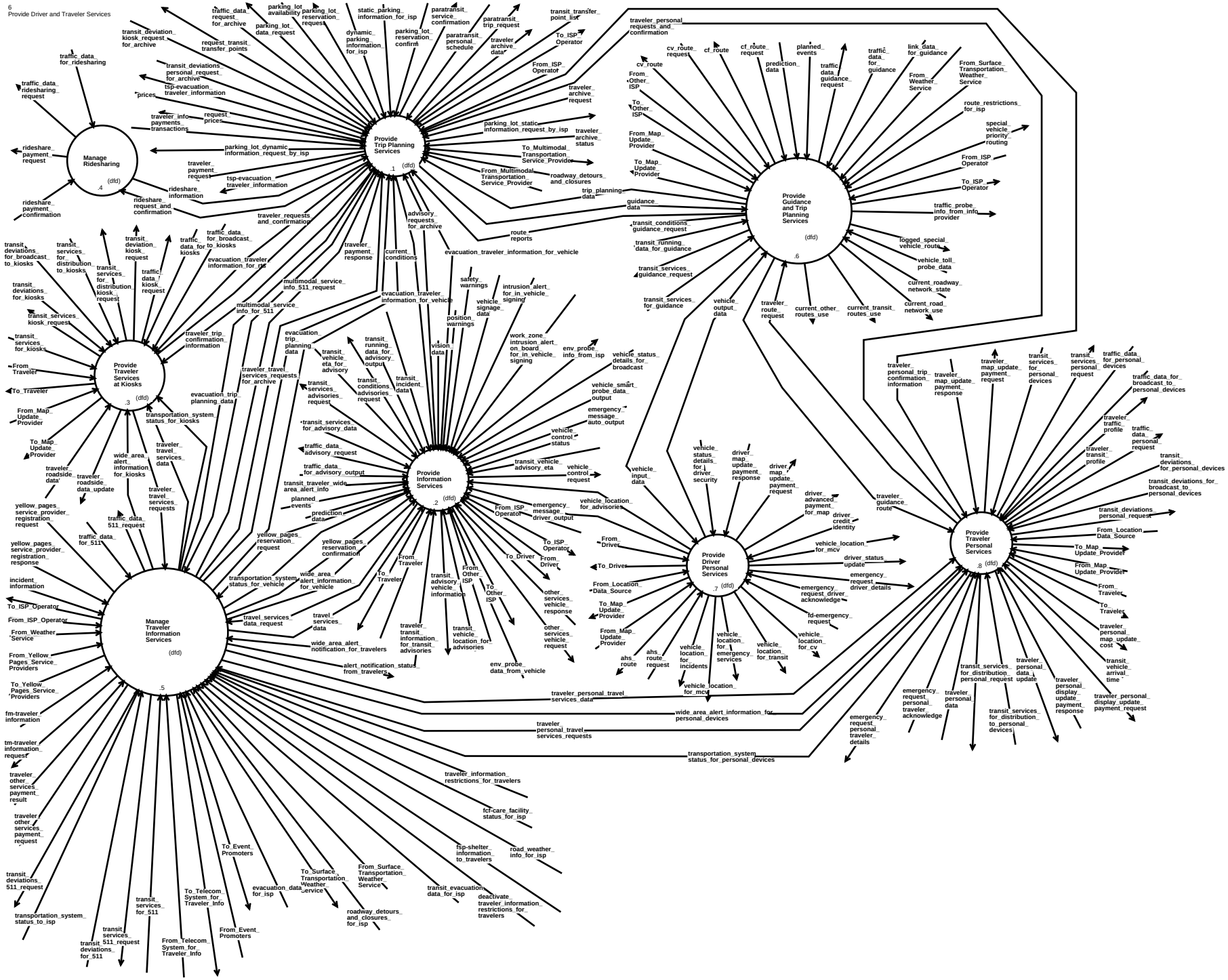
5.7
Coordinate Disaster Response and Evacuation



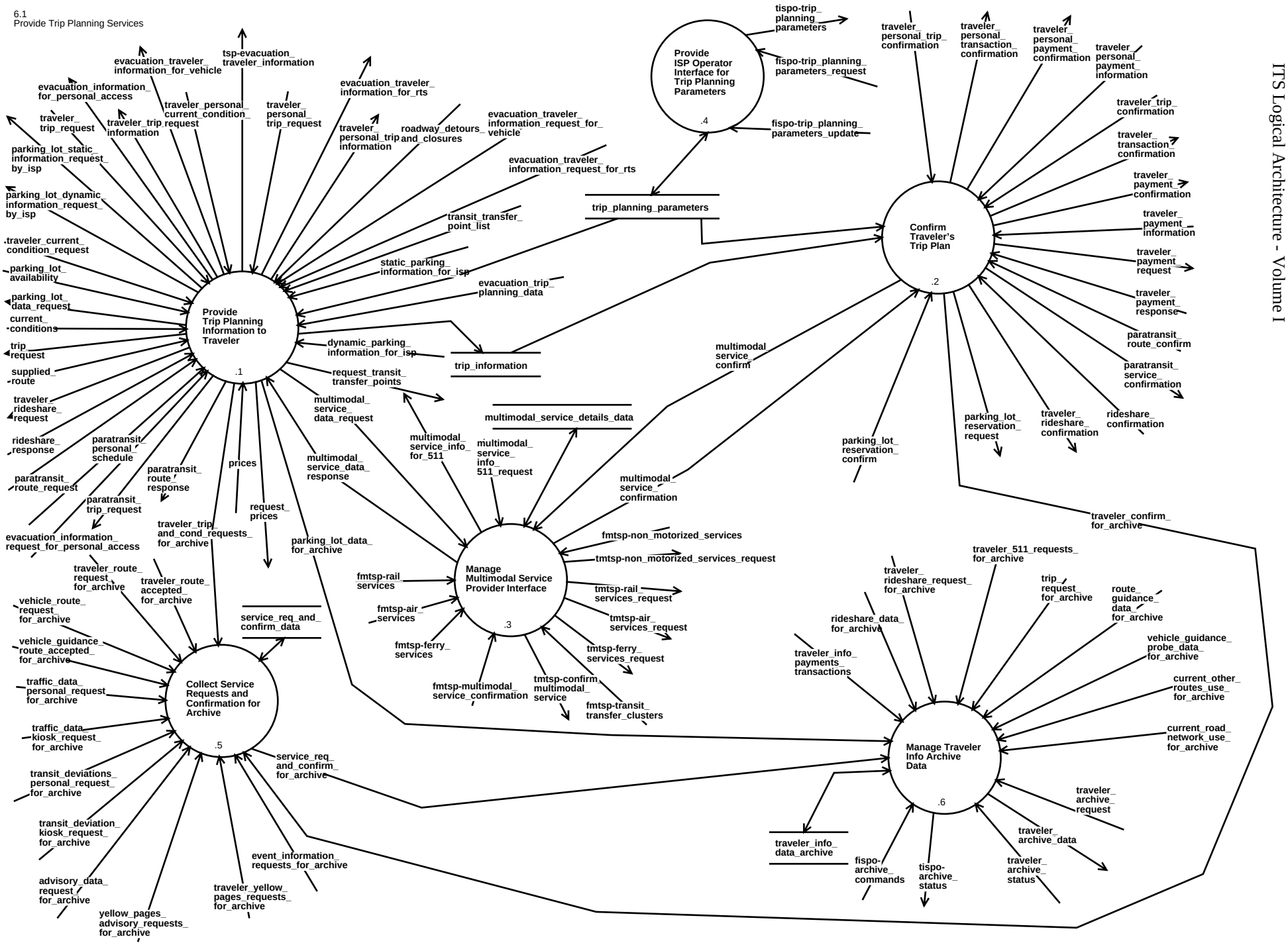
5.7.6
Provide Safeguard System Control

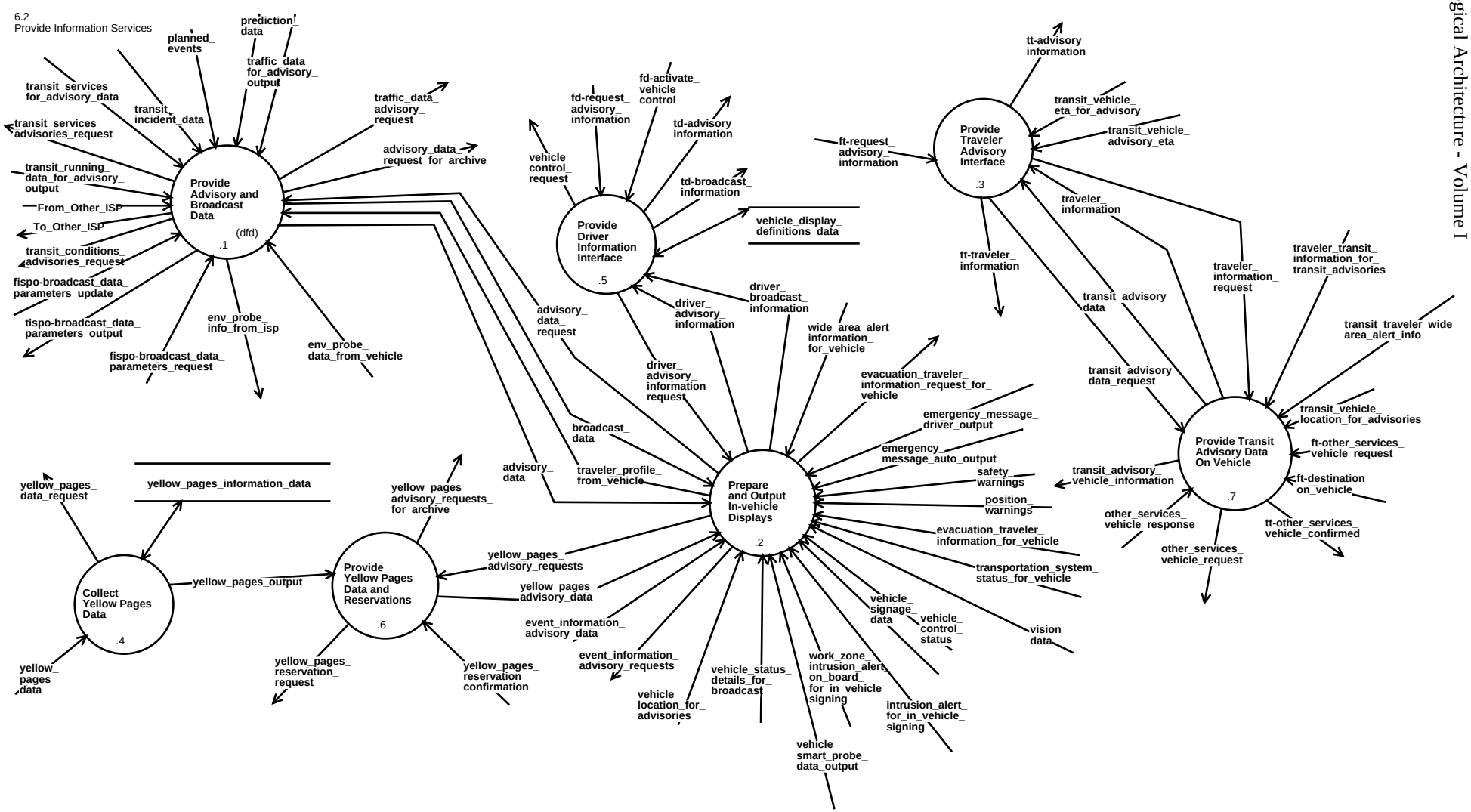


Provide Driver and Traveler Services



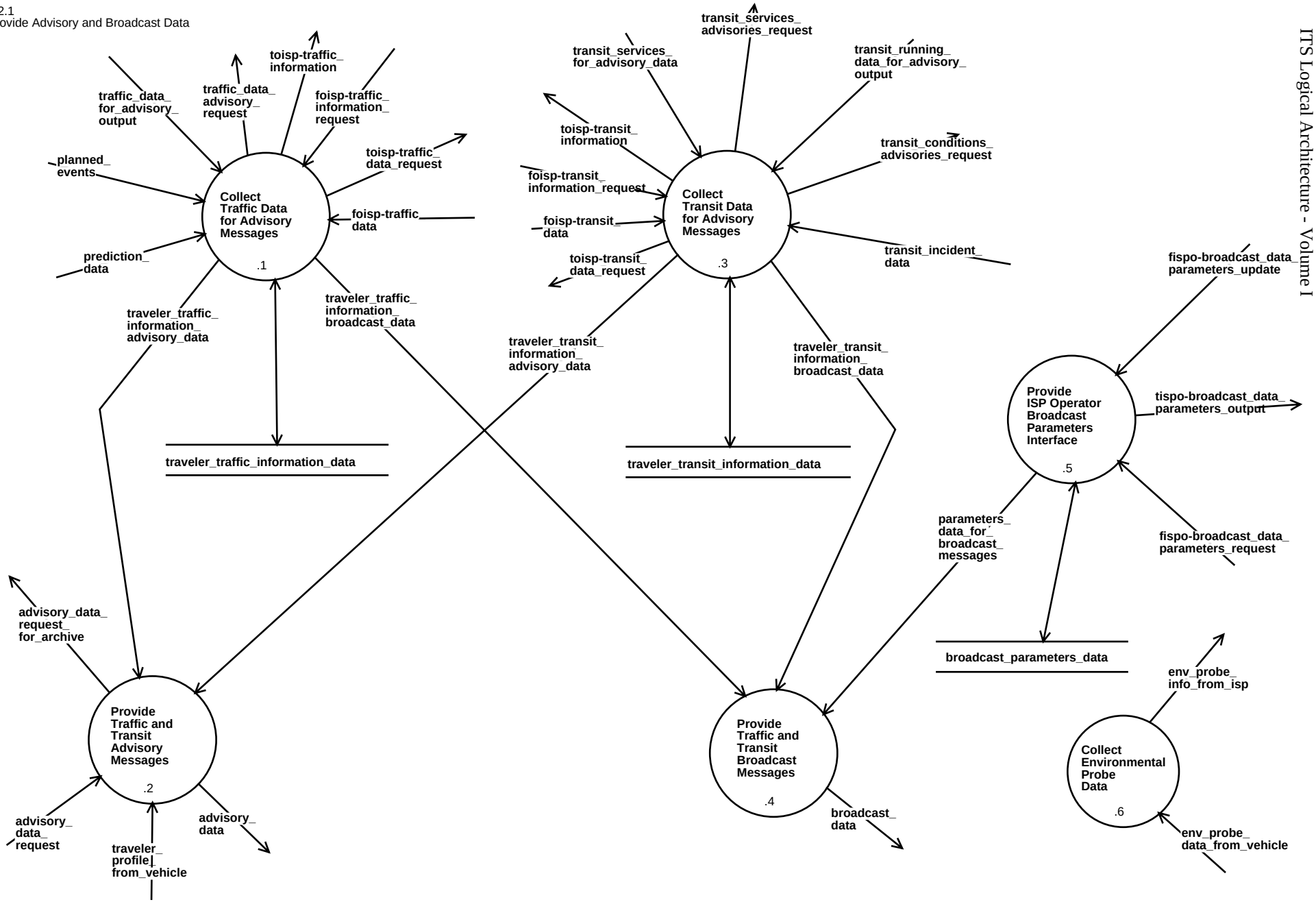
Provide Trip Planning Services




6.2
Provide Information Services
Provide Advisory and Broadcast Data
(dfd)
.1
transit_services_for_advisory_data
transit_services_advisories_request
transit_running_data_for_advisory_output
From_Other_ISP
To_Other_ISP
transit_conditions_advisories_request
fispo-broadcast_data_parameters_update
tispo-broadcast_data_parameters_output
fispo-broadcast_data_parameters_request
transit_incident_data
planned_events
prediction_data
traffic_data_for_advisory_output
traffic_data_advisory_request
advisory_data_request_for_archive
env_probe_info_from_isp
env_probe_data_from_vehicle
Provide Driver Information Interface
.5
vehicle_control_request
fd-request_advisory_information
fd-activate_vehicle_control
td-advisory_information
td-broadcast_information
vehicle_display_definitions_data
driver_advisory_information
driver_broadcast_information
driver_advisory_information_request
advisory_data_request
broadcast_data
advisory_data
traveler_profile_from_vehicle
Prepare and Output In-vehicle Displays
.2
wide_area_alert_information_for_vehicle
evacuation_traveler_information_request_for_vehicle
emergency_message_driver_output
emergency_message_auto_output
safety_warnings
position_warnings
evacuation_traveler_information_for_vehicle
transportation_system_status_for_vehicle
vision_data
vehicle_signage_data
vehicle_control_status
work_zone_intrusion_alert_on_board_for_in_vehicle_signing
intrusion_alert_for_in_vehicle_signing
vehicle_smart_probe_data_output
vehicle_status_details_for_broadcast
vehicle_location_for_advisories
event_information_advisory_requests
event_information_advisory_data
yellow_pages_advisory_requests
yellow_pages_advisory_data
yellow_pages_reservation_confirmation
yellow_pages_reservation_request
yellow_pages_advisory_requests_for_archive
Provide Yellow Pages Data and Reservations
.6
yellow_pages_output
Collect Yellow Pages Data
.4
yellow_pages_data_request
yellow_pages_data
yellow_pages_information_data
Provide Traveler Advisory Interface
.3
ft-request_advisory_information
tt-advisory_information
transit_vehicle_eta_for_advisory
transit_vehicle_advisory_eta
traveler_information
tt-traveler_information
transit_advisory_data
Provide Transit Advisory Data On Vehicle
.7
traveler_information_request
traveler_transit_information_for_transit_advisories
transit_traveler_wide_area_alert_info
transit_advisory_data_request
transit_vehicle_location_for_advisories
ft-other_services_vehicle_request
ft-destination_on_vehicle
transit_advisory_vehicle_information
other_services_vehicle_response
tt-other_services_vehicle_confirmed
other_services_vehicle_request

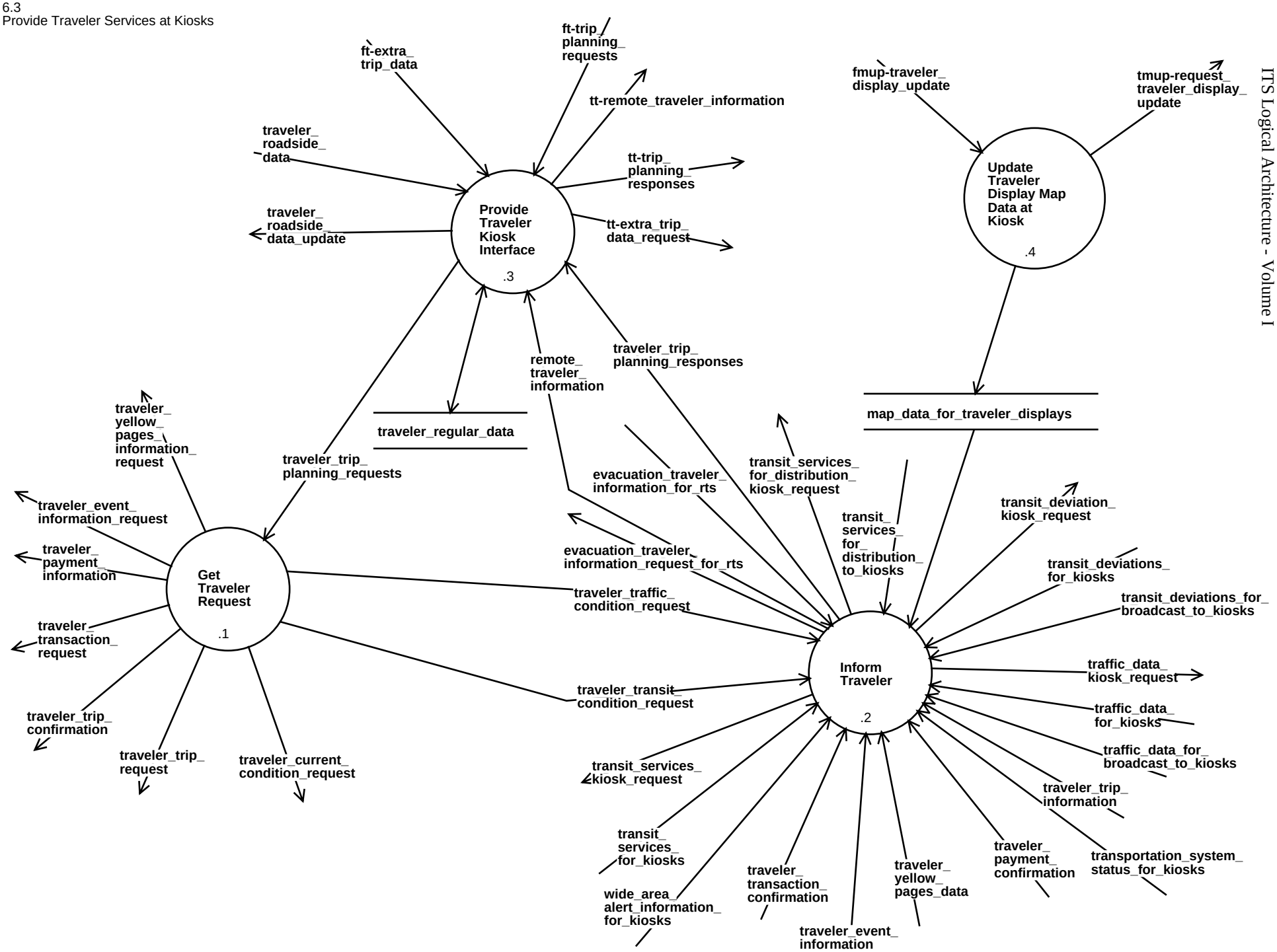
Provide Advisory and Broadcast Data

6.2.1
Provide Advisory and Broadcast Data

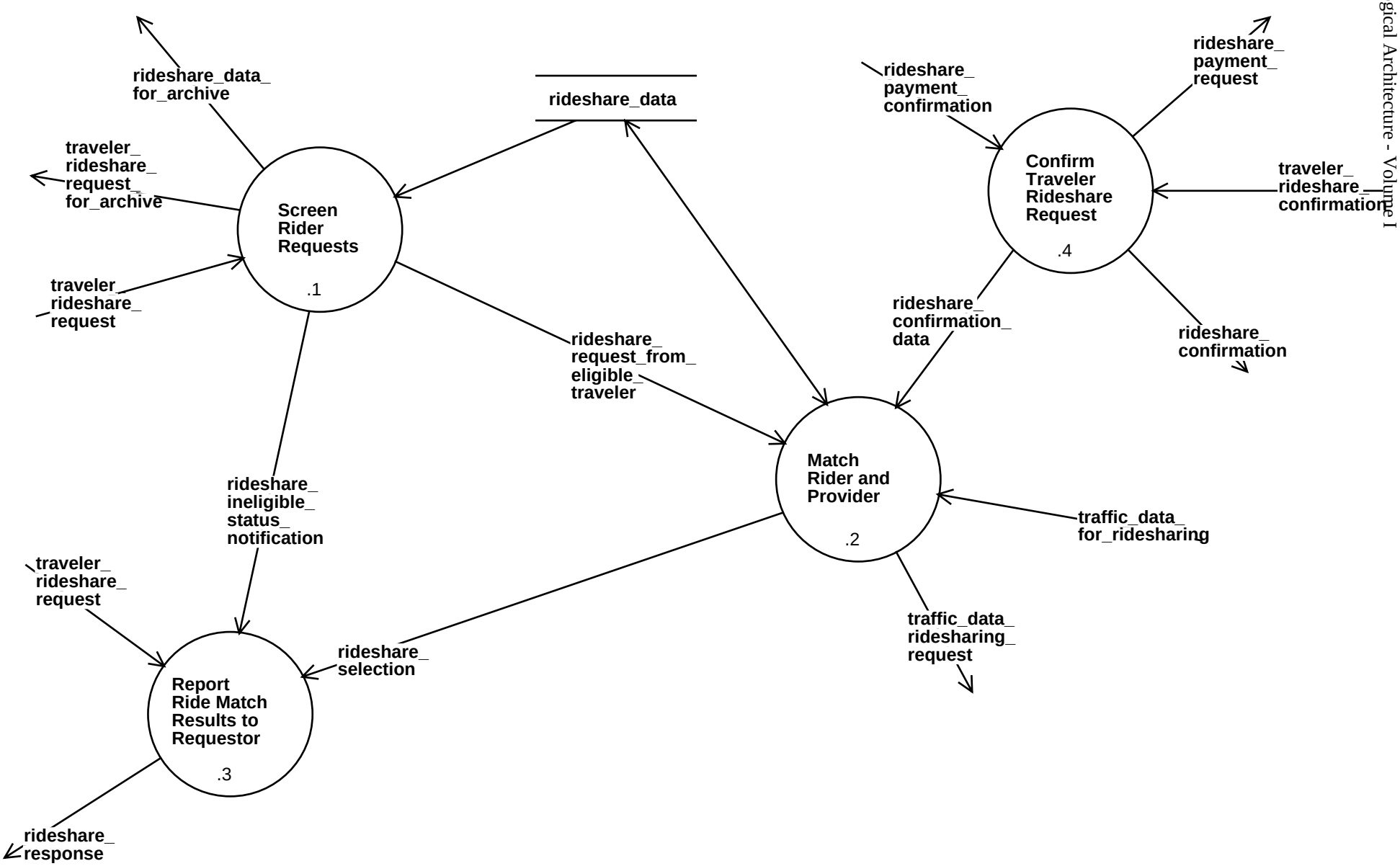


Provide Traveler Services at Kiosks

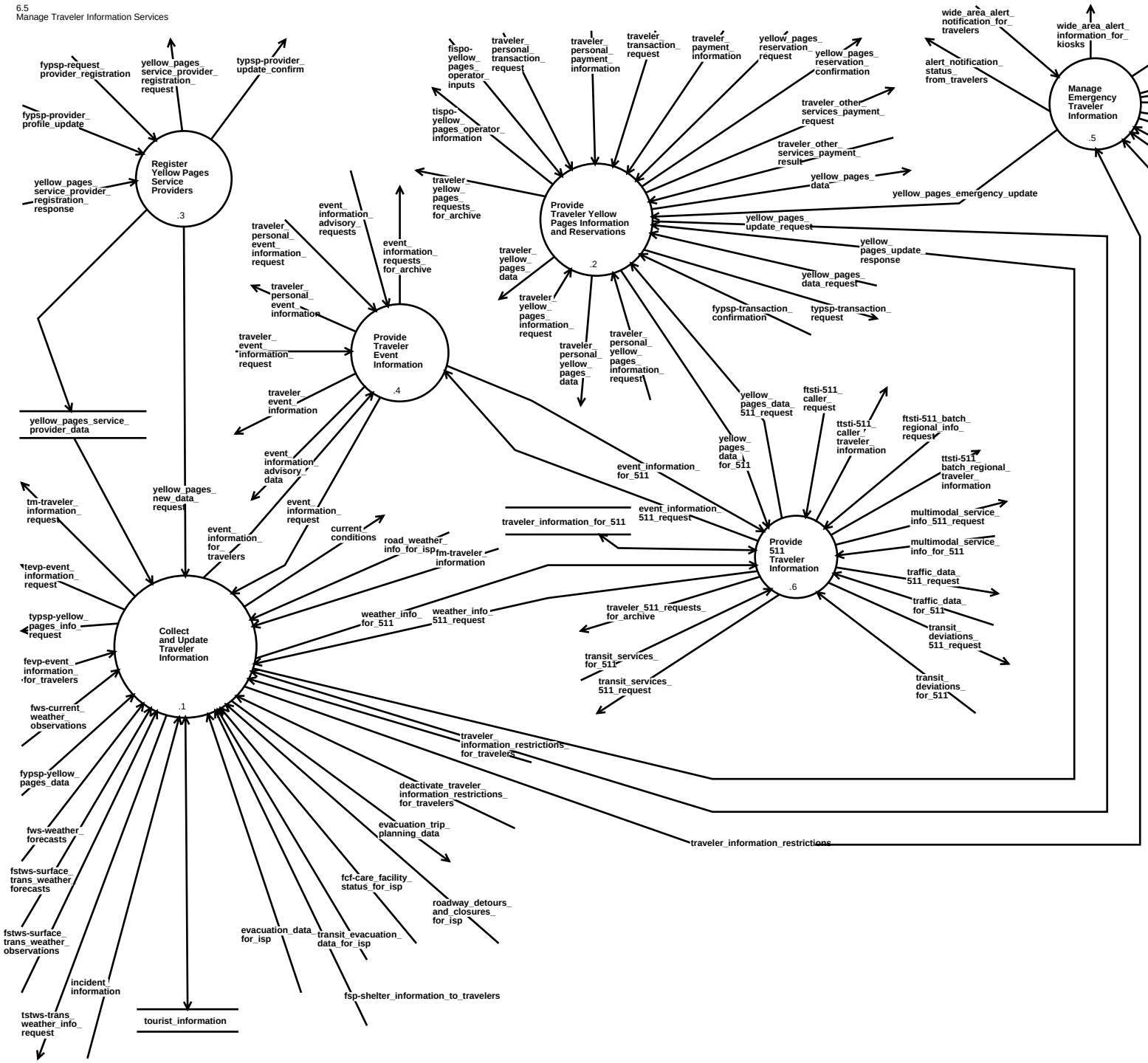
6.3
Provide Traveler Services at Kiosks



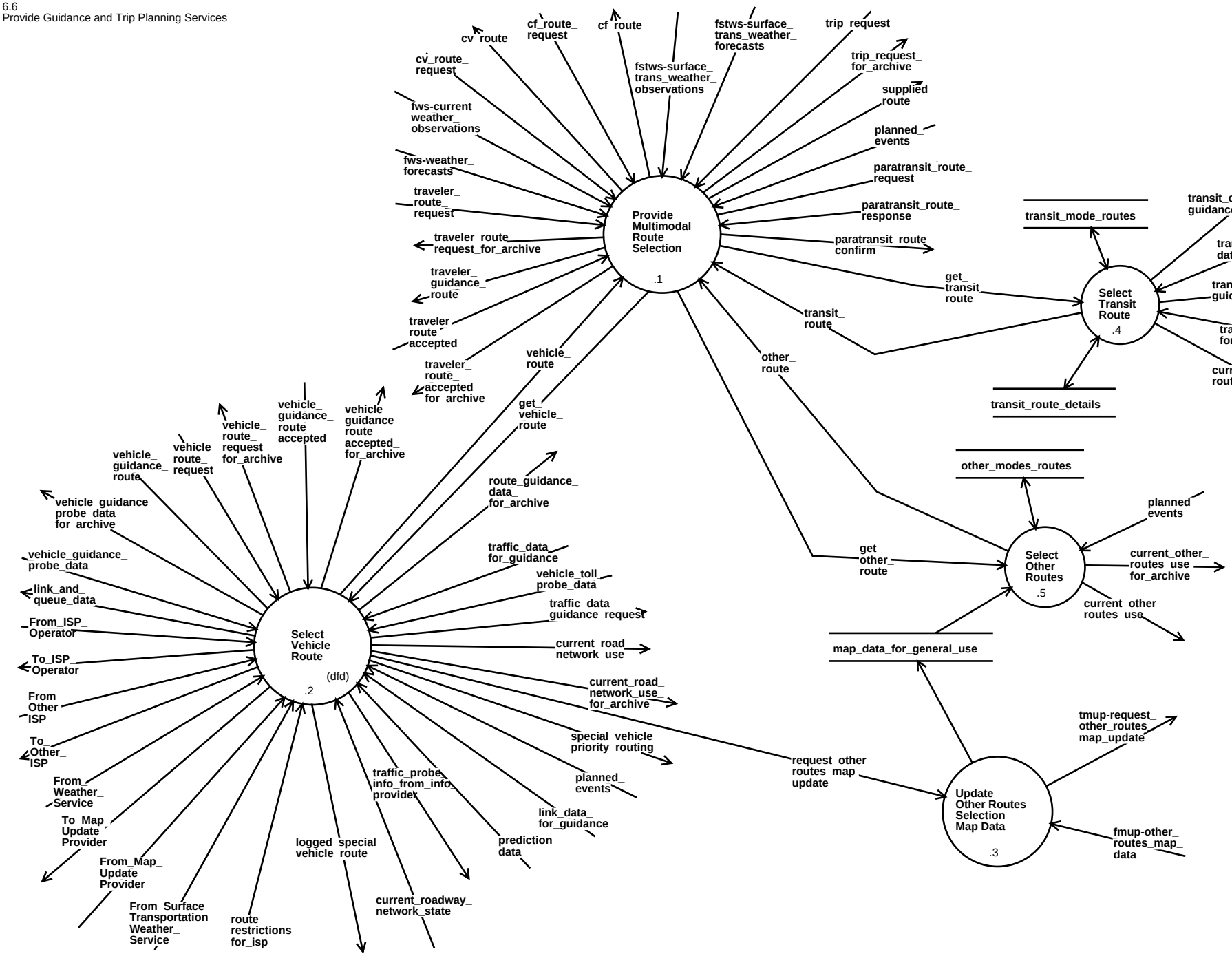
6.4
Manage Ridesharing



Manage Traveler Information Services

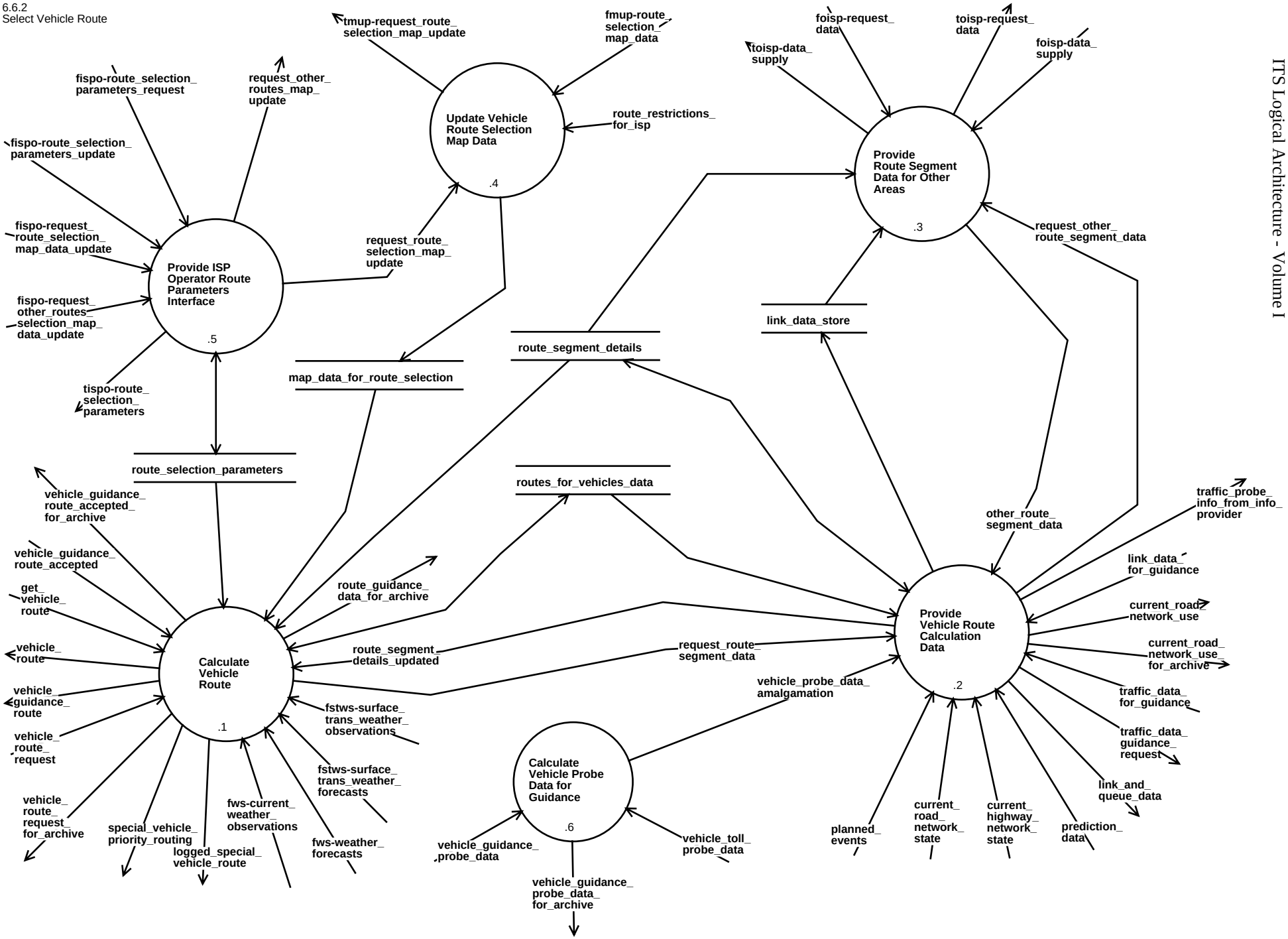


6.6
Provide Guidance and Trip Planning Services



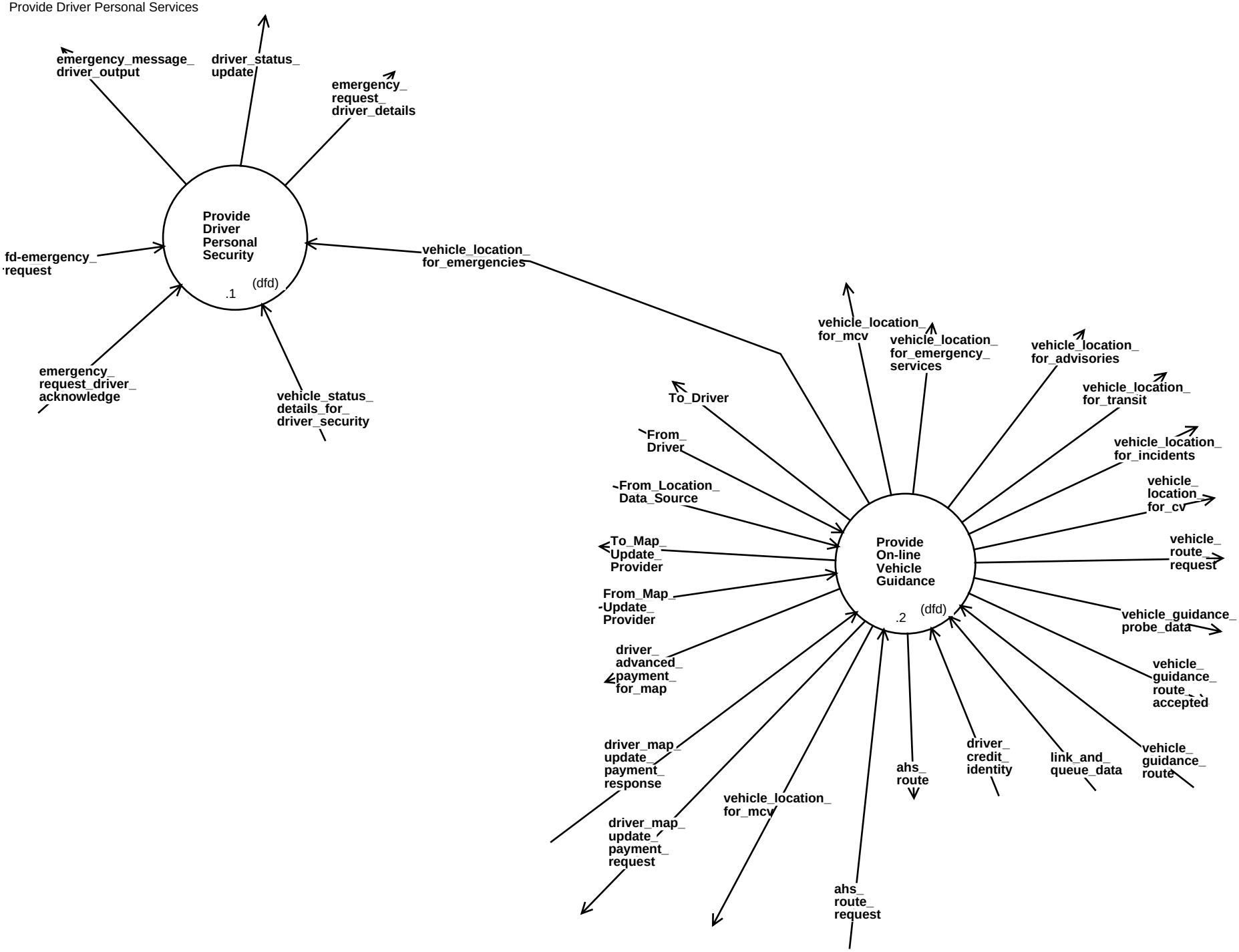
Select Vehicle Route

6.6.2
Select Vehicle Route

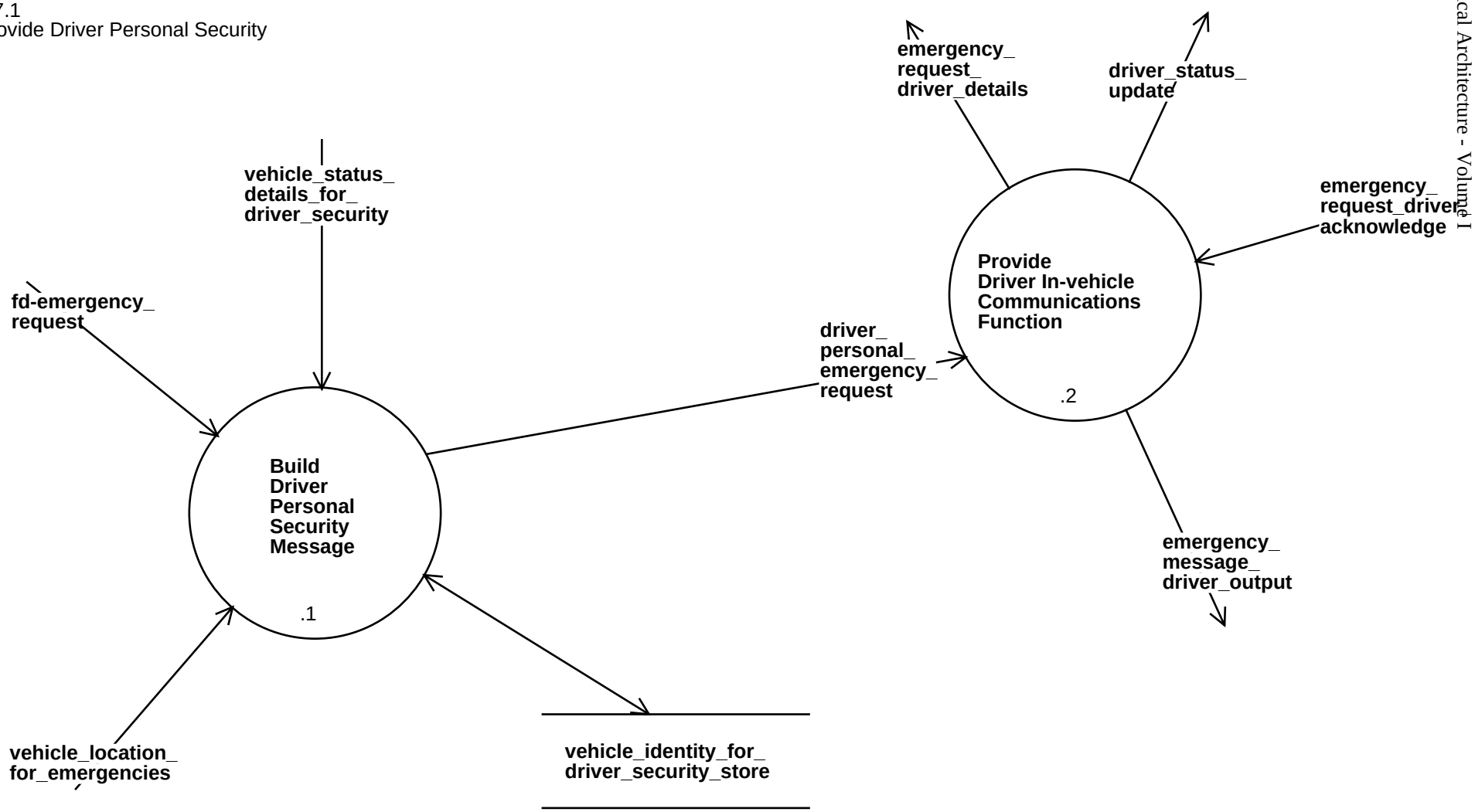


Provide Driver Personal Services

6.7
Provide Driver Personal Services

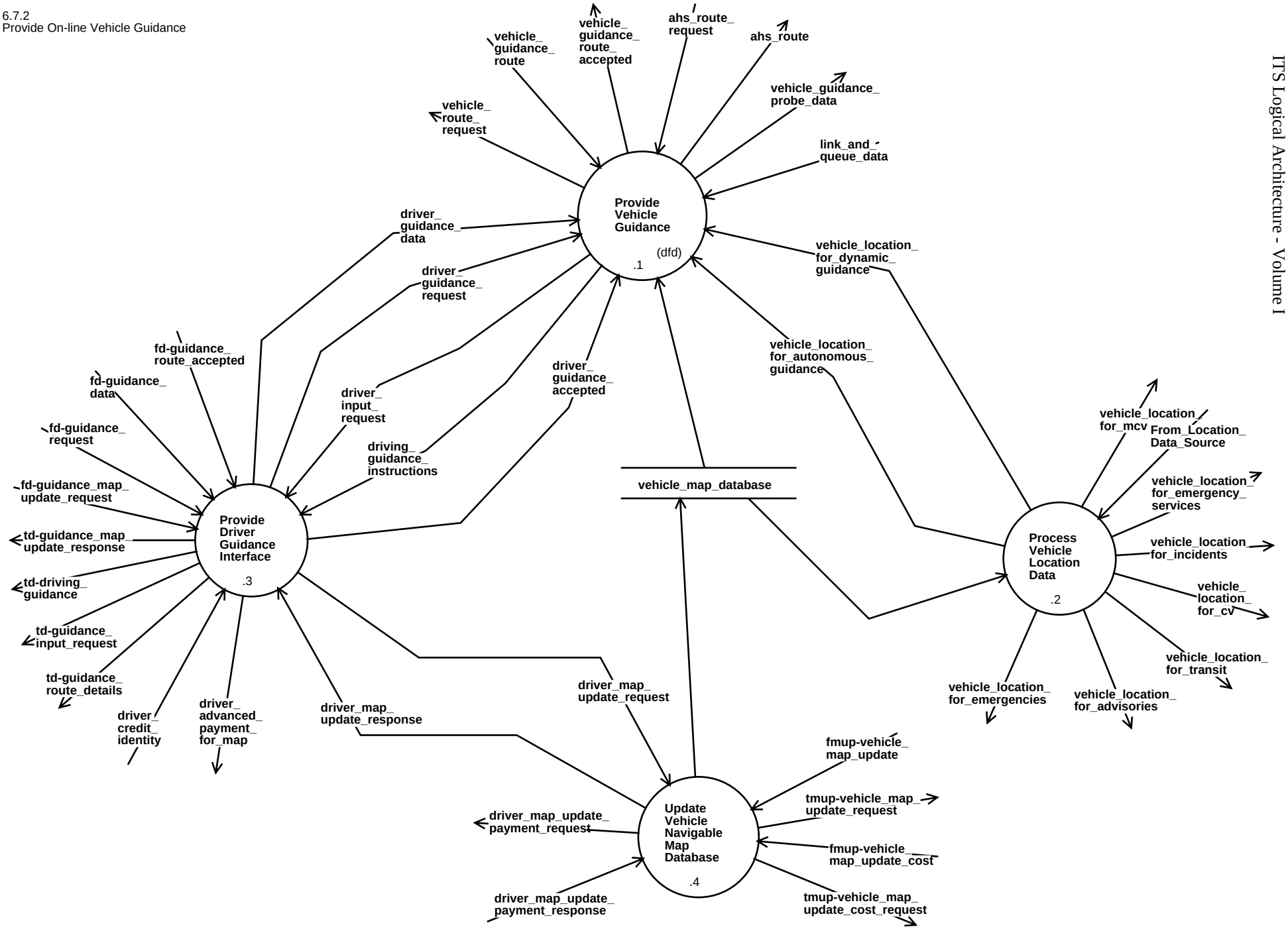


6.7.1
Provide Driver Personal Security



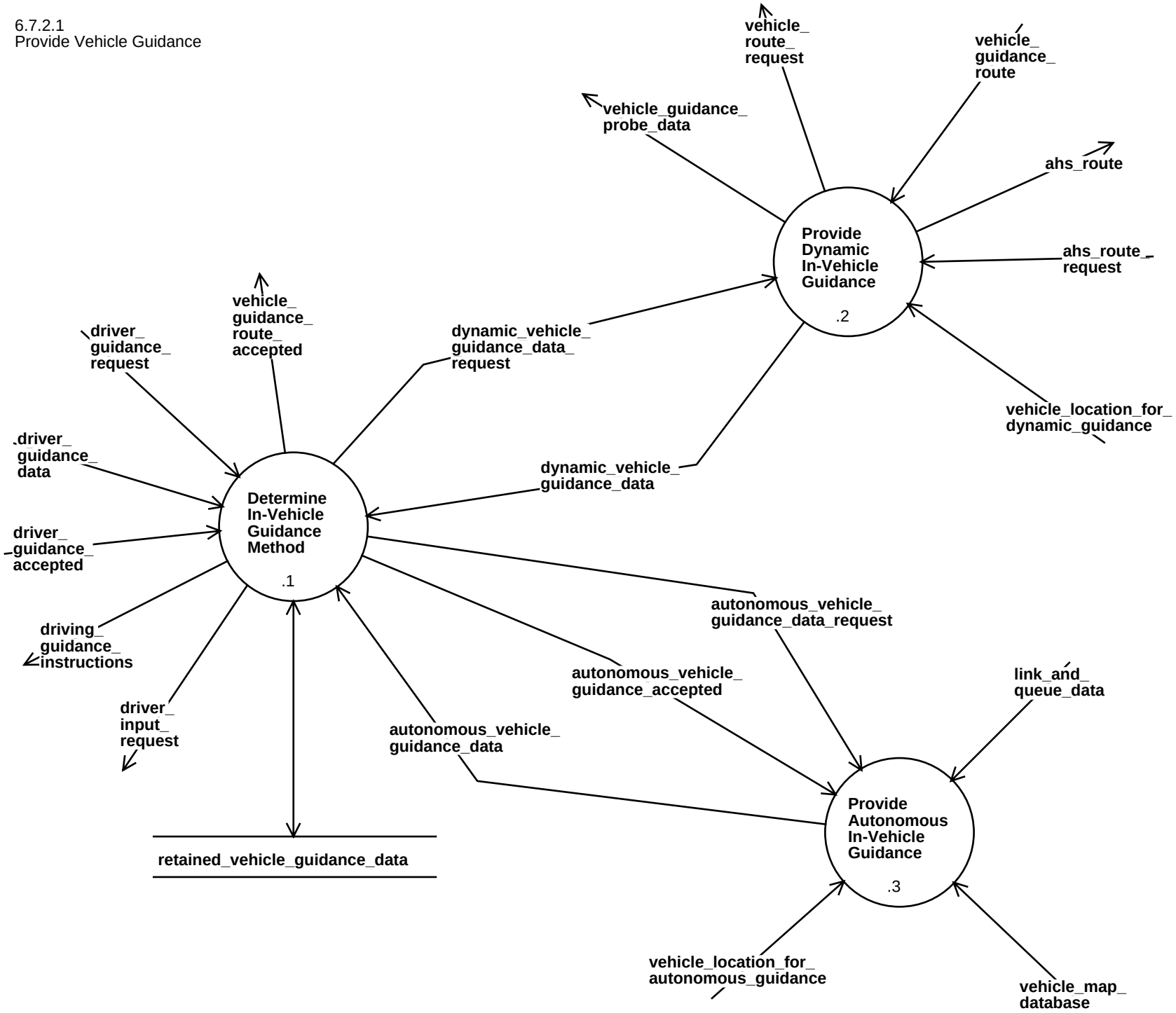
Provide On-line Vehicle Guidance

6.7.2
Provide On-line Vehicle Guidance



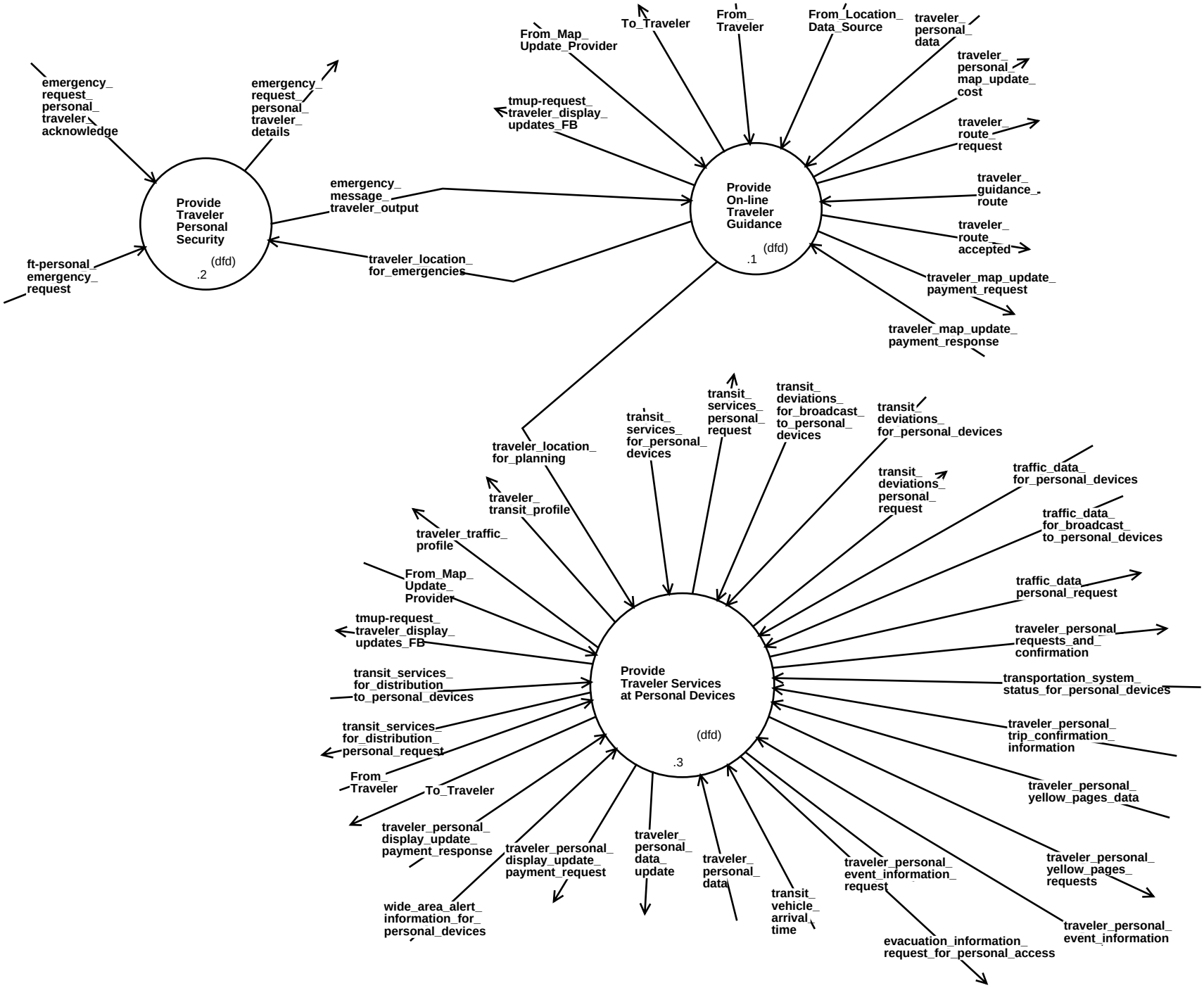
Provide Vehicle Guidance

6.7.2.1
Provide Vehicle Guidance



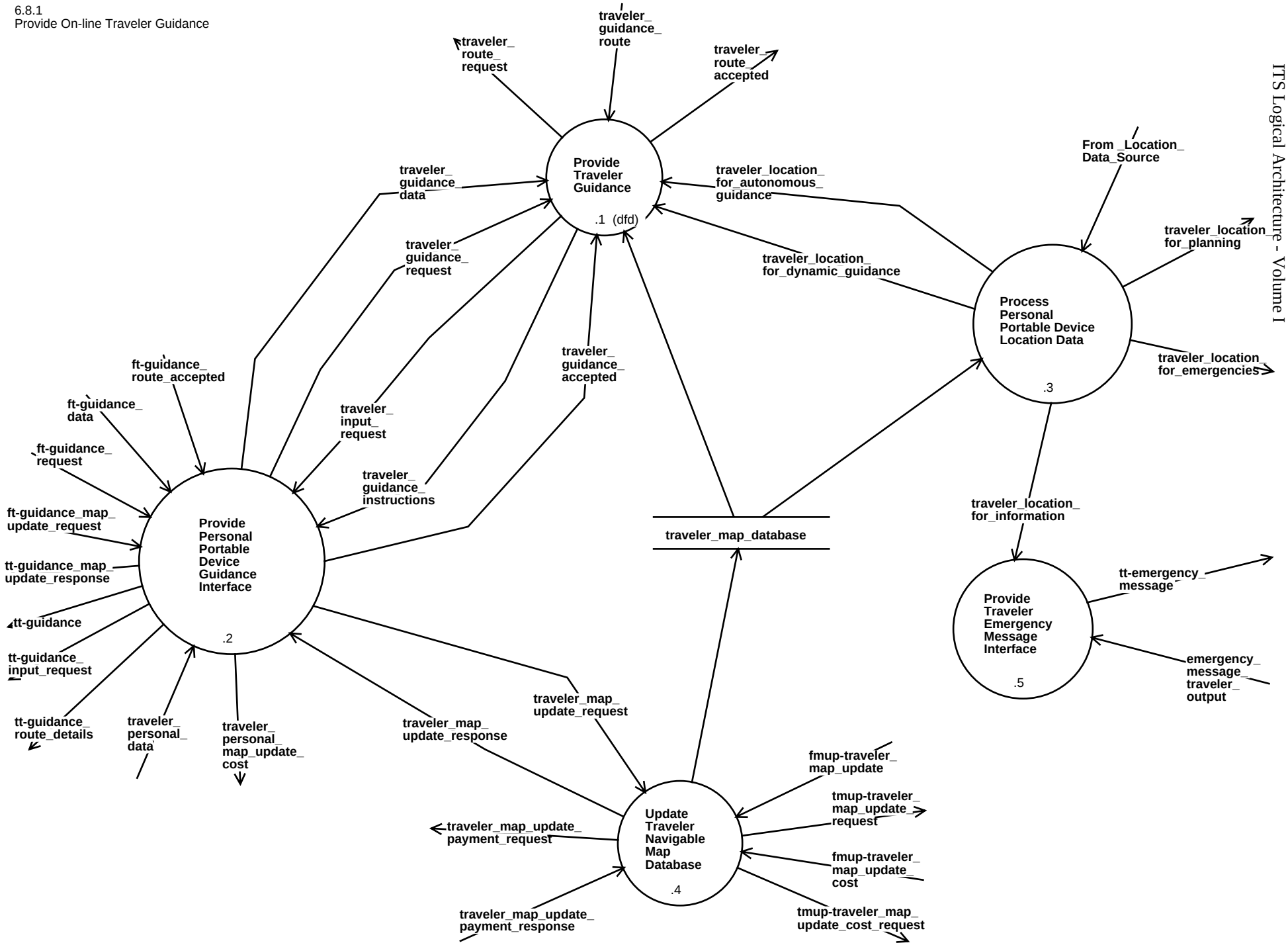
Provide Traveler Personal Services

6.8
Provide Traveler Personal Services

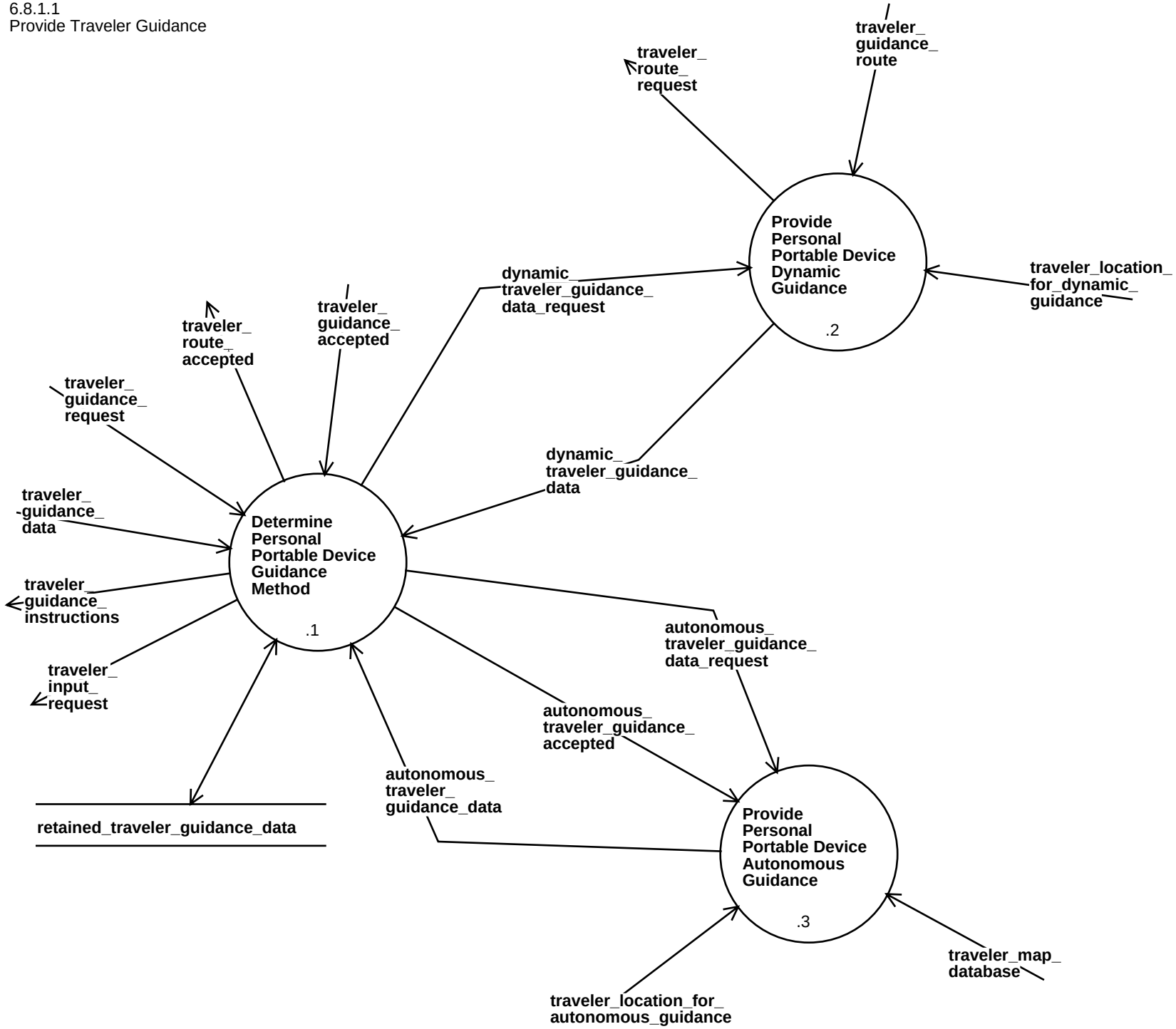


Provide On-line Traveler Guidance

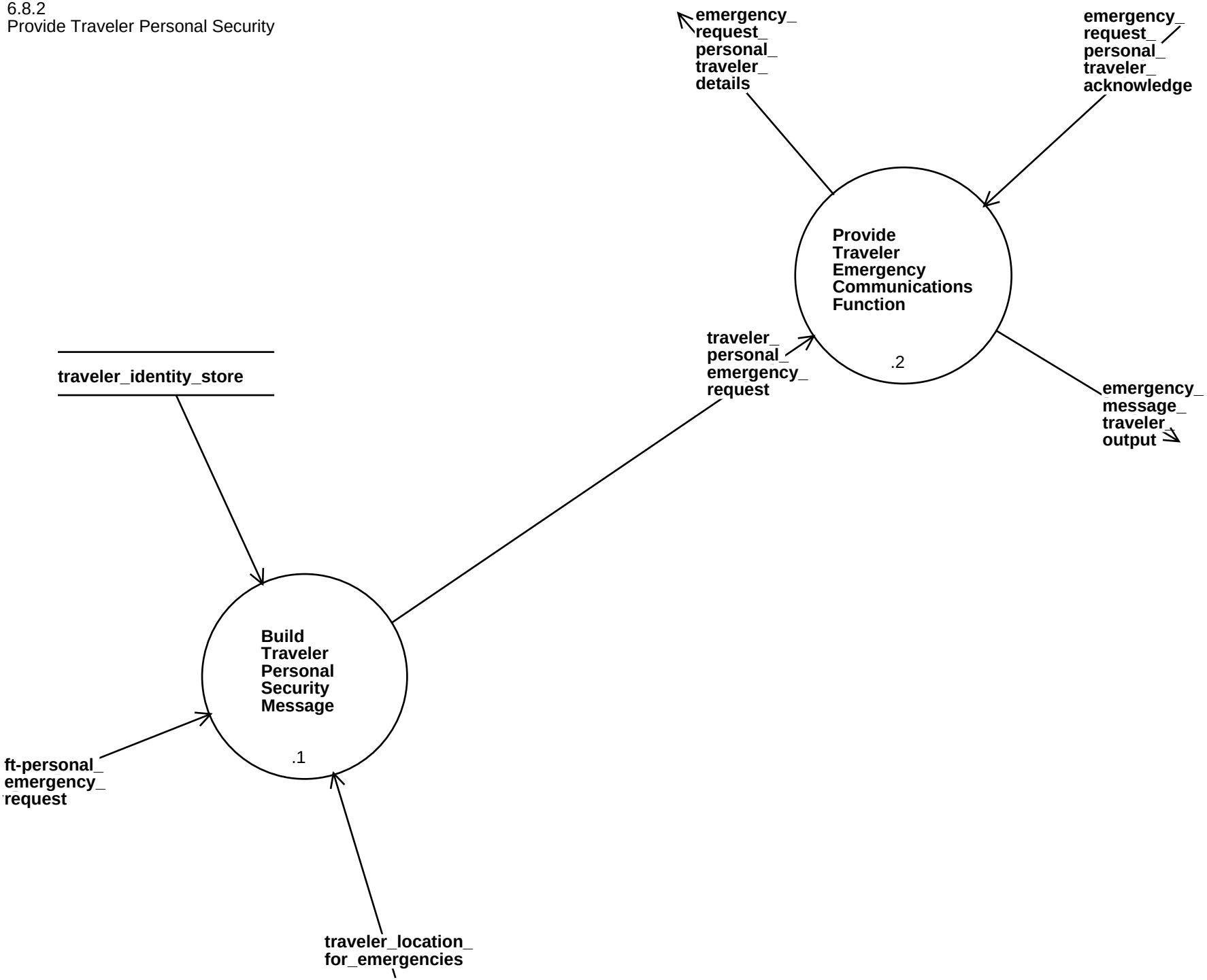
6.8.1
Provide On-line Traveler Guidance



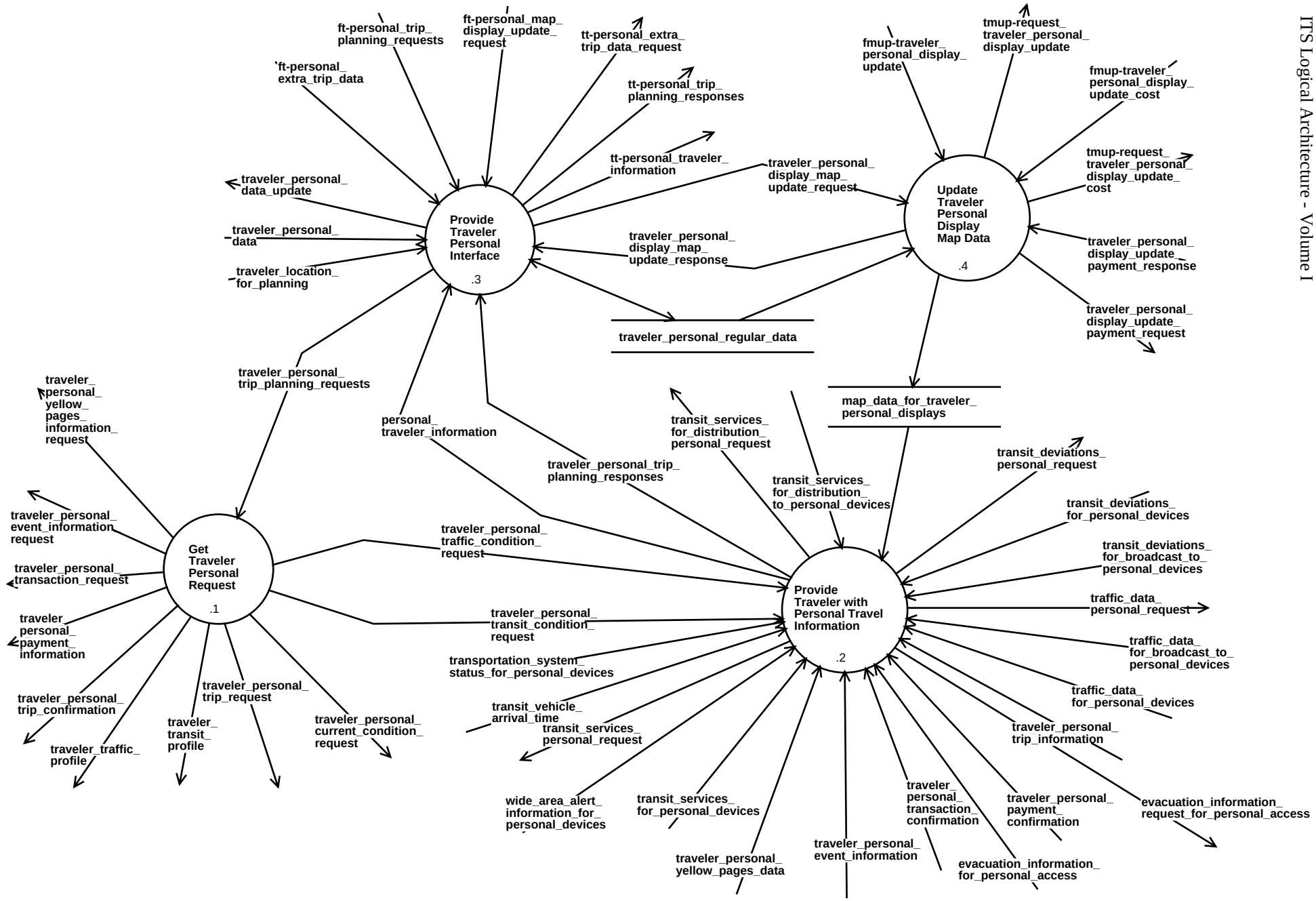
6.8.1.1
Provide Traveler Guidance



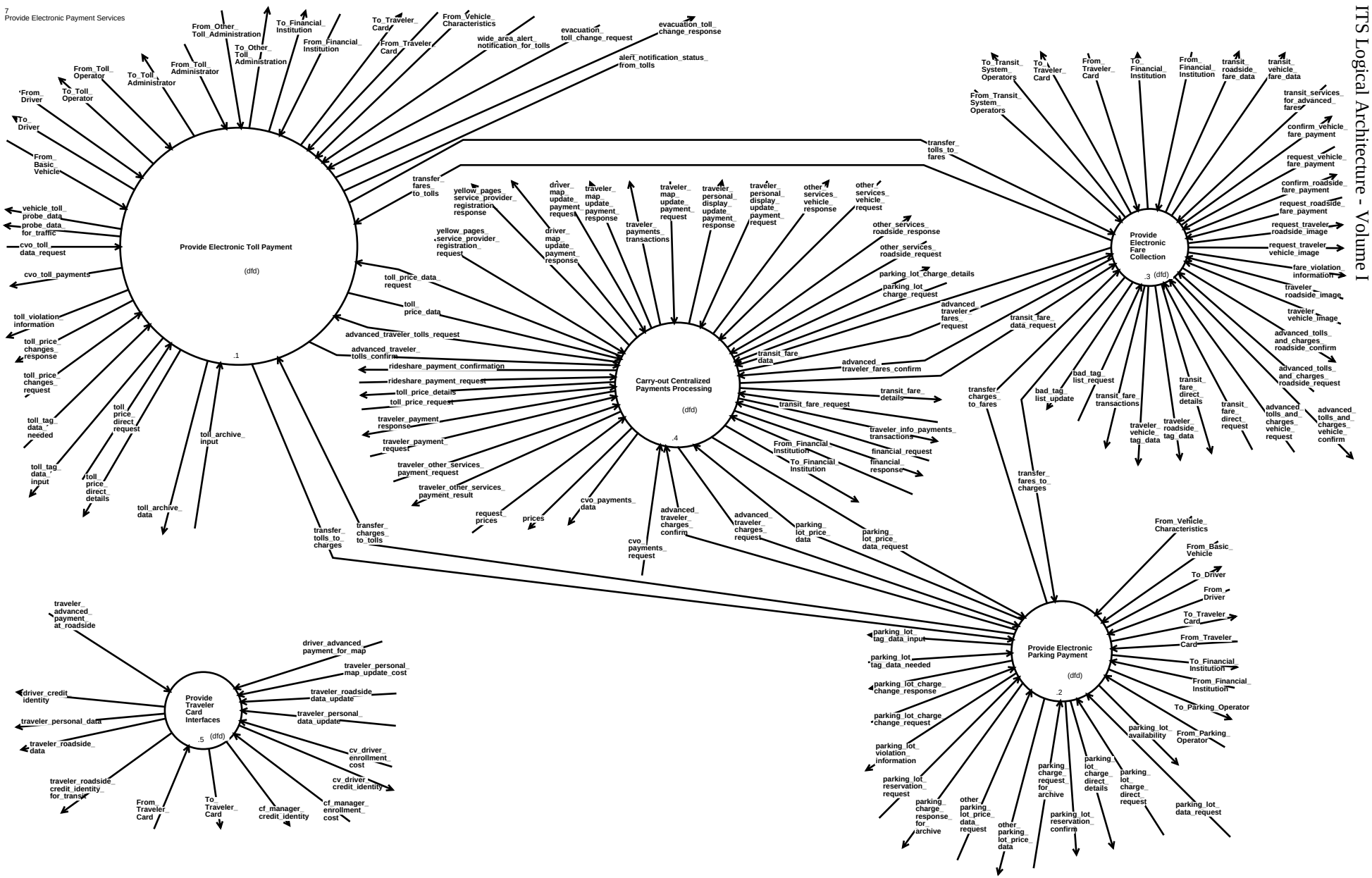
6.8.2
Provide Traveler Personal Security



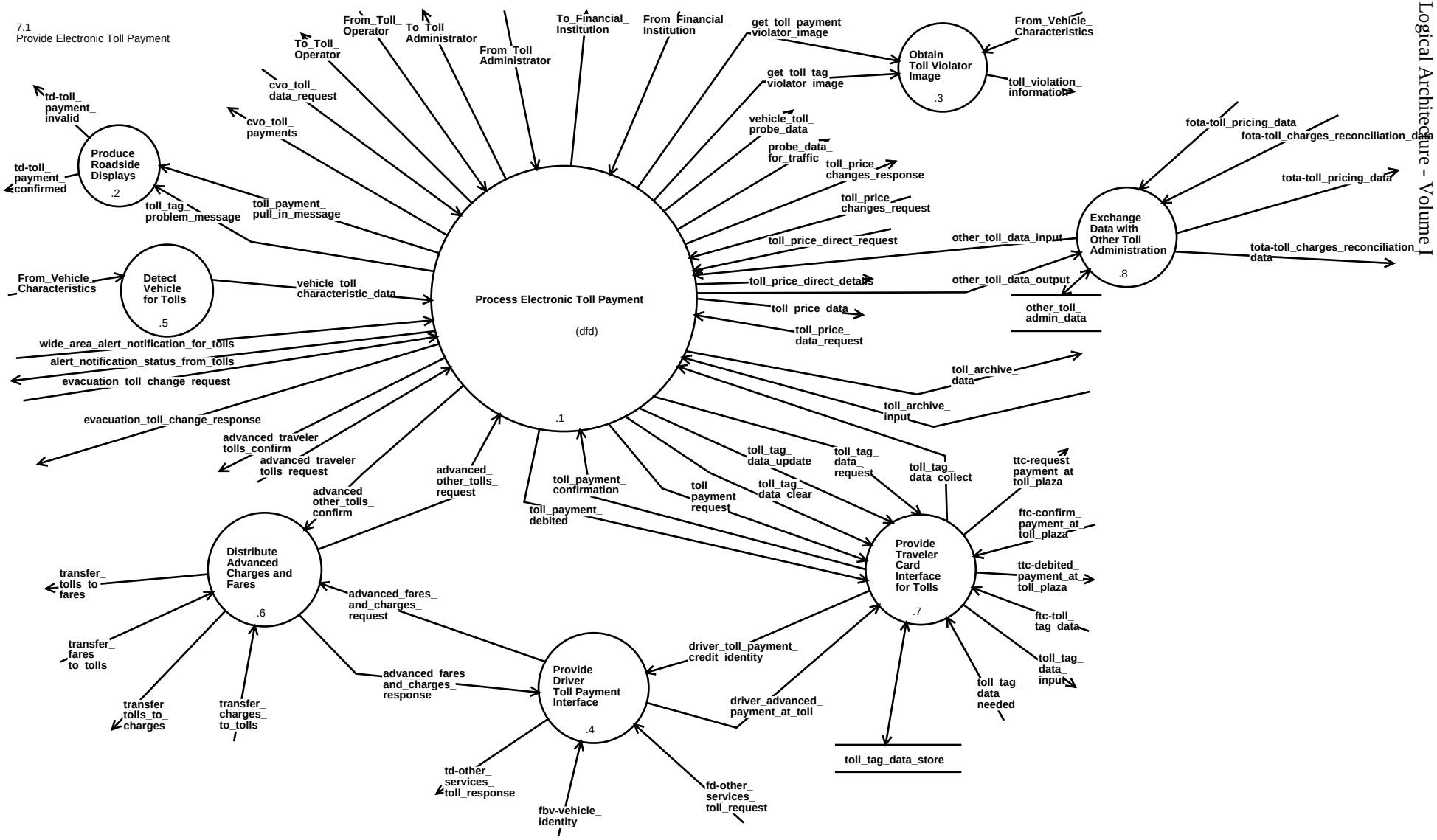
6.8.3
Provide Traveler Services at Personal Devices



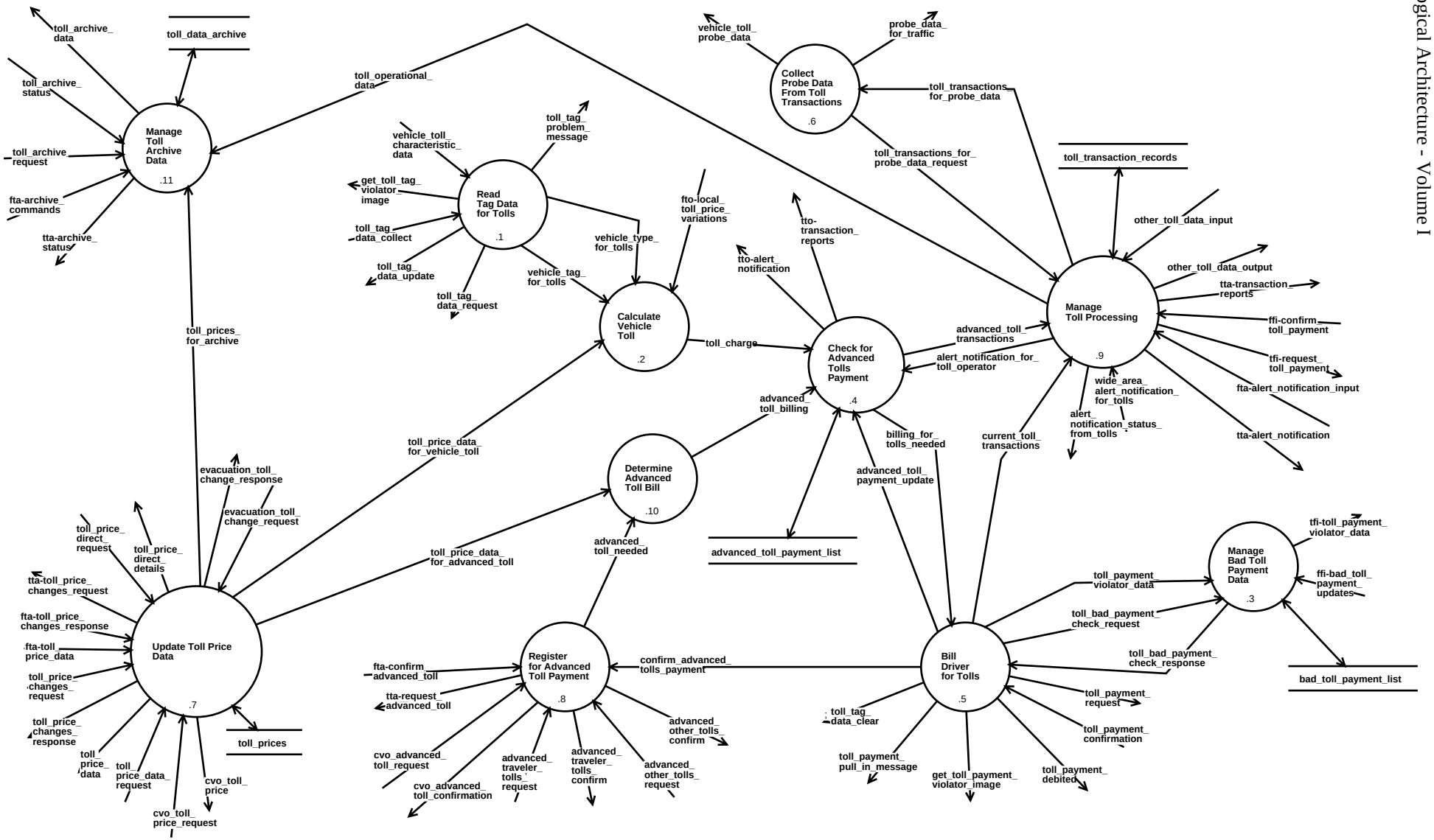
Provide Electronic Payment Services

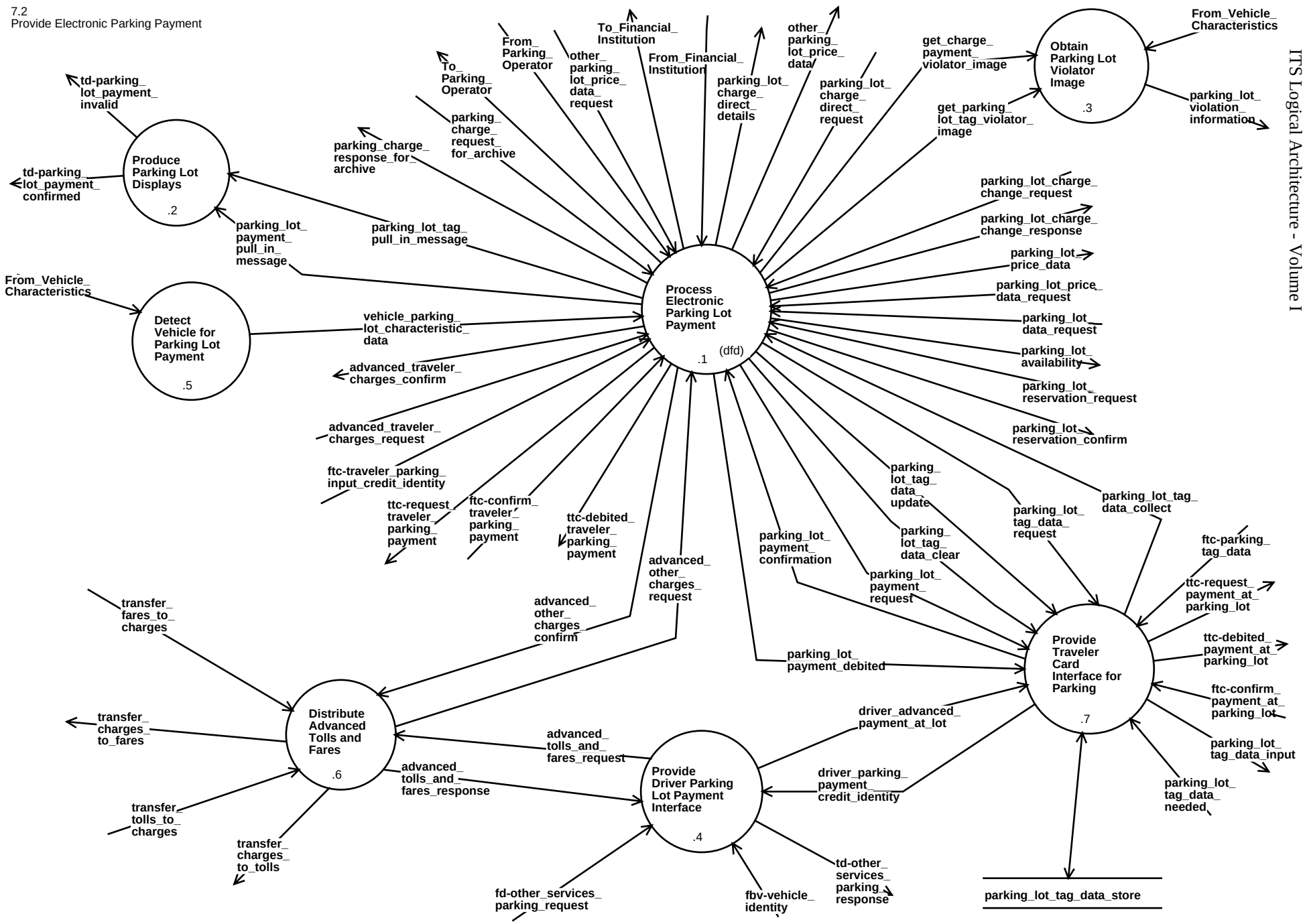


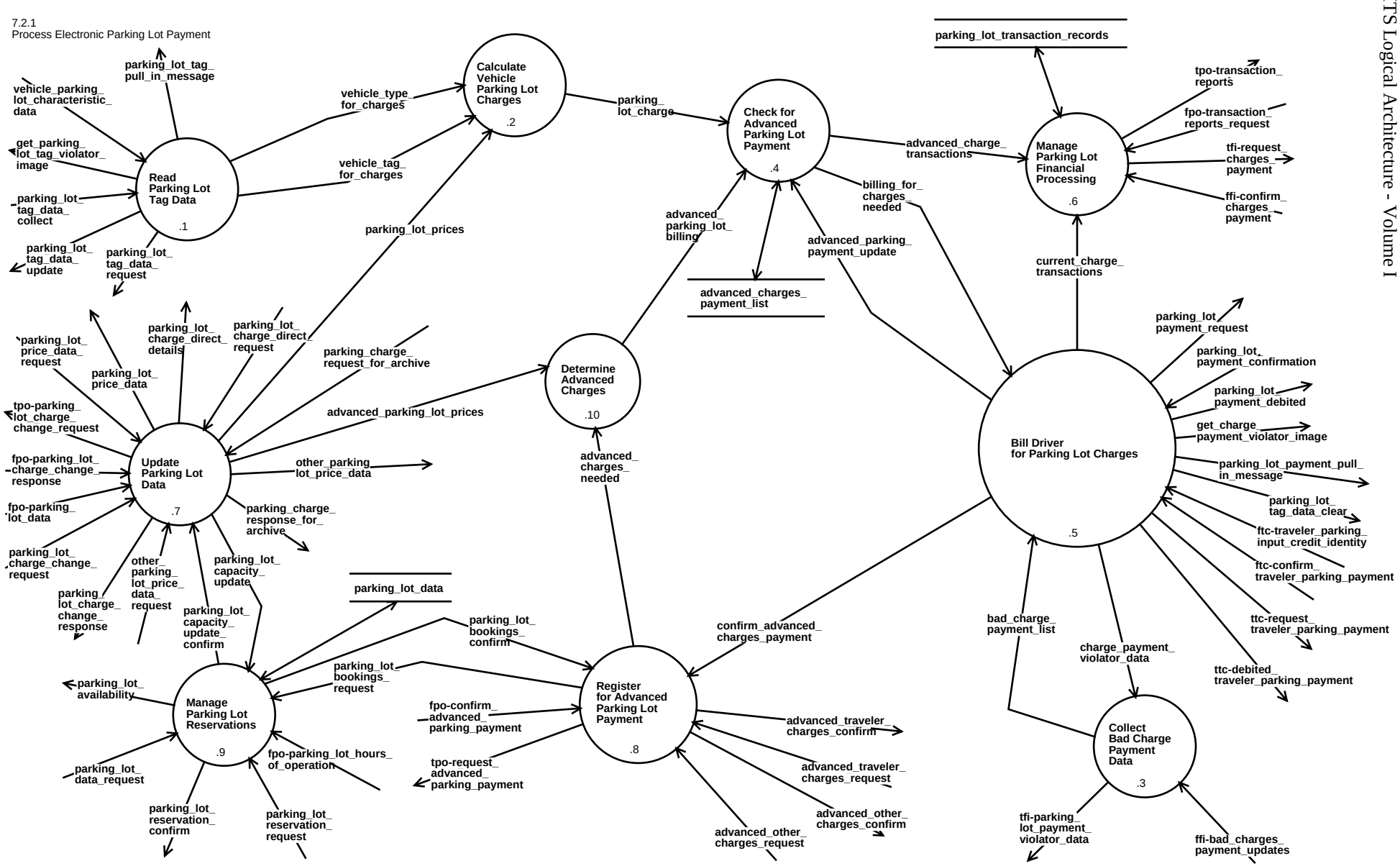
Provide Electronic Toll Payment

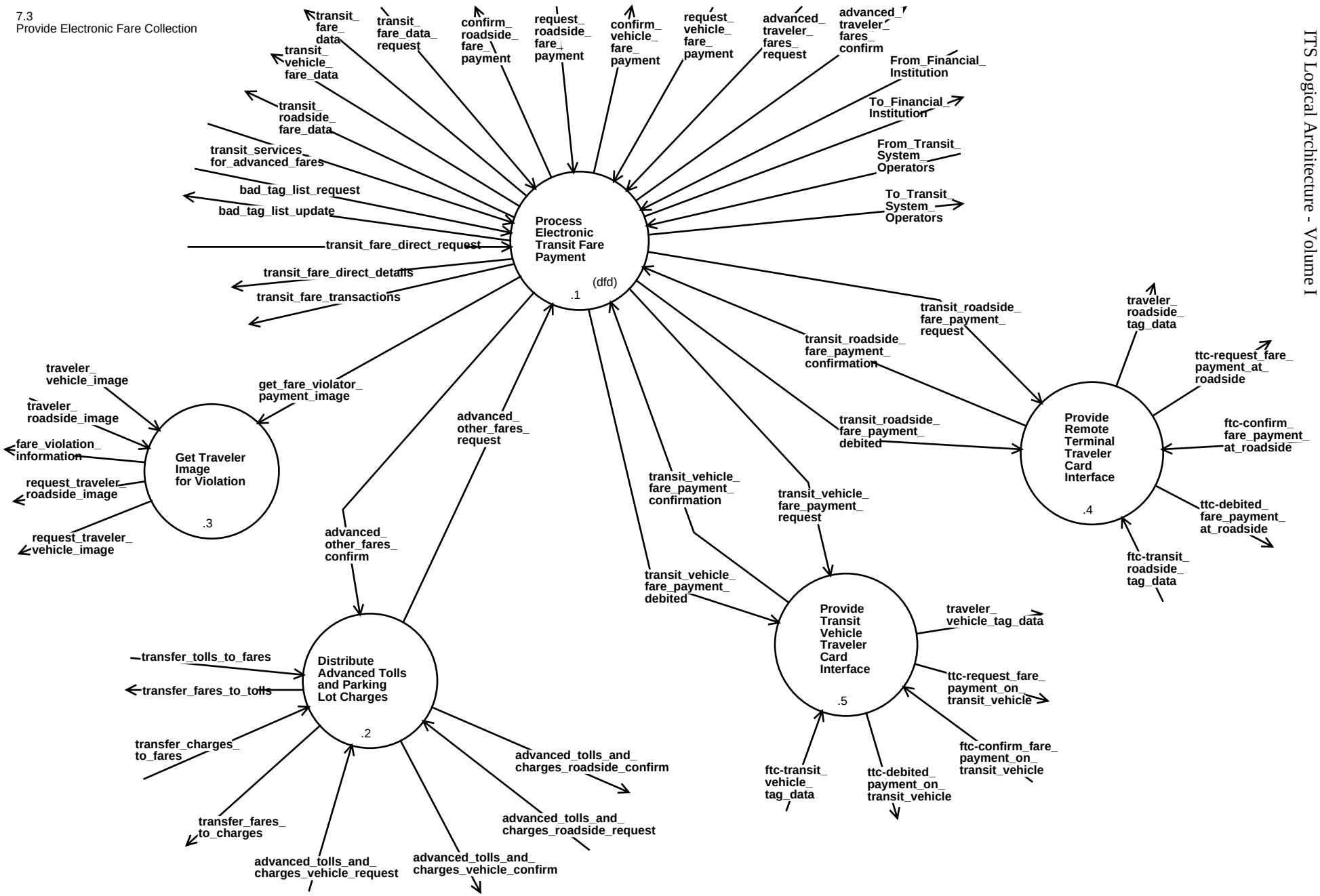


7.1.1
Process Electronic Toll Payment

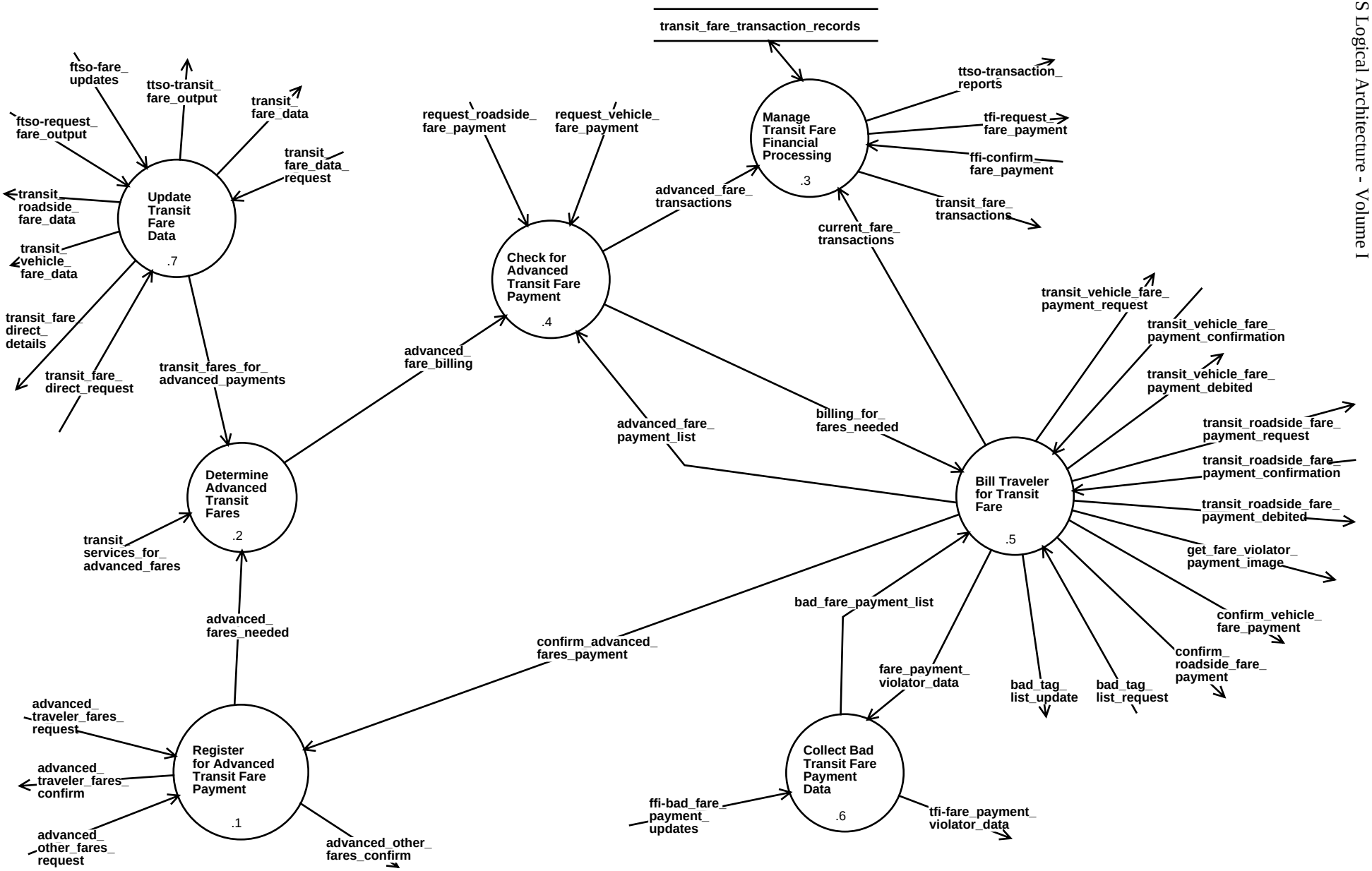



7.2
Provide Electronic Parking Payment
Produce Parking Lot Displays
.2
td-parking_lot_payment_invalid
td-parking_lot_payment_confirmed
Detect Vehicle for Parking Lot Payment
.5
From_Vehicle_Characteristics
Process Electronic Parking Lot Payment
.1
(dfd)
Obtain Parking Lot Violator Image
.3
From_Vehicle_Characteristics
parking_lot_violation_information
Provide Traveler Card Interface for Parking
.7
Distribute Advanced Tolls and Fares
.6
Provide Driver Parking Lot Payment Interface
.4
parking_lot_tag_data_store
To_Financial_Institution
From_Parking_Operator
To_Parking_Operator
other_parking_lot_price_data_request
From_Financial_Institution
parking_lot_charge_direct_details
other_parking_lot_price_data
parking_lot_charge_direct_request
get_charge_payment_violator_image
get_parking_lot_tag_violator_image
parking_charge_response_for_archive
parking_charge_request_for_archive
parking_lot_payment_pull_in_message
parking_lot_tag_pull_in_message
parking_lot_charge_change_request
parking_lot_charge_change_response
parking_lot_price_data
parking_lot_price_data_request
parking_lot_data_request
parking_lot_availability
parking_lot_reservation_request
parking_lot_reservation_confirm
vehicle_parking_lot_characteristic_data
advanced_traveler_charges_confirm
advanced_traveler_charges_request
ftc-traveler_parking_input_credit_identity
ttc-request_traveler_parking_payment
ftc-confirm_traveler_parking_payment
ttc-debited_traveler_parking_payment
parking_lot_tag_data_update
parking_lot_tag_data_clear
parking_lot_payment_confirmation
parking_lot_payment_request
parking_lot_tag_data_request
parking_lot_tag_data_collect
ftc-parking_tag_data
ttc-request_payment_at_parking_lot
ttc-debited_payment_at_parking_lot
ftc-confirm_payment_at_parking_lot
parking_lot_tag_data_input
parking_lot_tag_data_needed
advanced_other_charges_request
advanced_other_charges_confirm
parking_lot_payment_debited
transfer_fares_to_charges
transfer_charges_to_fares
transfer_tolls_to_charges
transfer_charges_to_tolls
advanced_tolls_and_fares_request
advanced_tolls_and_fares_response
driver_advanced_payment_at_lot
driver_parking_payment_credit_identity
fd-other_services_parking_request
fbv-vehicle_identity
td-other_services_parking_response

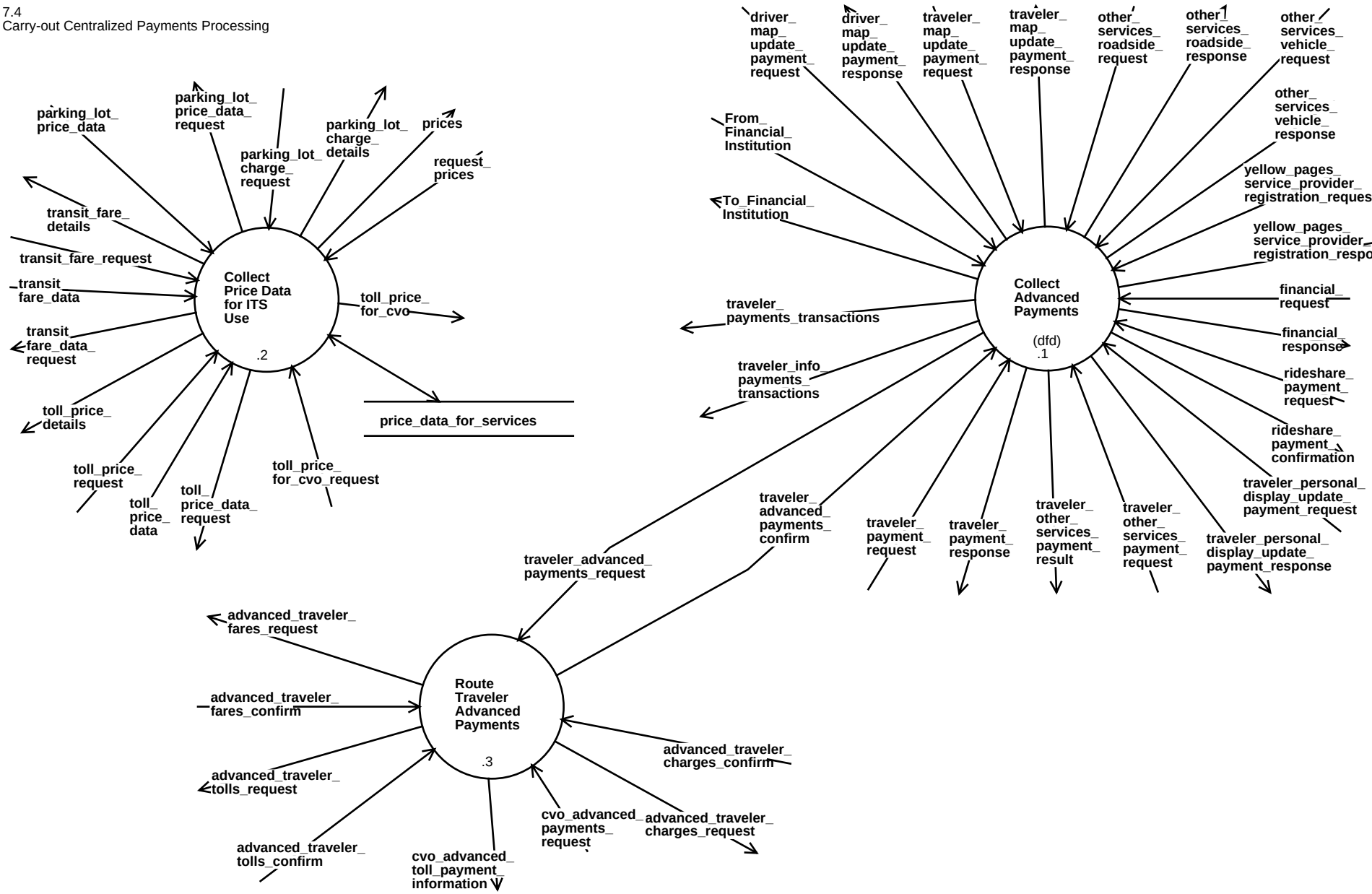

7.2.1
Process Electronic Parking Lot Payment
Read Parking Lot Tag Data .1
vehicle_parking_lot_characteristic_data
get_parking_lot_tag_violator_image
parking_lot_tag_data_collect
parking_lot_tag_data_update
parking_lot_tag_pull_in_message
parking_lot_tag_data_request
vehicle_type_for_charges
vehicle_tag_for_charges
Calculate Vehicle Parking Lot Charges .2
parking_lot_charge
Check for Advanced Parking Lot Payment .4
advanced_charge_transactions
billing_for_charges_needed
advanced_parking_payment_update
advanced_parking_lot_billing
advanced_charges_payment_list
parking_lot_transaction_records
Manage Parking Lot Financial Processing .6
tpo-transaction_reports
fpo-transaction_reports_request
tfi-request_charges_payment
ffi-confirm_charges_payment
current_charge_transactions
parking_lot_prices
Update Parking Lot Data .7
parking_lot_price_data_request
parking_lot_price_data
tpo-parking_lot_charge_change_request
fpo-parking_lot_charge_change_response
fpo-parking_lot_data
parking_lot_charge_change_request
parking_lot_charge_change_response
parking_lot_charge_direct_details
parking_lot_charge_direct_request
parking_charge_request_for_archive
advanced_parking_lot_prices
other_parking_lot_price_data
parking_charge_response_for_archive
other_parking_lot_price_data_request
parking_lot_capacity_update
parking_lot_capacity_update_confirm
Determine Advanced Charges .10
advanced_charges_needed
Bill Driver for Parking Lot Charges .5
parking_lot_payment_request
parking_lot_payment_confirmation
parking_lot_payment_debited
get_charge_payment_violator_image
parking_lot_payment_pull_in_message
parking_lot_tag_data_clear
ftc-traveler_parking_input_credit_identity
ftc-confirm_traveler_parking_payment
ttc-request_traveler_parking_payment
ttc-debited_traveler_parking_payment
bad_charge_payment_list
charge_payment_violator_data
Collect Bad Charge Payment Data .3
tfi-parking_lot_payment_violator_data
ffi-bad_charges_payment_updates
confirm_advanced_charges_payment
Register for Advanced Parking Lot Payment .8
advanced_traveler_charges_confirm
advanced_traveler_charges_request
advanced_other_charges_confirm
advanced_other_charges_request
fpo-confirm_advanced_parking_payment
tpo-request_advanced_parking_payment
parking_lot_bookings_confirm
parking_lot_bookings_request
parking_lot_data
Manage Parking Lot Reservations .9
parking_lot_availability
parking_lot_data_request
parking_lot_reservation_confirm
parking_lot_reservation_request
fpo-parking_lot_hours_of_operation


7.3
Provide Electronic Fare Collection
Process Electronic Transit Fare Payment
(dfd)
.1
Get Traveler Image for Violation
.3
Distribute Advanced Tolls and Parking Lot Charges
.2
Provide Remote Terminal Traveler Card Interface
.4
Provide Transit Vehicle Traveler Card Interface
.5
transit_fare_data
transit_vehicle_fare_data
transit_fare_data_request
confirm_roadside_fare_payment
request_roadside_fare_payment
confirm_vehicle_fare_payment
request_vehicle_fare_payment
advanced_traveler_fares_request
advanced_traveler_fares_confirm
From_Financial_Institution
To_Financial_Institution
From_Transit_System_Operators
To_Transit_System_Operators
transit_roadside_fare_data
transit_services_for_advanced_fares
bad_tag_list_request
bad_tag_list_update
transit_fare_direct_request
transit_fare_direct_details
transit_fare_transactions
traveler_vehicle_image
traveler_roadside_image
fare_violation_information
request_traveler_roadside_image
request_traveler_vehicle_image
get_fare_violator_payment_image
advanced_other_fares_request
advanced_other_fares_confirm
transit_roadside_fare_payment_request
transit_roadside_fare_payment_confirmation
transit_roadside_fare_payment_debited
traveler_roadside_tag_data
ttc-request_fare_payment_at_roadside
ftc-confirm_fare_payment_at_roadside
ttc-debited_fare_payment_at_roadside
ftc-transit_roadside_tag_data
transit_vehicle_fare_payment_confirmation
transit_vehicle_fare_payment_request
transit_vehicle_fare_payment_debited
traveler_vehicle_tag_data
ttc-request_fare_payment_on_transit_vehicle
ftc-confirm_fare_payment_on_transit_vehicle
ftc-transit_vehicle_tag_data
ttc-debited_payment_on_transit_vehicle
transfer_tolls_to_fares
transfer_fares_to_tolls
transfer_charges_to_fares
transfer_fares_to_charges
advanced_tolls_and_charges_vehicle_request
advanced_tolls_and_charges_vehicle_confirm
advanced_tolls_and_charges_roadside_request
advanced_tolls_and_charges_roadside_confirm

7.3.1
Process Electronic Transit Fare Payment

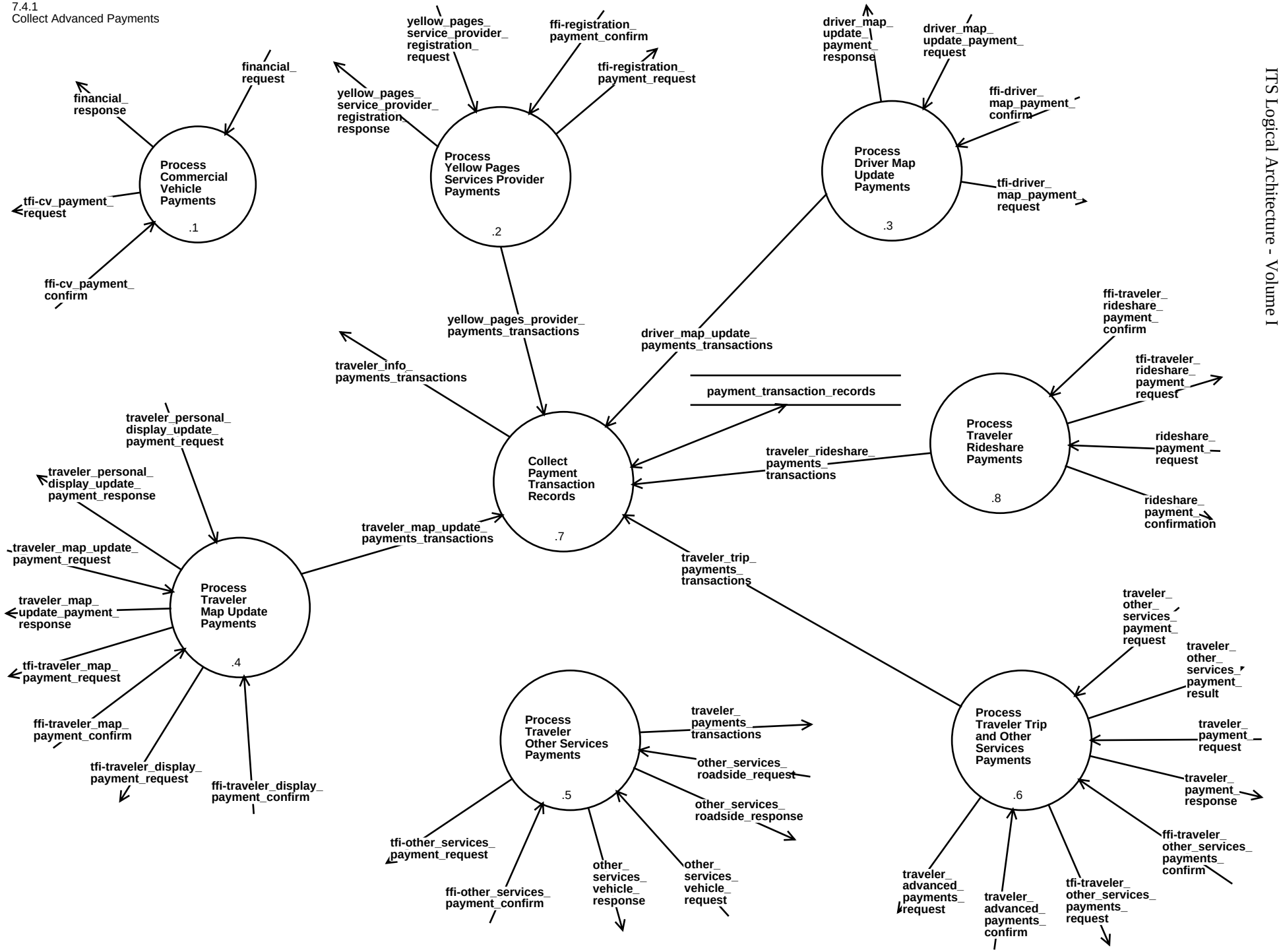


7.4
Carry-out Centralized Payments Processing

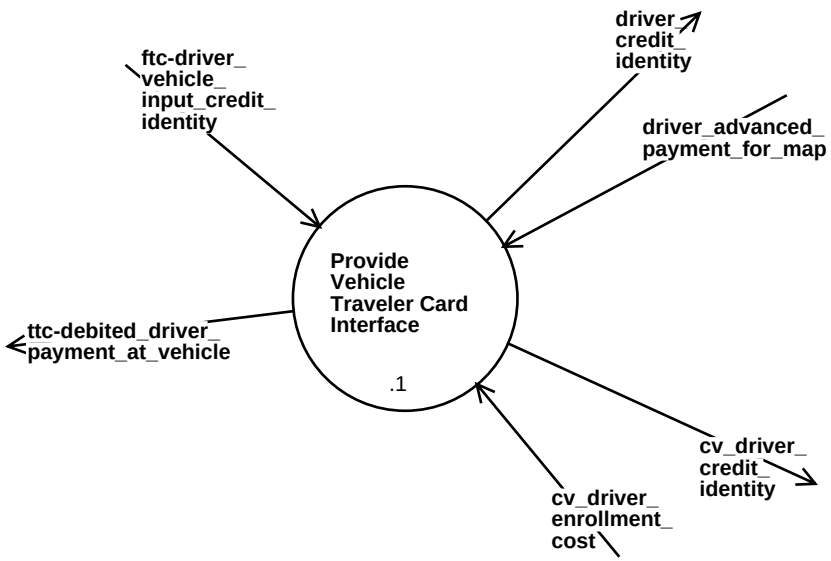


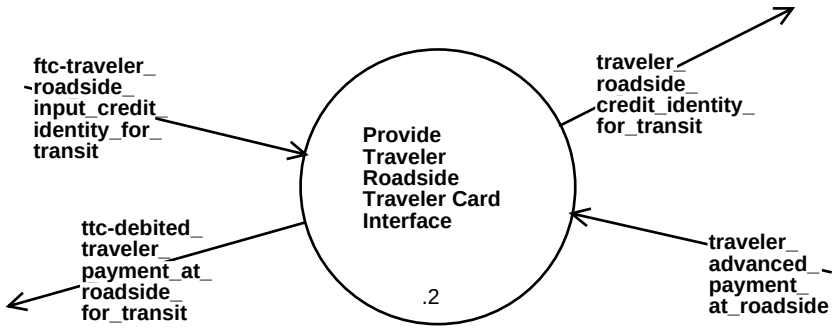
Collect Advanced Payments

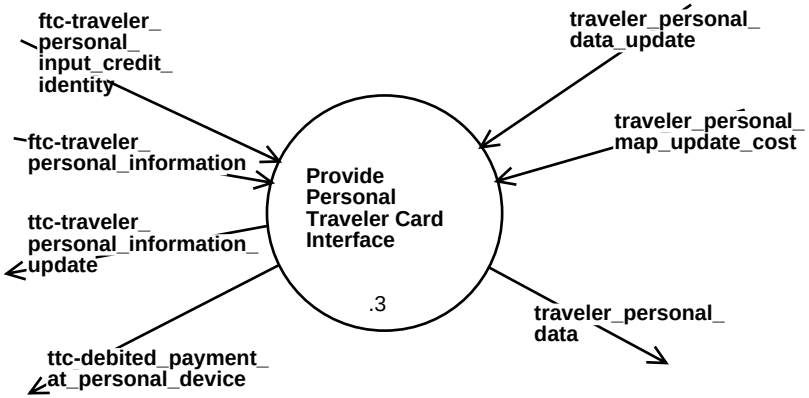
7.4.1
Collect Advanced Payments

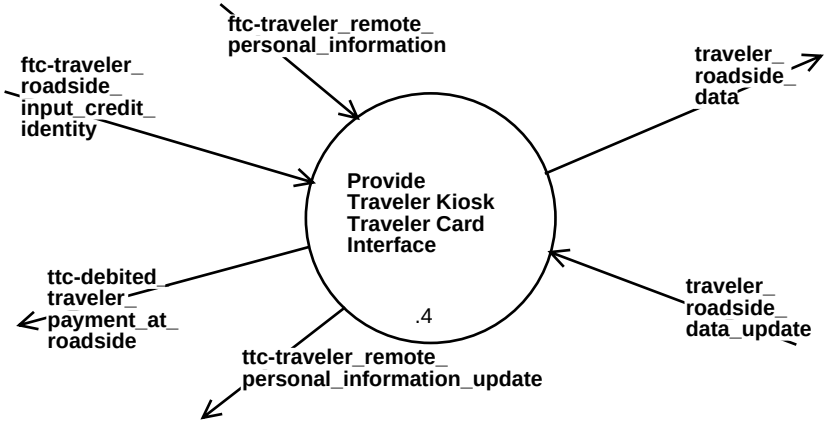


7.5
Provide Traveler Card Interfaces

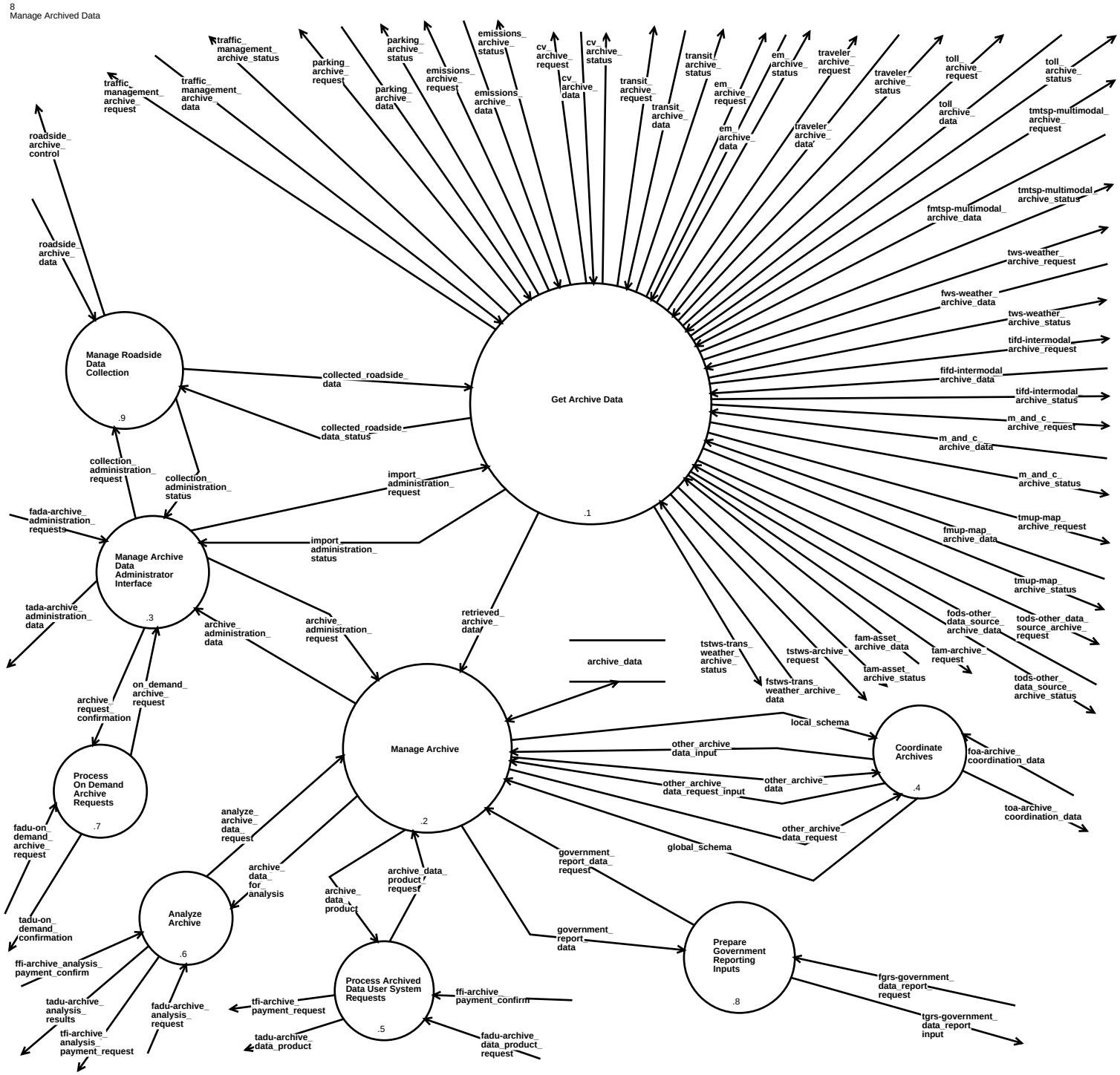




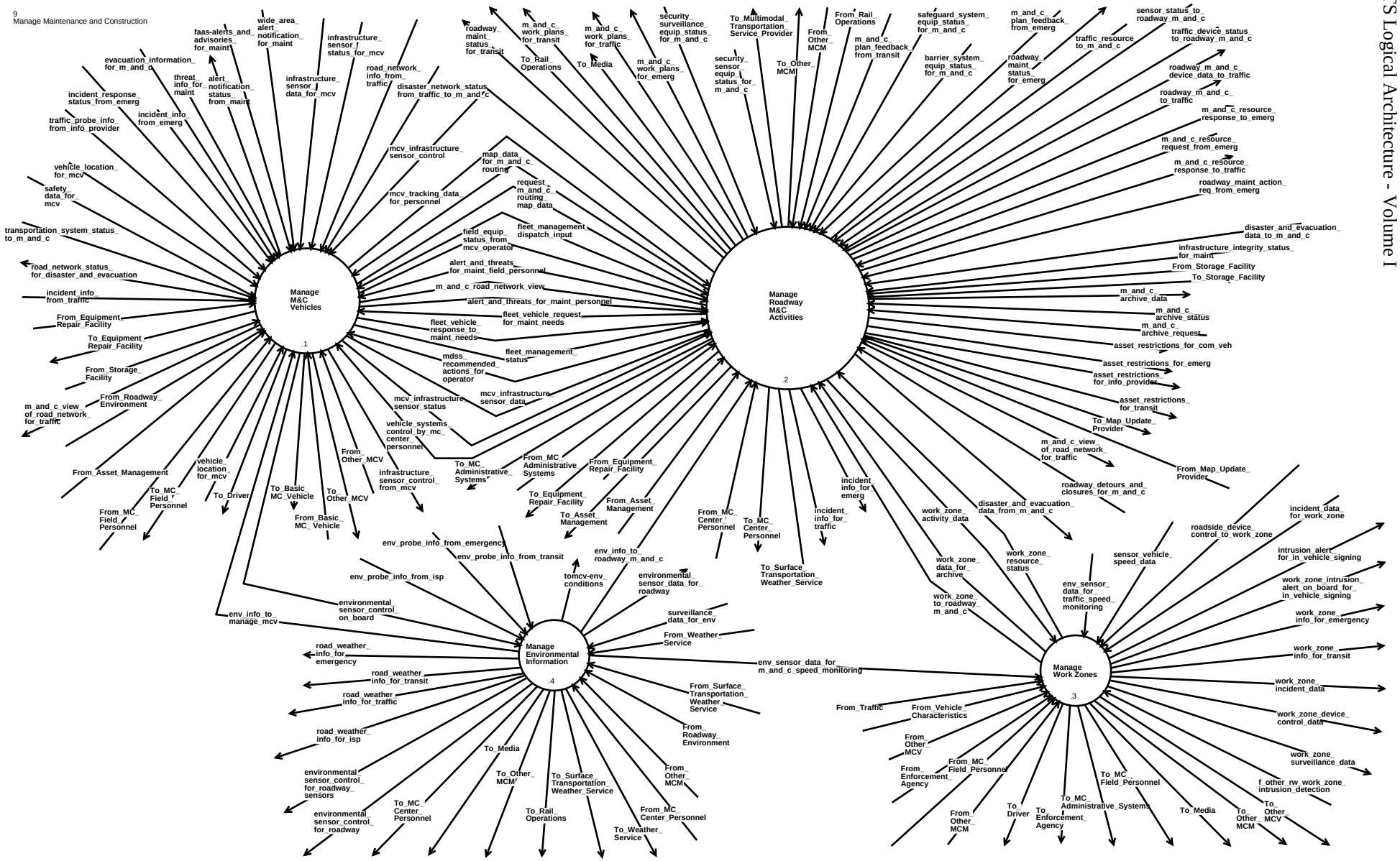




Manage Archived Data

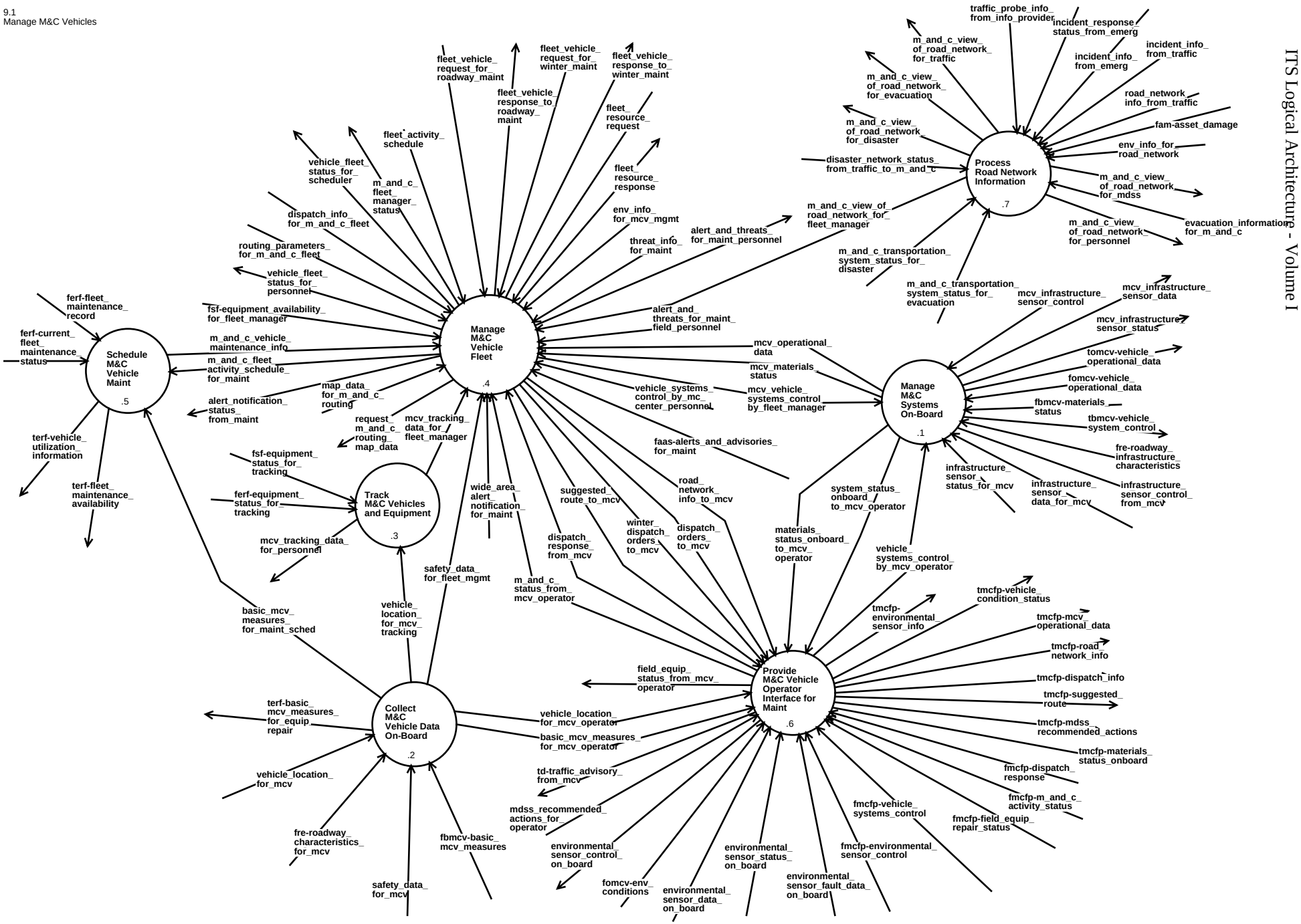


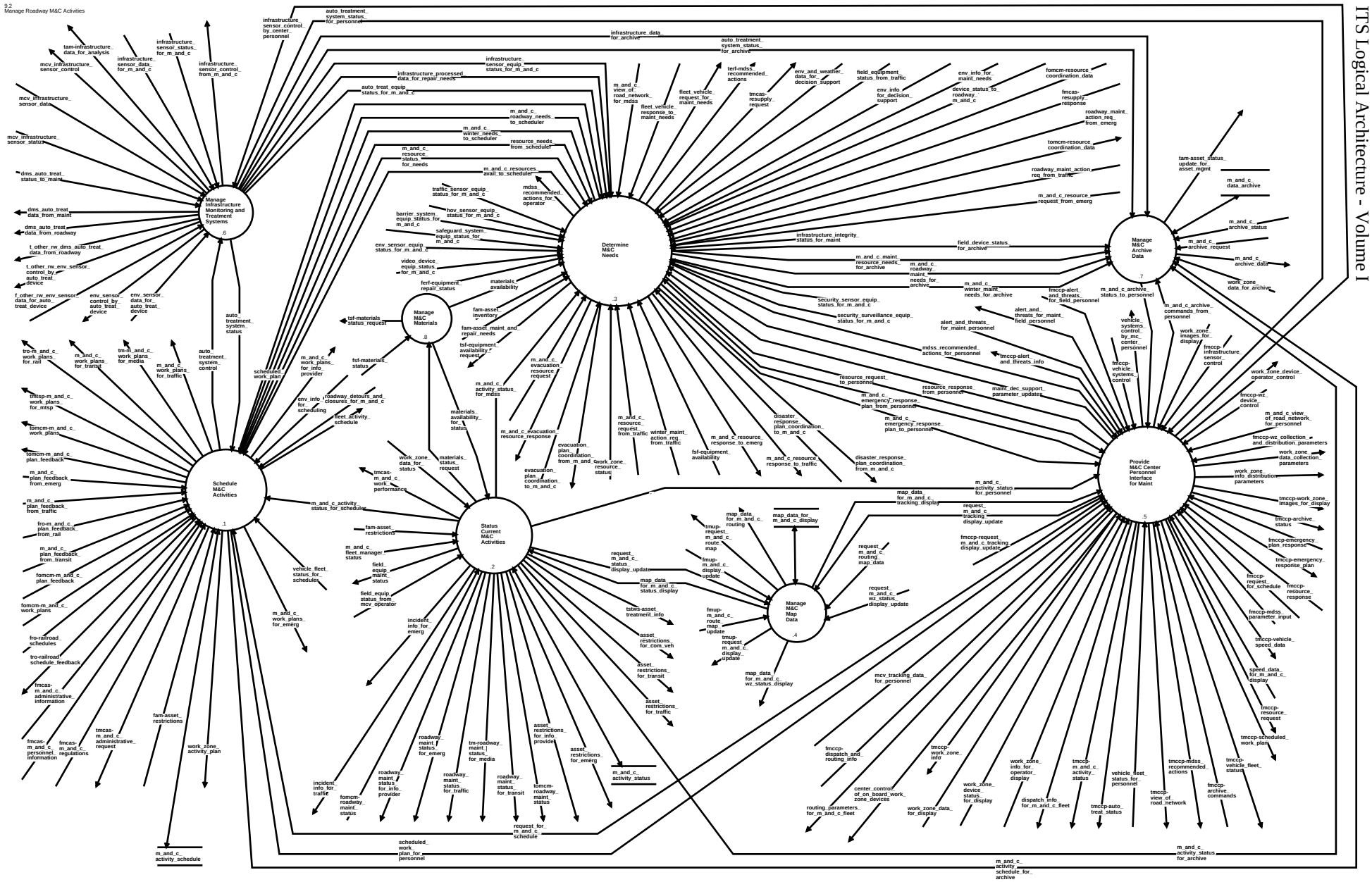
Manage Maintenance and Construction



Manage M&C Vehicles

9.1
Manage M&C Vehicles




9.2
Manage Roadway M&C Activities
Manage Infrastructure Monitoring and Treatment Systems
.6
Schedule M&C Activities
.1
Manage M&C Materials
.8
Status Current M&C Activities
.2
Determine M&C Needs
.3
Manage M&C Map Data
.4
Provide M&C Center Personnel Interface for Maint
.5
Manage M&C Archive Data
.7
tam-infrastructure_data_for_analysis
mcv_infrastructure_sensor_control
infrastructure_sensor_status_for_m_and_c
infrastructure_sensor_data_for_m_and_c
infrastructure_sensor_control_from_m_and_c
mcv_infrastructure_sensor_data
mcv_infrastructure_sensor_status
dms_auto_treat_status_to_maint
dms_auto_treat_data_from_maint
dms_auto_treat_data_from_roadway
t_other_rw_dms_auto_treat_data_from_roadway
t_other_rw_env_sensor_control_by_auto_treat_device
f_other_rw_env_sensor_data_for_auto_treat_device
env_sensor_control_by_auto_treat_device
env_sensor_data_for_auto_treat_device
auto_treatment_system_status
auto_treatment_system_control
infrastructure_sensor_control_by_center_personnel
auto_treatment_system_status_for_personnel
infrastructure_data_for_archive
auto_treatment_system_status_for_archive
infrastructure_sensor_equip_status_for_m_and_c
infrastructure_processed_data_for_repair_needs
auto_treat_equip_status_for_m_and_c
m_and_c_roadway_needs_to_scheduler
m_and_c_winter_needs_to_scheduler
resource_needs_from_scheduler
m_and_c_resource_status_for_needs
m_and_c_resources_avail_to_scheduler
traffic_sensor_equip_status_for_m_and_c
mdss_recommended_actions_for_operator
hov_sensor_equip_status_for_m_and_c
barrier_system_equip_status_for_m_and_c
safeguard_system_equip_status_for_m_and_c
env_sensor_equip_status_for_m_and_c
video_device_equip_status_for_m_and_c
ferf-equipment_repair_status
materials_availability
tsf-materials_status_request
fam-asset_inventory
fam-asset_maint_and_repair_needs
tsf-equipment_availability_request
tro-m_and_c_work_plans_for_rail
m_and_c_work_plans_for_transit
tm-m_and_c_work_plans_for_media
m_and_c_work_plans_for_traffic
scheduled_work_plan
m_and_c_work_plans_for_info_provider
tsf-materials_status
env_info_for_scheduling
roadway_detours_and_closures_for_m_and_c
fleet_activity_schedule
mtsp-m_and_c_work_plans_for_mtsp
tomcm-m_and_c_work_plans
tomcm-m_and_c_plan_feedback
m_and_c_plan_feedback_from_emerg
m_and_c_plan_feedback_from_traffic
fro-m_and_c_plan_feedback_from_rail
m_and_c_plan_feedback_from_transit
fomcm-m_and_c_plan_feedback
fomcm-m_and_c_work_plans
fro-railroad_schedules
tro-railroad_schedule_feedback
tmcas-m_and_c_administrative_information
fmcas-m_and_c_personnel_information
fmcas-m_and_c_regulations
tmcas-m_and_c_administrative_request
fam-asset_restrictions
work_zone_activity_plan
m_and_c_activity_schedule
m_and_c_activity_status_for_scheduling
vehicle_fleet_status_for_schedules
m_and_c_work_plans_for_emerg
fam-asset_restrictions
m_and_c_fleet_manager_status
field_equip_maint_status
field_equip_status_from_mcv_operator
incident_info_for_emerg
incident_info_for_traffic
fomcm-roadway_maint_status
roadway_maint_status_for_info_provider
roadway_maint_status_for_emerg
roadway_maint_status_for_traffic
tm-roadway_maint_status_for_media
roadway_maint_status_for_transit
asset_restrictions_for_info_provider
tomcm-roadway_maint_status
asset_restrictions_for_emerg
request_for_m_and_c_schedule
scheduled_work_plan_for_personnel
m_and_c_activity_status
tmcas-m_and_c_work_performance
work_zone_data_for_status
materials_status_request
materials_availability_for_status
m_and_c_activity_status_for_mdss
m_and_c_evacuation_resource_request
evacuation_plan_coordination_from_m_and_c
evacuation_plan_coordination_to_m_and_c
work_zone_resource_status
m_and_c_resource_request_from_traffic
winter_maint_action_req_from_traffic
fsf-equipment_availability
m_and_c_resource_response_to_emerg
m_and_c_resource_response_to_traffic
disaster_response_plan_coordination_to_m_and_c
disaster_response_plan_coordination_from_m_and_c
m_and_c_view_of_road_network_for_maint
fleet_vehicle_request_for_maint_needs
fleet_vehicle_response_to_maint_needs
tmcas-resupply_request
terf-mdss_recommended_actions
env_and_weather_data_for_decision_support
field_equipment_status_from_traffic
env_info_for_decision_support
env_info_for_maint_needs
device_status_to_roadway_m_and_c
fomcm-resource_coordination_data
fmcas-resupply_response
roadway_maint_action_req_from_emerg
tomcm-resource_coordination_data
roadway_maint_action_req_from_traffic
m_and_c_resource_request_from_emerg
tam-asset_status_update_for_asset_mgmt
m_and_c_data_archive
m_and_c_archive_status
m_and_c_archive_request
m_and_c_archive_data
work_zone_data_for_archive
infrastructure_integrity_status_for_maint
field_device_status_for_archive
m_and_c_maint_resource_needs_for_archive
m_and_c_roadway_maint_needs_for_archive
m_and_c_winter_maint_needs_for_archive
fmccp-alert_and_threats_for_field_personnel
m_and_c_archive_status_to_personnel
security_sensor_equip_status_for_m_and_c
security_surveillance_equip_status_for_m_and_c
alert_and_threats_for_maint_personnel
alert_and_threats_for_maint_field_personnel
m_and_c_archive_commands_from_personnel
mdss_recommended_actions_for_personnel
fmccp-alert_and_threats_info
vehicle_systems_control_by_mc_center_personnel
fmccp-vehicle_systems_control
work_zone_images_for_display
fmccp-infrastructure_sensor_control
work_zone_device_operator_control
resource_request_to_personnel
resource_response_from_personnel
maint_dec_support_parameter_updates
m_and_c_emergency_response_plan_from_personnel
m_and_c_emergency_response_plan_to_personnel
fmccp-wz_device_control
m_and_c_view_of_road_network_for_personnel
fmccp-wz_collection_and_distribution_parameters
work_zone_data_collection_parameters
work_zone_info_distribution_parameters
m_and_c_activity_status_for_personnel
map_data_for_m_and_c_tracking_display
request_m_and_c_tracking_display_update
fmccp-request_m_and_c_tracking_display_update
tmccp-work_zone_images_for_display
tmccp-archive_status
fmccp-emergency_plan_response
fmccp-emergency_response_plan
tmccp-request_for_schedule
tmccp-resource_response
fmccp-mdss_parameter_input
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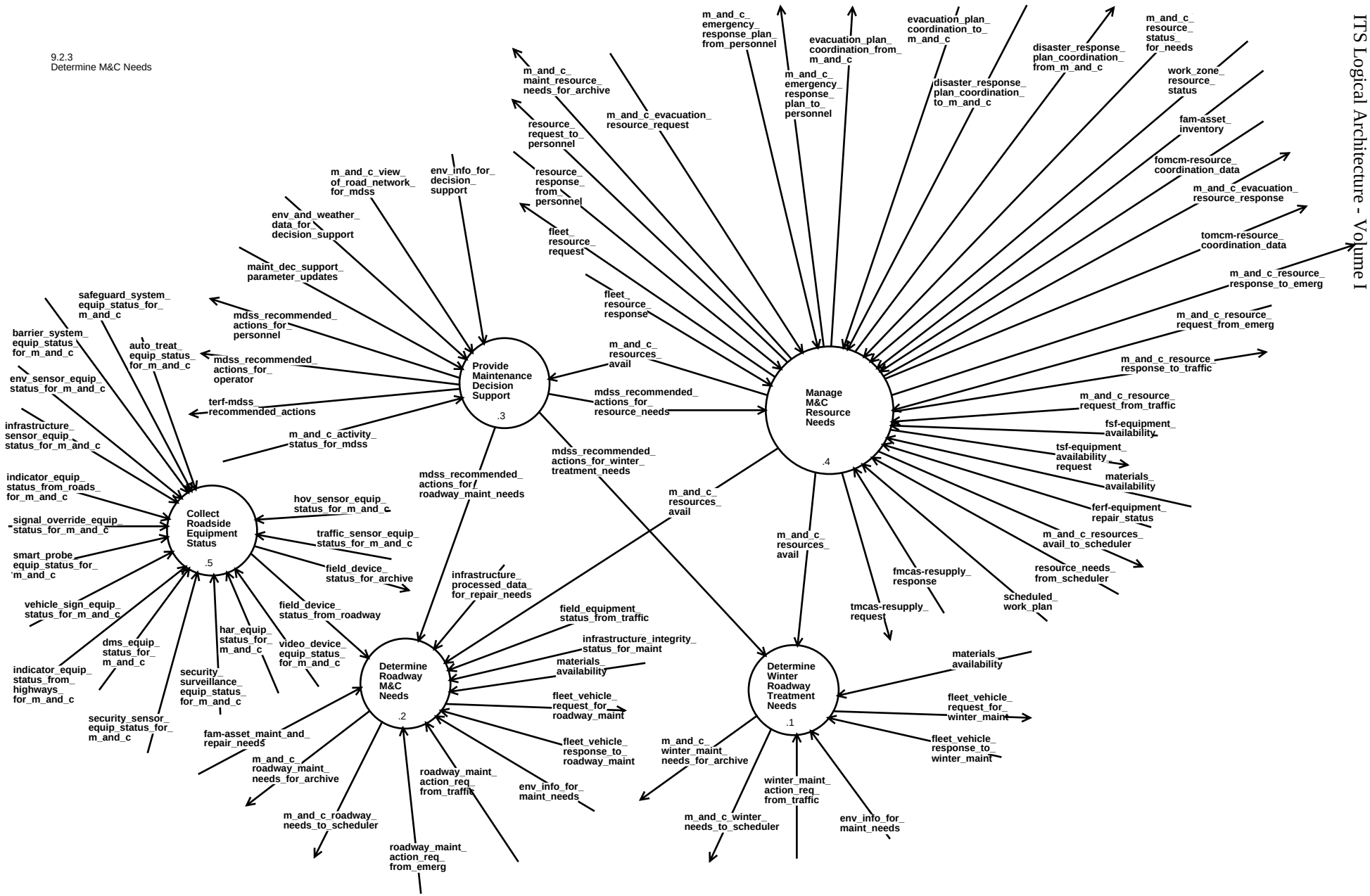
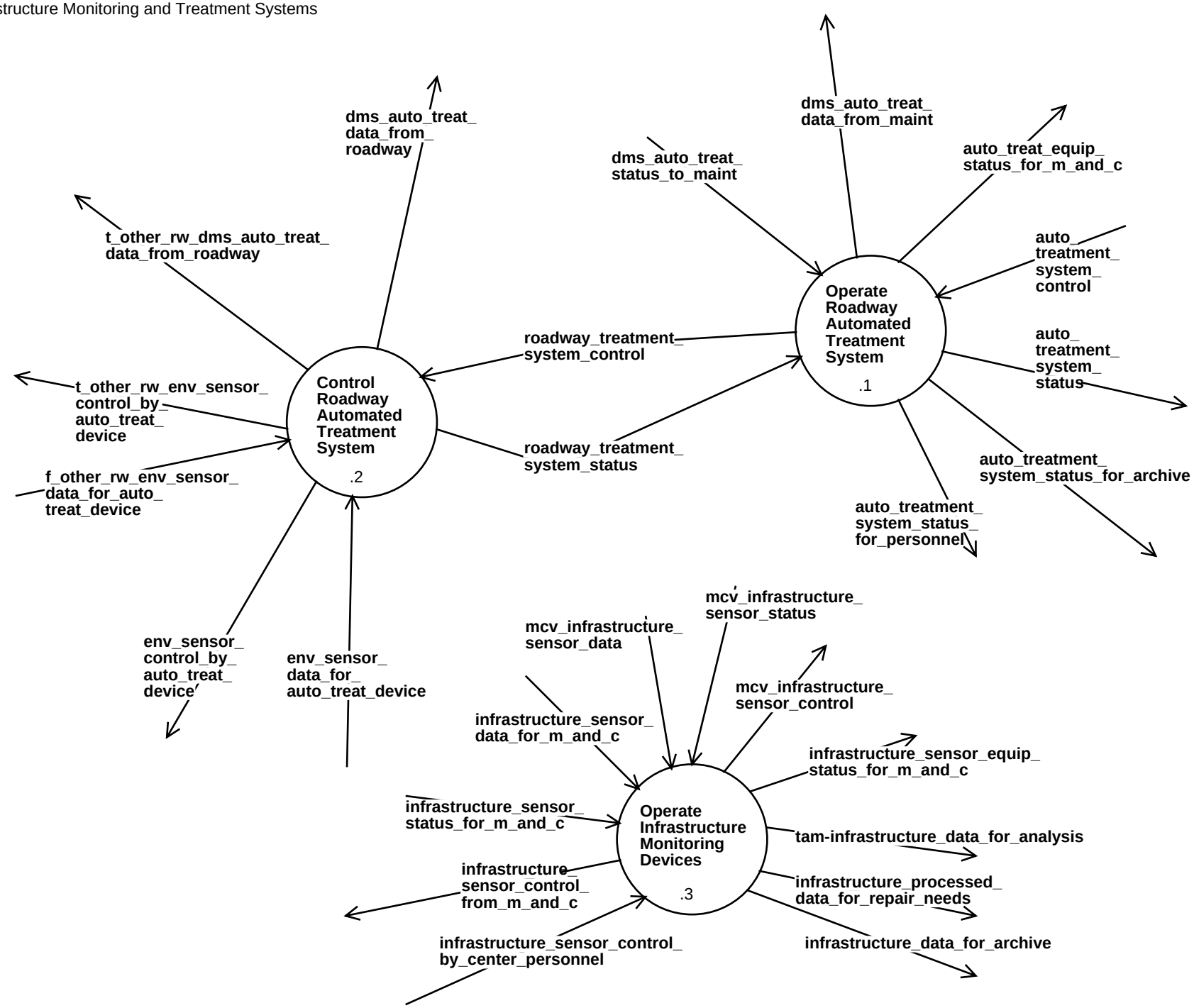
speed_data_for_m_and_c_display
tmccp-resource_request
tmccp-scheduled_work_plan
tmccp-vehicle_fleet_status
map_data_for_m_and_c_routing
map_data_for_m_and_c_display
tmup-request_m_and_c_route_map
tmup-m_and_c_display_update
request_m_and_c_routing_map_data
request_m_and_c_wz_status_display_update
request_m_and_c_status_display_update
map_data_for_m_and_c_status_display
tstws-asset_treatment_info
asset_restrictions_for_com_veh
asset_restrictions_for_transit
asset_restrictions_for_traffic
tmup-m_and_c_route_map_update
tmup-request_m_and_c_display_update
map_data_for_m_and_c_wz_status_display
mcv_tracking_data_for_personnel
fmccp-dispatch_and_routing_info
tmccp-work_zone_info
work_zone_info_for_operator_display
tmccp-m_and_c_activity_status
vehicle_fleet_status_for_personnel
tmccp-mdss_recommended_actions
tmccp-vehicle_fleet_status
tmccp-view_of_road_network
tmccp-archive_commands
tmccp-auto_treat_status
dispatch_info_for_m_and_c_fleet
work_zone_device_status_for_display
center_control_of_on_board_work_zone_devices
routing_parameters_for_m_and_c_fleet
work_zone_data_for_display
m_and_c_activity_status_for_archive
m_and_c_activity_schedule_for_archive

9.2.3
Determine M&C Needs

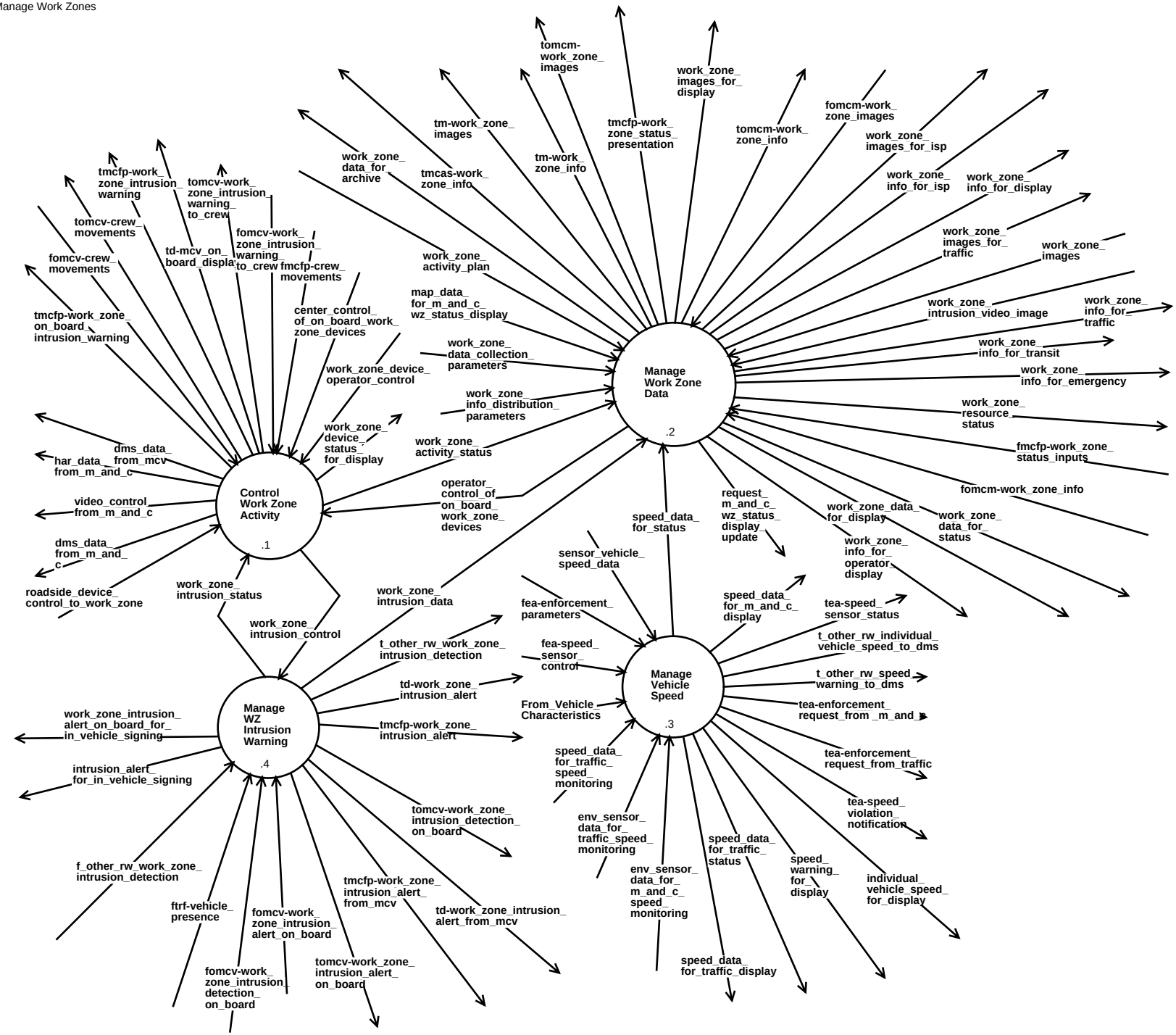


9.2.6
Manage Infrastructure Monitoring and Treatment Systems

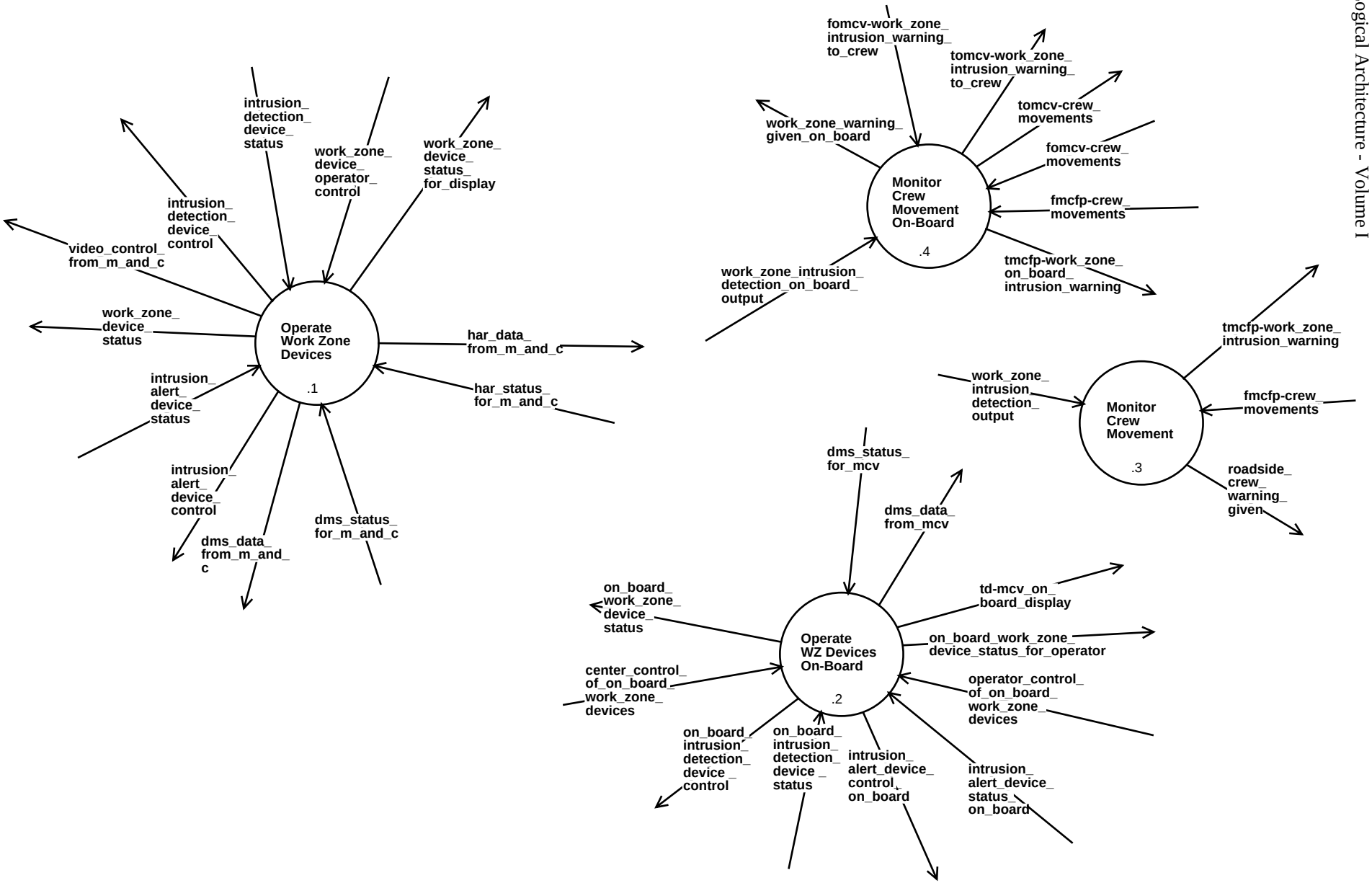


Manage Work Zones

9.3
Manage Work Zones

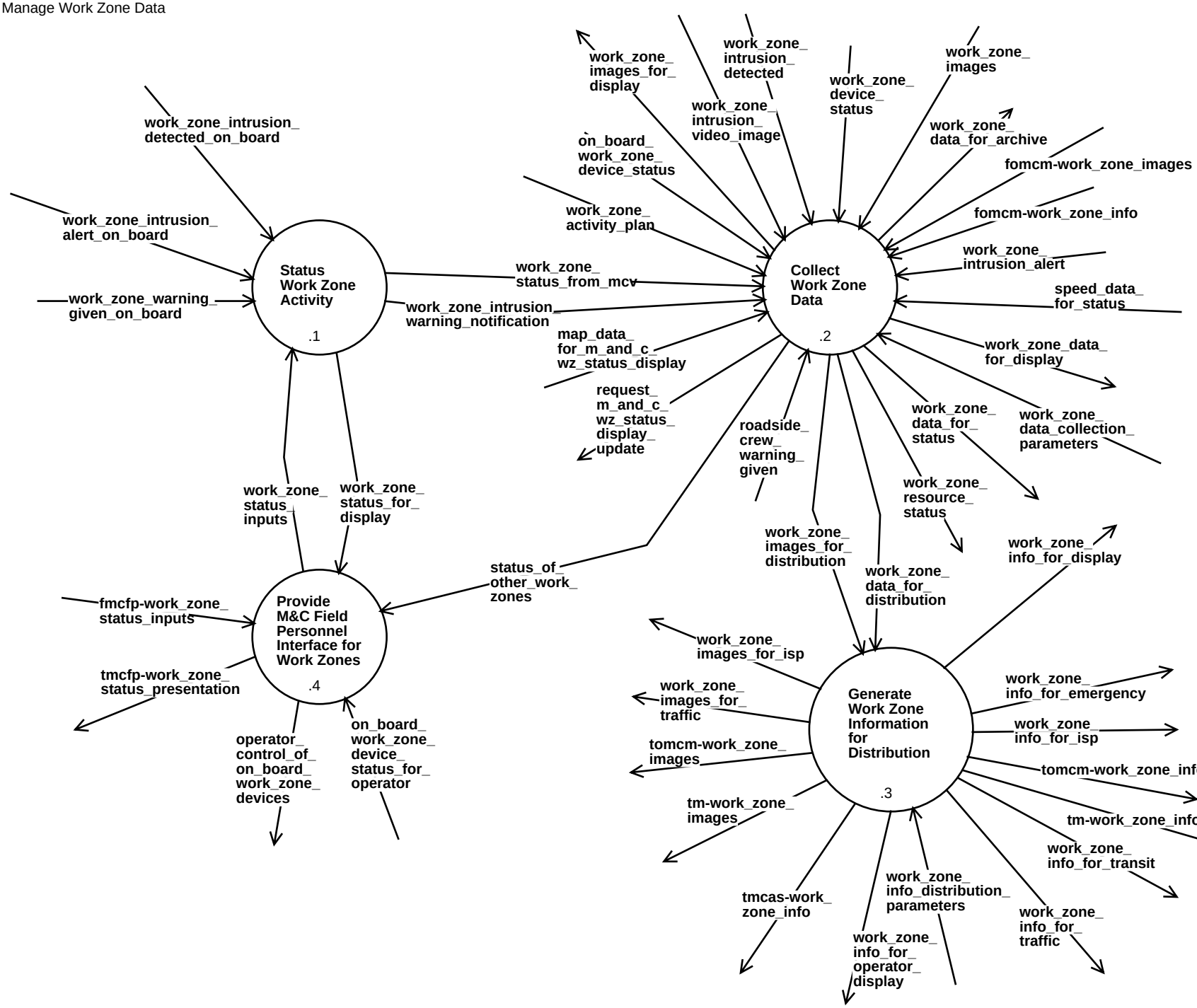


9.3.1
Control Work Zone Activity

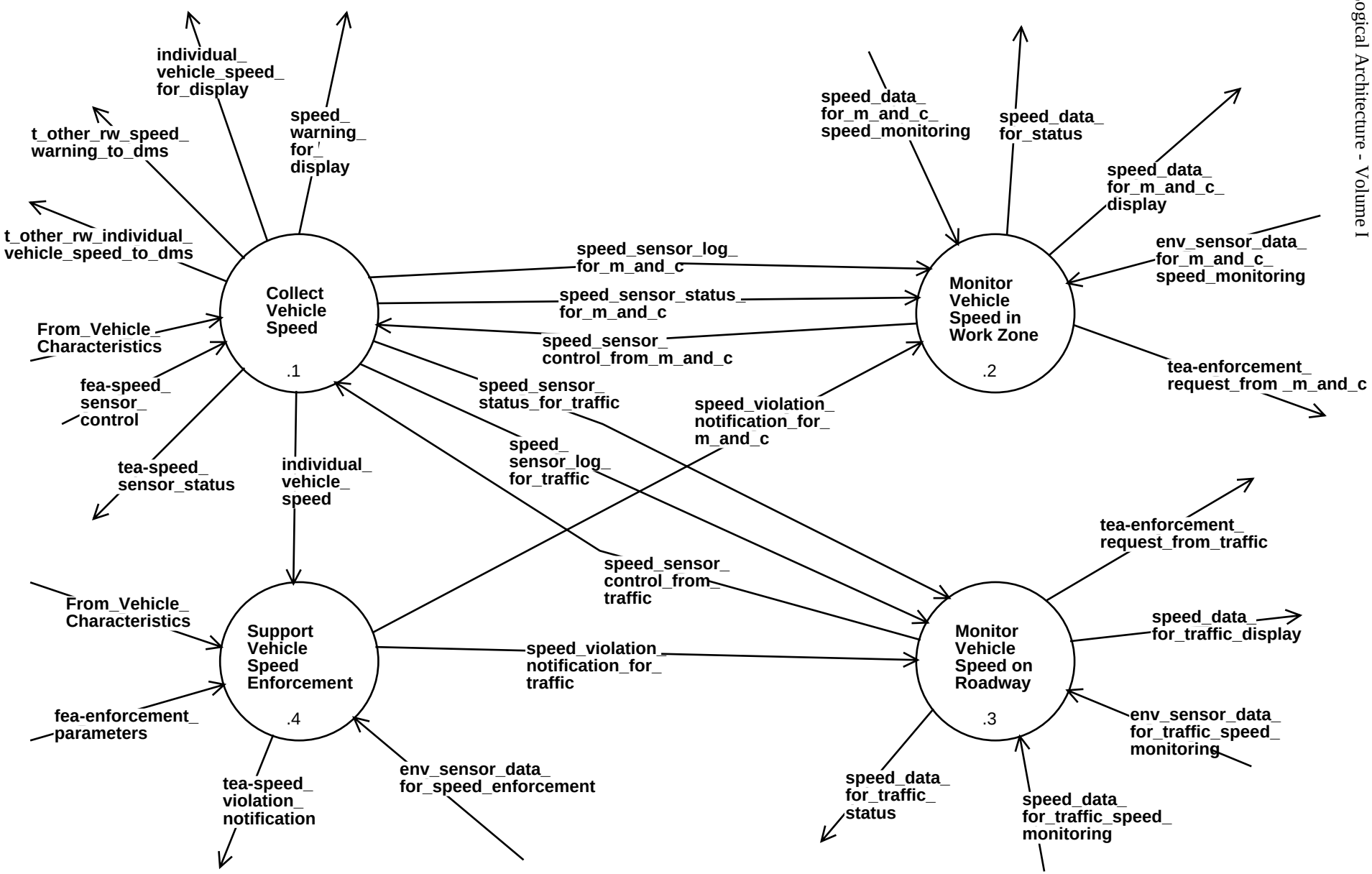


Manage Work Zone Data

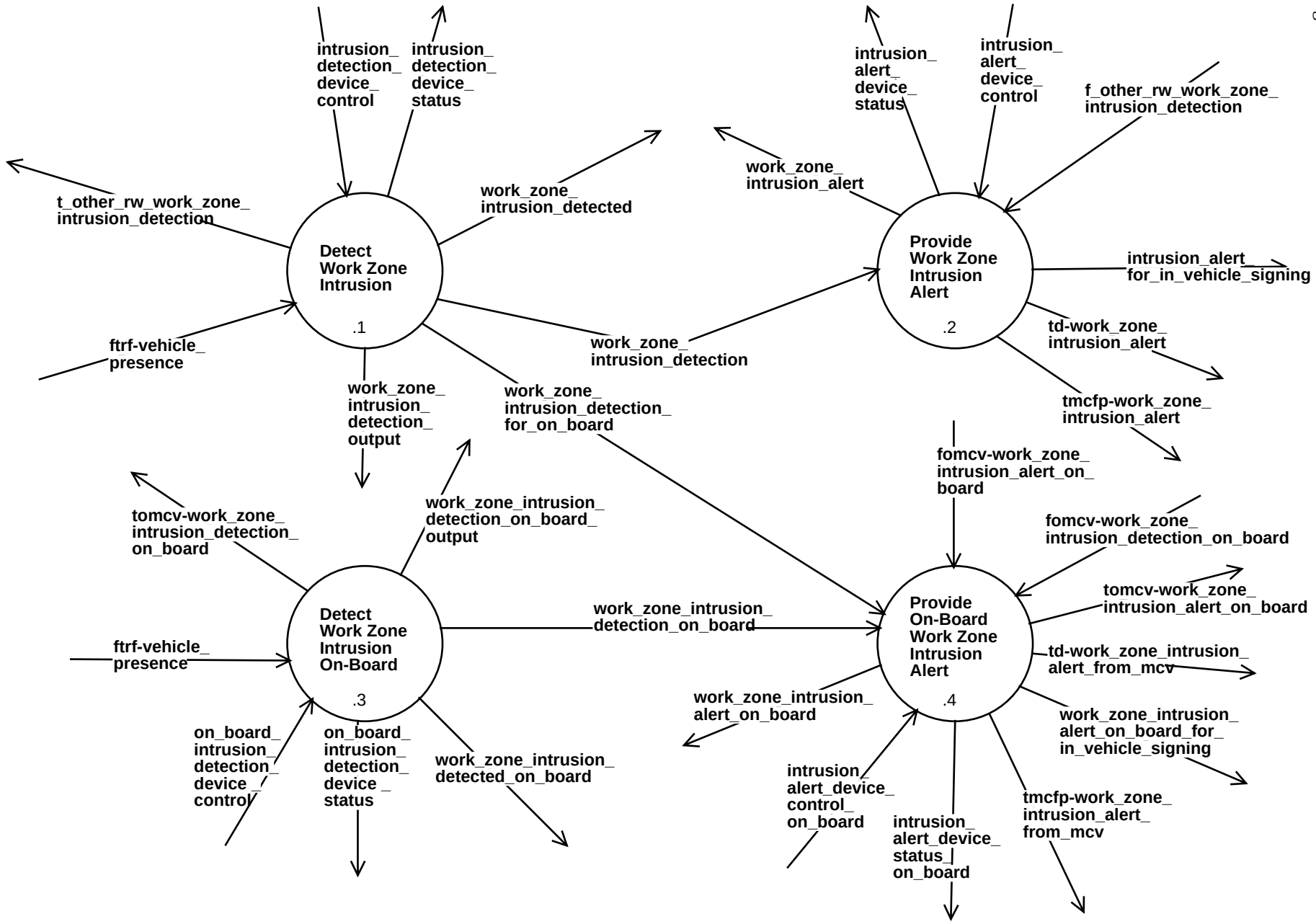
9.3.2
Manage Work Zone Data



9.3.3
Manage Vehicle Speed

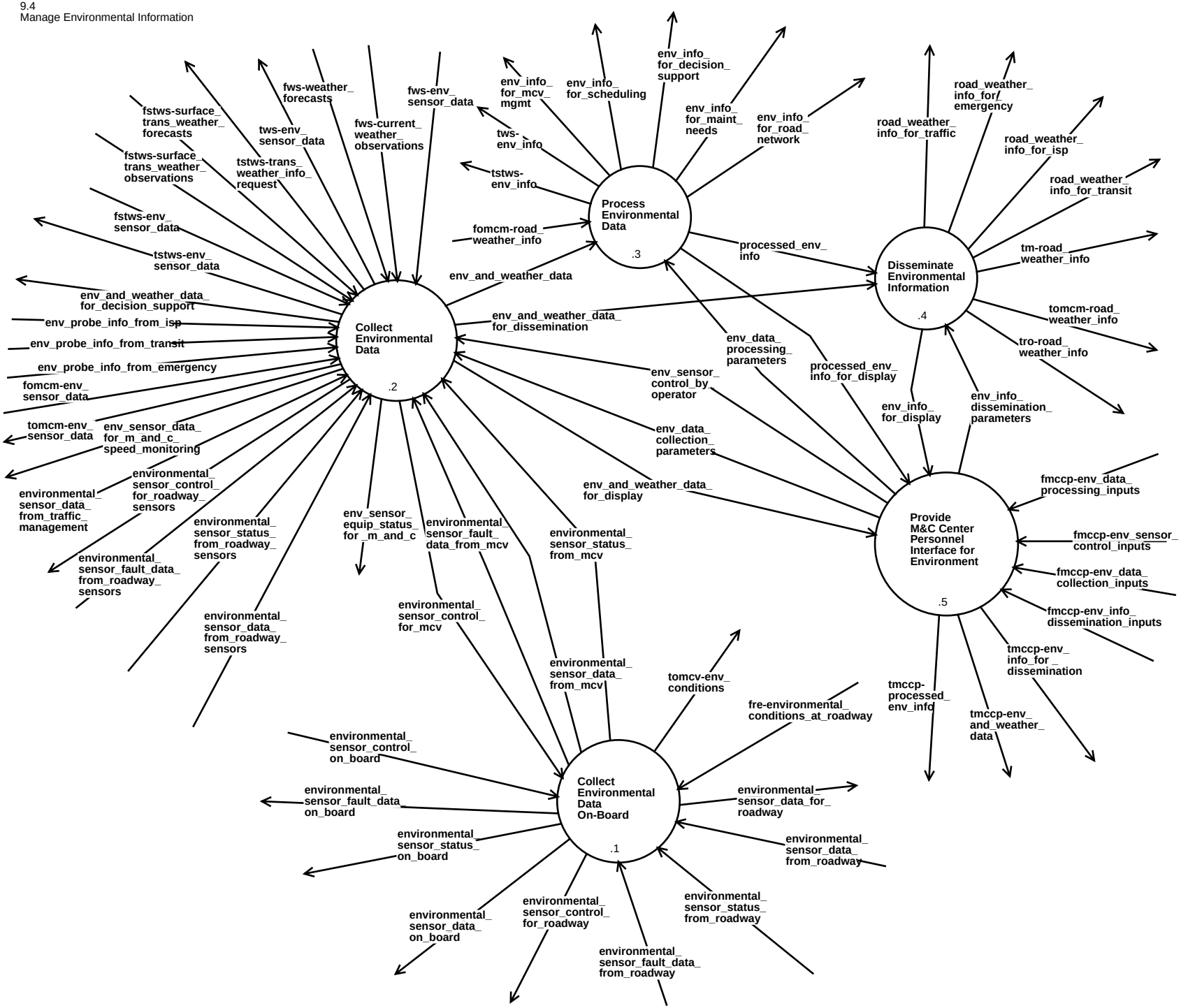


9.3.4
Manage WZ Intrusion Warning



Manage Environmental Information

9.4
Manage Environmental Information



APPENDIX B: User Service Requirements

1.0	TRAVEL AND TRAFFIC MANAGEMENT
1.1	PRE-TRIP TRAVEL INFORMATION
1.1.0	ITS shall include a Pre-Trip Travel Information (PTTI) capability to assist travelers in making mode choices, travel time estimates, and route decisions prior to trip departure. It consists of four major functions, which are, (1) Available Services Information, (2) Current Situation Information, (3) Trip Planning Service, and (4) User Access. Information is integrated from various transportation modes and presented to the user for decision making.
1.1.1	PTTI shall provide travelers with Available Services Information on travel, for their use.
1.1.1.1	PTTI shall provide users with available services information that is timely.
1.1.1.1.1	PTTI shall provide users the latest available information on transit routes.
1.1.1.1.2	PTTI shall provide users the latest available information on transit schedules.
1.1.1.1.3	PTTI shall provide users with the latest available schedule adherence information.
1.1.1.1.4	PTTI shall provide users the latest available information on transit transfer options.
1.1.1.1.5	PTTI shall provide users the latest available information on transit fares.
1.1.1.1.6	PTTI shall provide users information on accessing ridematching services.
1.1.2	PTTI shall provide the capability for users to access the Current Situation Information on transportation systems.
1.1.2.1	PTTI shall provide the latest available information on the current status of transportation services.
1.1.2.1.1	Real-time information provided by PTTI shall include the current condition of any incidents, including rural incidents such as high winds, extreme temperature, and falling rocks.
1.1.2.1.2	Real-time information provided by PTTI shall include the current status of any accidents or incidents.
1.1.2.1.3	Real-time information provided by PTTI shall include the current condition of any road construction.
1.1.2.1.4	Real-time information provided by PTTI shall include any currently recommended alternate routes.
1.1.2.1.5	Real-time information provided by PTTI shall include the current speeds on specific routes.
1.1.2.1.6	Real-time information provided by PTTI shall include current parking conditions in key areas.
1.1.2.1.7	Real-time information provided by PTTI shall include the schedules for any current or soon to start events.
1.1.2.1.8	Real-time information provided by PTTI shall include the current weather situation.
1.1.3	PTTI shall include a Trip Planning Service.
1.1.3.1	PTTI trip planning service shall provide the users with information needed for planning an upcoming trip.
1.1.3.1.1	Based on user specified parameters PTTI shall provide users with a calculated itinerary.
1.1.3.1.2	Based on user specified parameters PTTI shall provide users with transportation mode choices.
1.1.3.1.3	Based on user specified parameters PTTI shall provide users with real-time travel conditions for time of inquiry and estimated conditions for estimated time of travel.
1.1.3.1.4	Based on user specified parameters PTTI shall provide users with one or more alternate itineraries in addition to the primary calculated itinerary.
1.1.3.2	PTTI shall provide the capability for users to specify transportation parameters that are unique to their individual needs.
1.1.3.2.1	PTTI shall provide the capability for users to specify a desired destination.
1.1.3.2.10	PTTI shall provide the capability for users to specify their preferred weather conditions.
1.1.3.2.2	PTTI shall provide the capability for users to specify a planned departure location.
1.1.3.2.3	PTTI shall provide the capability for users to specify their desired departure time.
1.1.3.2.4	PTTI shall provide the capability for users to specify their desired arrival time.
1.1.3.2.5	PTTI shall provide the capability for users to specify their maximum acceptable travel time.

1.1.3.2.6	PTTI shall provide the capability for users to specify their maximum acceptable number of mode changes.
1.1.3.2.7	PTTI shall provide the capability for users to specify a maximum number of transfers.
1.1.3.2.8	PTTI shall provide the capability for users to specify their preferred route(s) or segment of route(s).
1.1.3.2.9	PTTI shall provide the capability for users to specify their preferred transportation mode(s).
1.1.3.3	In addition to the user specified parameters PTTI shall use additional factors when planning trips.
1.1.3.3.1	PTTI shall consider current travel conditions when calculating a trip itinerary.
1.1.3.3.2	PTTI shall consider predicted travel conditions when calculating a trip itinerary.
1.1.4	PTTI shall provide the capability for User Access.
1.1.4.1	PTTI shall provide the capability for users to access the system from multiple distributed locations.
1.1.4.1.1	PTTI shall provide the capability for users to access the system from their homes.
1.1.4.1.2	PTTI shall provide the capability for users to access the system from their place of work.
1.1.4.1.3	PTTI shall provide the capability for users to access the system from major trip generation sites.
1.1.4.1.4	PTTI shall provide the capability for users to access the system from personal portable devices.
1.1.4.2	PTTI shall provide the capability for users to access the system over multiple types of electronic media.
1.1.4.2.1	Access media shall comply with the Americans with Disabilities Act (ADA) legislation.
1.10	HIGHWAY RAIL INTERSECTION
1.10.0	ITS shall include a Highway-Rail Intersection (HRI) function to control highway and rail traffic in at-grade HRIs. Two sub-services are supported: Standard Speed Rail Subservice which is applicable to light rail transit, commuter rail and heavy rail trains with operational speeds up to 79 miles per hour (MPH); and High Speed Rail Subservice which is applicable to all passenger and freight trains with operational speeds from 80 to 125 MPH.
1.10.1	The Highway-Rail Intersection (HRI) function shall be applicable to operational, at-grade highway-rail intersections with train operational speeds up to 125 MPH.
1.10.1.1	HRI users shall include light rail transit and rapid rail transit approaching and crossing HRIs.
1.10.1.2	HRI users shall include commuter rail trains approaching and crossing HRIs.
1.10.1.3	HRI users shall include freight and intercity passenger trains approaching and crossing HRIs.
1.10.1.4	HRI users shall include highway vehicles approaching and crossing HRIs.
1.10.1.5	HRI users shall include motor vehicle operators, bicyclists and pedestrians approaching and crossing HRIs.
1.10.1.6	HRI users shall include train crews operating rail traffic while approaching and crossing HRIs.
1.10.1.7	HRI users shall include rail maintenance and inspection vehicles approaching and crossing HRIs.
1.10.2	HRI shall provide interfaces between highway and rail management functions.
1.10.2.1	HRI shall provide information management interfaces between highway and rail to coordinate traffic, demand and schedules.
1.10.2.1.1	HRI shall be capable of acquiring current train schedules from rail operations functions, and shall determine projected HRI closure times and duration.
1.10.2.1.2	HRI shall be capable of interacting with traffic management functions.
1.10.2.1.3	HRI shall provide closure data to traffic management for in-vehicle traveler advisory messages.
1.10.2.2	HRI shall provide the capability for interactive real-time interfaces.
1.10.2.2.1	HRI shall provide the capability to interface with rail operations functions for rail traffic control information.
1.10.2.2.2	HRI shall provide the capability to interface with traffic management functions for highway traffic coordination.
1.10.2.2.3	HRI shall provide the capability to interface with trains approaching and crossing the HRI for traffic coordination.

1.10.2.2.4	HRI shall provide the capability to interface with highway vehicles approaching and crossing HRIs for traffic control information.
1.10.3	At all HRIs with active railroad warning systems, HRI shall manage the traffic in the intersection.
1.10.3.1	HRI shall be capable of augmenting the intersection with standard highway traffic signal devices.
1.10.3.2	HRI shall include an automated collision avoidance function for highway vehicles approaching HRIs.
1.10.3.3	HRI shall provide an Intelligent Intersection Controller (IIC) function to manage highway and rail traffic in the intersection.
1.10.3.3.1	IIC shall control active highway traffic signal devices at HRIs to manage highway traffic.
1.10.3.3.2	IIC function shall control active railway warning devices, including flashing lights and physical barriers for highway and walkway lanes at HRIs.
1.10.3.3.3	IIC function shall provide an intersection surveillance system to derive the real-time status of traffic in the intersection.
1.10.3.3.4	IIC function shall report real-time HRI equipment status.
1.10.3.3.5	IIC function shall report real-time HRI traffic status as advisories or alerts.
1.10.4	HRI shall include a Standard Speed Rail (SSR) Subservice to manage highway and rail traffic at HRIs for rail lines with operational speeds less than 80 MPH.
1.10.4.1	SSR shall include active railroad warning systems at designated HRIs.
1.10.4.2	SSR shall include passive HRIs with non-active warning systems.
1.10.4.2.1	SSR shall augment passive warning signs with additional highway traffic control devices at passive HRIs.
1.10.5	HRI shall provide a High Speed Rail (HSR) Subservice for HRIs on rail lines with operational speeds between 80 and 125 MPH.
1.10.5.1	HSR shall include active roadside message devices to provide highway closure information at HSR HRIs.
1.10.5.2	HSR shall provide special safety features to enhance safety.
1.10.5.2.1	HSR shall close the HRI to highway traffic at a predetermined time (up to three minutes) before train arrival or when directed by train operations.
1.10.5.2.2	HSR shall include a positive barrier function (e.g. four quadrant gates) to close the intersection to highway traffic for rail lines operating at speeds over 110 MPH.
1.10.5.2.3	HSR HRIs shall verify the intersection's status as either "OPEN" or "BLOCKED" for rail traffic by an immobile obstacle.
1.10.5.2.4	HSR shall provide HRI status to rail operations functions as either a "PROCEED" or a "STOP" indication.
1.10.5.2.5	HSR shall provide HRI status to the train as either a "PROCEED" or a "STOP" indication.
1.10.5.2.6	HSR shall provide HRI status to highway vehicles as either a "STOP FOR TRAIN" or a "PROCEED" indication.
1.10.6	At HRIs with active railroad warning systems, HRI shall provide the capability for automatic collision notification to rail operations and traffic management.
1.2	EN-ROUTE DRIVER INFORMATION
1.2.0	ITS shall include an En-Route Driver Information (DI) function. Driver Information provides vehicle drivers with information, while en-route, which will allow alternative routes to be chosen for their destination. Driver Information consists of two major functions, which are, (1) Driver Advisory and (2) In-vehicle Signing. The potential decrease in traffic may also provide benefits in highway safety, reduced air pollution, and decreased congestion.
1.2.1	DI shall be implemented in a manner that is beneficial to the transportation system and the public.
1.2.1.1	DI shall be implemented in a manner that helps improve highway safety.
1.2.1.2	DI shall be implemented in a manner that helps reduce air pollution.
1.2.1.3	DI shall be implemented in a manner that helps decrease congestion.
1.2.1.4	DI shall be designed in a manner that permits a two-phase implementation.

1.2.1.4.1	The DI two-phase implementation shall include a short term capability to address those features that can be implemented in the present time frame.
1.2.1.4.2	The DI two-phase implementation shall include a long term capability to address those features that can be implemented when the remainder of the ITS system is deployed.
1.2.1.5	DI shall include a driver advisory capability and an in-vehicle signing capability.
1.2.2	DI shall include a Driver Advisory function, which shall be implemented in two phases with first a short term capability and later a long term capability.
1.2.2.1	The short term DI driver information capability shall include the ability to provide information to travelers within the limited area of deployment.
1.2.2.1.1	DI shall include the capability to provide travelers with accurate information concerning available travel options and their state of operational availability.
1.2.2.1.2	DI shall provide information to travelers required for them to avoid areas of congestion.
1.2.2.1.2.1	DI shall provide information needed for travelers to select transportation modes that allow them to avoid congestion.
1.2.2.1.3	DI shall provide the capability for users to receive travel information in their vehicles.
1.2.2.1.4	In the short-term DI shall be deployed in those limited areas where the need and associated benefits are more immediate.
1.2.2.2	The long term DI driver information capability shall include the ability to provide information to travelers within all geographic areas of the ITS deployment.
1.2.3	DI shall provide an In-vehicle Signing capability.
1.2.3.1	The DI In-vehicle Signing function shall include a short term capability to serve the more immediate needs of travelers.
1.2.3.1.1	The short term In-vehicle Signing function shall include the capability to provide assistance to individuals with impaired vision.
1.2.3.1.2	The short term In-vehicle Signing function shall include the capability to provide assistance to individuals needing local guidance in areas that the driver is unfamiliar with (e.g., airports, resort areas, tourist attractions).
1.2.3.1.3	The short term In-vehicle Signing function shall include the capability to provide assistance to individuals in areas that frequently have conditions of poor visibility, high winds, extreme temperature, and falling rocks.
1.2.3.1.4	The short term In-vehicle Signing function shall be implemented in a manner that augments existing signs.
1.2.3.1.4.1	The short term In-vehicle Signing function shall augment control signs (e.g., stop signs).
1.2.3.1.4.2	The short term In-vehicle Signing function shall augment warning signs (e.g., slow signs).
1.2.3.1.5	The short term In-vehicle Signing function shall provide a user interface that allows travelers to access its capabilities.
1.2.3.2	The DI In-vehicle Signing function shall include a long term capability to serve more of the traveler's needs.
1.2.3.2.1	The long term In-vehicle Signing function shall be integrated with other ITS system capabilities.
1.2.3.2.2	The long term In-vehicle Signing function shall provide the capability to customize warnings.
1.2.3.2.2.1	The customized warnings function shall provide the capability to control the contents of warning messages to the extant environmental conditions.
1.2.3.2.3	The In-vehicle Signing function shall provide the capability to utilize data from roadside environmental sensors as inputs to warning messages.
1.2.3.2.4	The In-vehicle Signing function shall provide travelers with information on road conditions.
1.2.3.2.5	The In-vehicle Signing function shall provide travelers with precautionary reminder messages.
1.3	ROUTE GUIDANCE
1.3.0	ITS shall include a Route Guidance (RG) function. Route Guidance will provide travelers with directions to selected destinations. Four functions are provided, which are, (1) Provide Directions, (2) Static Mode, (3) Real-Time Mode, and (4) User Interface.
1.3.1	RG shall include the capability to Provide Directions to travelers.

1.3.1.1	The Provide Directions function shall provide travelers with directions to their selected destination locations.
1.3.1.2	The Provide Directions function shall issue directions to travelers based on information about current conditions of transportation systems.
1.3.1.2.1	Current transportation system conditions upon which directions to travelers is based shall include, but not be limited to, the following:
1.3.1.2.1(a)	Current traffic conditions.
1.3.1.2.1(b)	Status of transit systems.
1.3.1.2.1(c)	Schedules of transit systems.
1.3.1.2.1(d)	Events taking place that influence travel routes.
1.3.1.2.1(d).1	Street closures.
1.3.1.2.1(d).2	Pedestrian events.
1.3.1.2.1(d).3	No pedestrian zones.
1.3.1.3	The Provide Directions function shall issue traveler directions that are simple and easy to understand, providing turning instructions on which way to turn onto including, but not limited to, the following:
1.3.1.3(a)	Particular streets.
1.3.1.3(b)	Roads.
1.3.1.3(c)	Walkways.
1.3.1.3(d)	Transit facilities.
1.3.2	RG shall include a Static Mode for issuing information to travelers.
1.3.2.1	Static Mode shall provide travelers with information that includes, but is not limited to, the following:
1.3.2.1(a)	Mapping information about roadways.
1.3.2.1(b)	Scheduling information about transit systems.
1.3.2.2	Static Mode infrastructure systems shall provide the capability to have two-way communications between the traveler and the infrastructure.
1.3.2.2.1	The two-way communications shall provide the capability for the infrastructure to receive the traveler's desired destination.
1.3.2.2.2	The two-way communications shall provide the capability to provide directions back to the traveler that are based on the infrastructure's calculated routing.
1.3.2.3	The Real-Time Mode shall provide the capability for autonomous operation of mobile based systems.
1.3.2.3.1	Autonomous Mobile Based systems shall have the capability to operate independent of infrastructure.
1.3.3	RG shall include a Real-Time Mode for issuing information to travelers.
1.3.3.1	The Real-Time Mode shall utilize current travel condition information to provide performance that is enhanced over the Static Mode performance, to include, but not be limited to, the
1.3.3.1(a)	Traffic conditions information.
1.3.3.1(b)	Dynamic transit schedule information.
1.3.3.2	The Real-Time Mode shall include the capability to operate in either or both of the following two configurations:
1.3.3.2(a)	Route selection processors located on the mobile unit.
1.3.3.2(b)	Route selection processors installed in the transportation system infrastructure.
1.3.3.2.1	Real-Time Mode Mobile Based systems shall include the capability to receive infrastructure information and use it in determining routing.
1.3.3.2.2	If current real-time information is included in route determination, the system shall be denoted as an Infrastructure-based real-time system.
1.3.3.3	The Real-Time Mode shall provide the capability for autonomous operation of mobile-based systems.

1.3.4	RG shall include a User Interface function.
1.3.4.1	The User Interface function shall provide the capability for travelers to access the system by utilizing interactive devices that include, but are not limited to, the following:
1.3.4.1(a)	Visual displays.
1.3.4.1(b)	Keypads.
1.3.4.1(c)	Touch sensitive devices.
1.3.4.1(d)	Computer generated voice.
1.3.4.1(e)	Voice recognition system.
1.3.4.2	Mobile systems shall use the best information available to provide routing instructions.
1.3.4.2.1	Mobile systems shall provide the capability for individual travelers to customize the routing selected for them.
1.3.4.2.2	Mobile systems shall allow customization of traveler's routing based on certain conditions specified by the traveler to include, but not be limited to, the following:
1.3.4.2.2(a)	Avoid expressway-type highways.
1.3.4.2.2(b)	Avoid multiple mass transit transfers.
1.3.4.3	Infrastructure-based systems shall permit individual travelers to customize their routing selection.
1.3.4.3.1	Infrastructure-based systems shall use the traveler's destination information to estimate extra demand on the transportation system and then provide routing to the traveler based on this predicted demand.
1.4	RIDE MATCHING AND RESERVATION
1.4.0	ITS shall include a Ride Matching and Reservation (RMR) function. Ride Matching and Reservation will provide travel users with information on rideshare providers. Three major functions are provided, which are, (1) Rider Request, (2) Transportation Provider Services, and (3) Information Processing. This will also include a billing service to the providers.
1.4.1	RMR shall include a Rider Request capability.
1.4.1.1	Rider Request shall provide the capability for a traveler to request a ride by placing a single request from a facility to include, but not be limited to, the following:
1.4.1.1(a)	Telephones (including hearing-impaired capability).
1.4.1.1(b)	Kiosks.
1.4.1.2	Rider Request shall provide a traveler the capability to request a specific itinerary by specifying, but not be limited to, the following:
1.4.1.2(a)	Date.
1.4.1.2(b)	Time of pick-up and drop-off.
1.4.1.2(c)	Origin.
1.4.1.2(d)	Destination.
1.4.1.2(e)	Specific restrictions or preferences.
1.4.1.3	Rider Request shall provide the traveler with the available ridesharing options, based on the traveler's request and specified itinerary.
1.4.1.4	Rider Request shall also include the capability to perform real-time ridematching by instantly matching rider and driver.
1.4.2	RMR shall include a Transportation Provider Service function.
1.4.2.1	Transportation Provider Services shall include the capability for providers to have their billing arranged through a central clearinghouse.
1.4.2.2	Transportation Provider Services shall include electronic safeguards against fraud and abuse.
1.4.2.3	Transportation Provider Services shall automatically generate needed reports and financial documentation.
1.4.2.4	Transportation Provider Services shall include the capability for commercial operators such as vanpools and taxis to be included as options for requesting travelers.
1.4.3	RMR shall include an Information Processing function.

1.4.3.1	Information Processing shall quickly match preferences and demands of requesting travelers with the services available from providers.
1.4.3.2	Information Processing shall provide a clearinghouse capability for rideshare financial transactions.
1.4.3.3	Information Processing shall link together the services available from all travel modes including, but not limited to, the following:
1.4.3.3(a)	Bus.
1.4.3.3(b)	Rail.
1.4.3.3(c)	Vanpools.
1.4.3.3(d)	Express bus.
1.4.3.3(e)	Commercial providers.
1.4.3.3(f)	Specialized service.
1.4.3.3(g)	Carpools.
1.4.3.4	Information Processing shall provide the informational infrastructure to connect providers and consumers.
1.4.3.5	Information Processing shall provide the capability to gather market information to assist in the planning of service improvements.
1.4.3.6	Information Processing shall provide the capability to gather market information to assist in operations.
1.5	TRAVELER SERVICES INFORMATION
1.5.0	ITS shall include a Traveler Services Information (TSI) function. Traveler Services Information provides travelers with service and facility data for the purpose of assisting prior to embarking on a trip or after the traveler is underway. The functions which are included in this capability are Information Receipt and Information Access. This will provide the traveler with a "yellow pages" type of capability.
1.5.1	TSI shall include an Information Receipt function for the collection of information to be provided to travelers.
1.5.1.1	Information Receipt shall provide and maintain a database of local area services available to travelers.
1.5.1.2	Information Receipt provides the capability to acquire current information relating to traveler services available in the local area.
1.5.1.2.1	Information Receipt shall acquire information on the condition of local traveler services.
1.5.1.2.2	Information Receipt shall acquire information on the status of local traveler services.
1.5.1.2.3	Information Receipt shall acquire information on the availability of local traveler services.
1.5.1.2.4	Information Receipt shall acquire information on the availability of local motorist services.
1.5.1.2.5	Information Receipt shall acquire information on the availability of local tourist services.
1.5.1.3	Information Receipt shall be capable of being integrated with Pre-Trip Planning information.
1.5.1.4	Information Receipt shall provide the capability to support the financial transactions required for travelers to be billed for the purchase of activity tickets and room reservations.
1.5.1.5	Information Receipt shall include the capability to have interactive connectivity between users, sponsors and providers of services.
1.5.2	TSI shall include an Information Access function that allows travelers to access the available information.
1.5.2.1	Information Access shall provide the capability for travelers to request and receive general information about the local area.

1.5.2.2	Information Access shall provide the capability for travelers and centers to request and receive information about the location of facilities and the quality of specific services provided in an area to include but, not be limited to, the following:
1.5.2.2(a)	Lodging information.
1.5.2.2(b)	Food information.
1.5.2.2(c)	Parking information.
1.5.2.2(d)	Hours of operation information.
1.5.2.2(e)	Tourist activities information.
1.5.2.2(f)	Daily or special events information.
1.5.2.2(g)	Local shelter/medical facility availability information including level of service provided.
1.5.2.2(h)	Nearest gas station information.
1.5.2.2(i)	Local care facility information.
1.5.2.3	Information Access shall provide the capability for travelers to request specific actions of area service providers to include, but not be limited to:
1.5.2.3(a)	Lodging reservations.
1.5.2.3(b)	Dining reservations.
1.5.2.4	Information Access shall provide the capability for all travelers to access information regardless of their particular mode of travel.
1.5.2.5	Information Access shall provide the capability for travelers to access the TSI information via any of, but not limited to, the following methods:
1.5.2.5(a)	Highway advisory radio.
1.5.2.5(b)	Dial-up telephone lines.
1.5.2.5(c)	Computers at home.
1.5.2.5(d)	Computers in the office.
1.5.2.5(e)	In-vehicle computers.
1.5.2.5(f)	Public area kiosks.
1.5.2.5(g)	Personal portable devices.
1.5.2.6	Information Access shall provide the capability for travelers to access TSI information from public kiosk locations which include, but are not limited to:
1.5.2.6(a)	Rest areas.
1.5.2.6(b)	Activity centers.
1.5.2.6(c)	Tourist attractions.
1.5.2.6(d)	Service plazas.
1.5.2.6(e)	Airports.
1.6	TRAFFIC CONTROL
1.6.0	ITS shall include a Traffic Control (TC) function. Traffic Control provides the capability to efficiently manage the movement of traffic on streets and highways. Four functions are provided, which are, (1) Traffic Flow Optimization, (2) Traffic Surveillance, (3) Control, and (4) Provide Information. This will also include control of network signal systems with eventual integration of freeway control.
1.6.1	TC shall include a Traffic Flow Optimization function to provide the capability to optimize traffic flow.
1.6.1.1	Traffic Flow Optimization shall employ control strategies that seek to maximize traffic-movement efficiency.
1.6.1.1.1	Traffic-movement control shall manage movement of traffic on streets.
1.6.1.1.2	Traffic-movement control shall manage movement of traffic on highways.
1.6.1.1.3	Traffic-movement control shall include the goal of minimizing delay times.
1.6.1.1.4	Traffic-movement control shall include the goal of minimizing energy use.
1.6.1.1.5	Traffic-movement control shall include the goal of minimizing air quality impacts due to traffic

1.6.1.2	Traffic Flow Optimization shall include a wide area optimization capability, to include several jurisdictions.
1.6.1.2.1	Wide area optimization shall integrate the control of network signal systems with the control of freeways.
1.6.1.2.2	Wide area optimization shall include features that provide preferential treatment for transit vehicles.
1.6.1.2.3	Wide area optimization shall include features that provide preferential treatment for HOV.
1.6.1.3	Traffic Flow Optimization shall be implemented in a manner that seeks to optimize traffic movement over a large geographic area.
1.6.1.4	Traffic Flow Optimization shall include a Control function that is responsive to both the current demand as well as the expected demand.
1.6.1.4.1	The Control function shall include the capability to facilitate the dissipation of traffic congestion.
1.6.1.5	Traffic Flow Optimization shall provide the capability to predict travel patterns.
1.6.1.6	The Control function shall include the use of data acquired from traffic surveillance as feedback to the control strategies.
1.6.1.7	Implementation of the Control function shall include strategies that account for at least the following:
1.6.1.7(a)	Human factors.
1.6.1.7(b)	Driver/traveler behavior and expectancies.
1.6.2	TC shall include a Traffic Surveillance function.
1.6.2.1	Traffic Surveillance shall include a vehicle detection function with the capability of accurately detecting vehicles in a real-time fashion.
1.6.2.1.1	Vehicle detection shall include the capability to determine those vehicles that are HOVs.
1.6.2.2	Traffic Surveillance shall include a data collect function to provide the capability to collect data for determining traffic flow and prediction.
1.6.2.2.1	The data collect function shall provide the capability to quickly feedback traffic data to the control processes.
1.6.2.3	Traffic Surveillance shall include a wide-area surveillance capability to include several jurisdictions.
1.6.2.3.1	The wide-area surveillance shall gather speed and flow information.
1.6.2.3.2	The wide-area surveillance shall cover a large number of roadway segments.
1.6.2.4	TC shall provide the capability to acquire detailed traffic measurements at specific locations.
1.6.2.4.1	Traffic Surveillance shall include a data process function to process the traffic data which are acquired.
1.6.2.5	The wide area surveillance shall acquire sufficient data to provide the system with the knowledge of the existing conditions.
1.6.2.5.1	The data process function shall combine and process traffic data from multiple sources and times in order to improve the accuracy of the view of the current traffic condition.
1.6.2.5.2	The data process function shall process traffic data to generate near term predictions of traffic conditions.
1.6.3	TC shall include a Device Control function.
1.6.3.1	The Device Control function shall include a "real-time" traffic-adaptive control capability.
1.6.3.2	The real-time traffic-adaptive control portion of the Device Control function shall be an area wide control to include several jurisdictions.
1.6.3.2.1	The area wide control shall be implemented in an integrated and consistent manner that avoids the issuance of conflicting controls.
1.6.3.2.2	The area wide control shall be implemented in a manner that permits the following types of vehicles to have preference over other vehicles being controlled.
1.6.3.2.2(a)	Transit.
1.6.3.2.2(b)	HOV.
1.6.3.2.2(c)	Emergency Medical Service Vehicles.

1.6.3.3	The Device Control function shall provide the capability to exercise control over those devices utilized for traffic control.
1.6.3.3.1	Device Control shall include the capability to control traffic signalization, including rapid modification of signalization parameters to respond to traffic requirements.
1.6.3.3.2	Device Control shall include the capability to dynamically control traffic signing.
1.6.3.3.3	Device Control shall include the capability to control freeway ramp metering.
1.6.3.3.4	Device Control shall include the capability to exercise dynamic control over the infrastructure (such as reversible-lanes, turning restrictions, etc.).
1.6.3.4	Device Control shall communicate control data to the following devices.
1.6.3.4(a)	Traffic signals.
1.6.3.4(b)	Ramp meters.
1.6.3.4(c)	Information signs.
1.6.3.4(d)	HOV lanes.
1.6.3.4(e)	Human operator support.
1.6.3.4.1	Traffic Surveillance shall include a data process function to process the traffic data which are acquired.
1.6.3.5	Device Control shall provide the operator with the capability to manually override the system's automatic controls.
1.6.3.6	Device Control shall provide the operator the capability to adaptively change system response in order to provide a response that is coordinated with other TMCs responding to
1.6.4	Device Control shall provide traffic control information to other elements of the ITS, including but not limited to the following:
1.6.4(a)	In-vehicle navigation.
1.6.4(b)	Trip planning.
1.6.4(c)	Routing systems.
1.6.4(d)	Fleet management systems.
1.7	INCIDENT MANAGEMENT
1.7.0	ITS shall include an Incident Management (IM) function. Incident Management will identify incidents, formulate response actions, and support initiation and ongoing coordination of those response actions. Four major functions are provided, which are, (1) Incidents Identification, (2) Response Formulation, (3) Response Implementation, and (4) Predict Hazardous
1.7.1	Incident Management shall provide an Incident Identification function to identify incidents.
1.7.1.1	The Incident Identification function shall include the capability to identify predicted incidents.
1.7.1.1.1	The Incident Identification function shall use information from the following types of sources, where available, to identify predicted incidents:
1.7.1.1.1(a)	Traffic flow sensors.
1.7.1.1.1(b)	Environmental sensors.
1.7.1.1.1(c)	Public safety sources.
1.7.1.1.1(d)	Media sources.
1.7.1.1.1(e)	Weather information sources.
1.7.1.1.1(f)	Transportation providers.
1.7.1.1.1(g)	Sponsors of special events.
1.7.1.1.1(h)	Hazardous condition prediction algorithms.

1.7.1.1.2	The Incident Identification function shall determine at least the following characteristics of each predicted incident:
1.7.1.1.2(a)	Type (including Terrain Hazards).
1.7.1.1.2(b)	Extent.
1.7.1.1.2(c)	Severity.
1.7.1.1.2(d)	Location.
1.7.1.1.2(e)	Expected duration.
1.7.1.1.3	The Incident Identification function shall determine the expected traffic flow impact of each predicted incident.
1.7.1.2	The Incident Identification function shall include the capability to identify existing (both planned and unplanned) incidents.
1.7.1.2.1	The Incident Identification function shall use information from the following types of sources, where available, to identify existing incidents:
1.7.1.2.1(a)	Traffic flow sensors.
1.7.1.2.1(b)	Environmental sensors.
1.7.1.2.1(c)	Public safety sources.
1.7.1.2.1(d)	Media sources.
1.7.1.2.1(e)	Weather information sources.
1.7.1.2.1(f)	Transportation providers.
1.7.1.2.1(g)	Travelers.
1.7.1.2.2	The Incident Identification function shall determine and continuously monitor at least the following characteristics of each existing incident:
1.7.1.2.2(a)	Type (including Terrain Hazards).
1.7.1.2.2(b)	Extent.
1.7.1.2.2(c)	Severity.
1.7.1.2.2(d)	Location.
1.7.1.2.2(e)	Expected duration.
1.7.1.2.3	The Incident Identification function shall determine and continuously monitor the current and expected traffic flow impact of each existing incident.
1.7.2	IM shall provide a Response Formulation function to formulate appropriate response actions to each identified incident and revise those actions when necessary.
1.7.2.1	The Response Formulation function shall propose and facilitate the appropriate scheduling of those predicted incidents that can be scheduled to minimize incident potential, incident impacts, and/or the resources required for incident management.
1.7.2.2	The Response Formulation function shall propose and facilitate the appropriate dispatch of emergency response vehicles to an incident.
1.7.2.3	The Response Formulation function shall propose and facilitate the appropriate dispatch of service vehicles to an incident.
1.7.2.4	The Response Formulation function shall propose and facilitate the appropriate dissemination of incident related information to travelers and potential travelers.
1.7.2.5	The Response Formulation function shall propose and facilitate the appropriate control of traffic signals and other traffic control to reduce the traffic flow impact of an incident.
1.7.3	IM shall include a Response Implementation function to provide the services to implement a response coordinated with all appropriate agencies.

1.7.3.1	The Response Implementation function shall provide at least the following decision support capabilities needed to implement coordinated incident response actions by all participating institutions:
1.7.3.1(a)	Response Implementation shall allow coordinated selection/determination of the procedures, including alternate routes, needed for resolution of each incident and provide the procedures to those agencies responding to the incident.
1.7.3.1(b)	Response Implementation shall provide the status of all resources needed for incident resolution to those agencies responding to the incident.
1.7.3.2	The Response Implementation function shall provide a link between Incident Management and all other user services necessary to implement incident response actions.
1.7.3.3	The Response Implementation function shall provide the capability to disseminate information relating to response status to other agencies and user services.
1.7.4	IM shall provide the capability to Predict Hazardous Conditions, including the time and location of hazardous conditions that may cause an incident.
1.8	TRAVEL DEMAND MANAGEMENT
1.8.0	ITS shall include a Travel Demand Management (TDM) function. Travel Demand Management will generate and communicate management and control strategies that will support and facilitate the implementation of TDM programs, policies and regulations. It consists of two major functions, which are, (1) Increase Efficiency of Transportation System and (2) Provide Wide Variety of Mobility Options.
1.8.1	TDM shall include a communications function.
1.8.1.1	The communications function shall include the capability to send the information needed to implement management and control strategies that are in response to policies and regulations.
1.8.1.2	The communications function shall include the capability to send information and rates needed to implement management and control strategies that respond to changing environments, conditions, and policy needs to include, but not limited to, the following locations of action:
1.8.1.2(a)	Parking facilities.
1.8.1.2(b)	HOV lanes.
1.8.1.2(c)	Transit centers.
1.8.1.2(d)	Employment sites.
1.8.1.2(e)	Toll facilities.
1.8.1.2(f)	Travel (and traveler) information facilities.
1.8.1.2(g)	Ridesharing facilities.
1.8.1.3	TDM shall provide the capability to receive information and rates needed to implement management and control strategies that respond to changing environments, conditions, and policy needs to include, but not limited to, the following locations of action:
1.8.1.3(a)	Parking facilities.
1.8.1.3(b)	HOV lanes.
1.8.1.3(c)	Transit centers.
1.8.1.3(d)	Employment sites.
1.8.1.3(e)	Toll facilities.
1.8.1.3(f)	Travel (and traveler) information facilities.
1.8.1.3(g)	Ridesharing facilities.
1.8.1.4	The communications function shall provide the capability to send information and data as needed to implement management and control strategies that respond to changing environments, conditions, and policy needs to include, but not limited to, the following:
1.8.1.4(a)	Sensor data.
1.8.1.4(b)	Individual vehicle monitoring.
1.8.1.4(c)	Parking availability.
1.8.1.4(d)	Usage data.

1.8.1.5	The communications function shall provide the capability to receive information and data from transportation operators and/or users that delineate their:
1.8.1.5(a)	Current status.
1.8.1.5(b)	Needs.
1.8.1.5(c)	Level of activity.
1.8.1.6	The communications function shall include the capability for two-way communications with other ITS user services including, but not limited to, the following:
1.8.1.6(a)	Pre-Trip Planning.
1.8.1.6(b)	En-Route Transit Advisory.
1.8.1.6(c)	Driver Information.
1.8.1.6(d)	Ride Matching and Reservation.
1.8.1.6(e)	Electronic Payment.
1.8.1.6(f)	Traffic Control.
1.8.2	TDM shall include a processing function.
1.8.2.1	The processing function shall provide the capability to generate management and control strategies that facilitate the implementation of policies and regulations designed to address the following:
1.8.2.1(a)	Vehicle trip reduction.
1.8.2.1(b)	HOV lanes and ramps.
1.8.2.1(c)	Parking management and control.
1.8.2.1(d)	Ridesharing and transit.
1.8.2.1(e)	Air pollution/emission information and detection.
1.8.2.1(f)	Public awareness of travel alternatives.
1.8.2.10	The processing function's dynamically generated management and control strategies shall include the parking management and controls to include, but not be limited to, the following:
1.8.2.10(a)	Price structure.
1.8.2.10(b)	Allocation to selected vehicles.
1.8.2.10(c)	Variable message signs.
1.8.2.11	The processing function's dynamically generated management and control strategies for parking management and controls shall be based on factors that include, but are not limited to, the following:
1.8.2.11(a)	Parking availability.
1.8.2.11(b)	Usage data.
1.8.2.12	The processing function's dynamically generated management and control strategies shall include the capability to respond to the need for control of pollution by generating messages for variable signs that include, but are not limited to, the following:
1.8.2.12(a)	Informing of higher tolls.
1.8.2.12(b)	Informing of higher parking fees.
1.8.2.13	The processing function's dynamically generated management and control strategies for air pollution control shall be based on factors that include, but are not limited to, the following:
1.8.2.13(a)	Sensor data.
1.8.2.13(b)	Individual vehicle monitoring.
1.8.2.13(c)	Individual vehicle database files.
1.8.2.14	The processing function's dynamically generated management and control strategies shall include the capability to respond to the need for the travelers to change modes by generating messages for variable signs that include, but are not limited to, the following:
1.8.2.14(a)	Where the mode change requests are being made.
1.8.2.14(b)	How the mode changes are requested to be made.
1.8.2.14(c)	Why the mode changes are requested to be made.

1.8.2.2	The processing function shall provide capabilities to enhance the ability to implement and enforce the following:
1.8.2.2(a)	Federal policies.
1.8.2.2(b)	State policies.
1.8.2.2(c)	Local policies.
1.8.2.3	Strategies developed by the processing function shall include the guidance for the operation of physical systems that:
1.8.2.3(a)	Monitor traffic.
1.8.2.3(b)	Inform travelers.
1.8.2.3(c)	Collect fees.
1.8.2.3(d)	Detect traffic.
1.8.2.4	The processing function shall provide the capability generate guidance for the pricing and control for locations of action that include, but are not limited to, the following:
1.8.2.4(a)	Parking facilities.
1.8.2.4(b)	HOV lanes.
1.8.2.4(c)	Transit centers.
1.8.2.4(d)	Employment sites.
1.8.2.4(e)	Toll facilities.
1.8.2.4(f)	Travel information facilities.
1.8.2.4(g)	Ridesharing facilities.
1.8.2.5	The processing function shall provide the capability to develop strategies for implementation of policies and regulations that will accommodate the following:
1.8.2.5(a)	Public sector users and service providers.
1.8.2.5(b)	Private sector users and service providers.
1.8.2.5(c)	Issues of legality.
1.8.2.5(d)	Privacy act.
1.8.2.5(e)	Multi-jurisdictional settings.
1.8.2.6	The processing function shall provide the capability to generate management and control strategies that dynamically respond to changing environments, conditions, and policies.
1.8.2.7	The processing function's dynamically generated management and control strategies shall include the control of HOV facilities including, but not limited to, the following:
1.8.2.7(a)	Lanes.
1.8.2.7(b)	Ramps.
1.8.2.7(c)	Parking areas.
1.8.2.8	The processing function's generation of management and control strategies for HOV facilities shall include as factors, but not be limited to, the following:
1.8.2.8(a)	Auto occupancy requirements.
1.8.2.8(b)	Priority for selected vehicle types at ramps.
1.8.2.8(c)	Priority for selected vehicle types at signalized intersections.
1.8.2.9	The processing function's dynamically generated management and control strategies shall include those roadway pricings that respond to the need for congestion control to include, but not be limited to, the following:
1.8.2.9(a)	Road user and toll rates.
1.8.2.9(b)	Transit fares adjusted concomitant with tolls.
1.8.2.9(c)	Time of day usage pricing (i.e. off hour rates).

1.8.3	TDM shall include a sensors/control function.
1.8.3.1	The sensors/control function shall provide the capability to gather information needed for the generation of management and control strategies to include, but not be limited to the,
1.8.3.1(a)	Parking availability.
1.8.3.1(b)	Usage levels.
1.8.3.1(c)	Vehicle occupancy.
1.8.3.1(d)	Vehicle pollution levels.
1.9	EMISSIONS TESTING AND MITIGATION
1.9.0	ITS shall include an Emission Testing and Mitigation (ETAM) Function. The ETAM function will provide state and local governments with the capability to enhance their air quality control strategies. The ETAM will provide both wide area and roadside emissions monitoring. Information gleaned from ETAM will be used by Traffic Demand Management (TDM) in the Traffic Management Center (TMC) to mitigate pollution and may be provided to enforcement agencies to compel offenders to comply with standards.
1.9.1	ETAM shall include a Wide Area Pollution Monitoring (WAPM) capability.
1.9.1.1	WAPM shall support air quality control strategies by assessing the level of emission of ozone precursors in all sectors of the area.
1.9.1.1.1	WAPM shall be capable of detecting the level of emission of ozone precursors with a high degree of accuracy.
1.9.1.1.2	WAPM shall be capable of determining those sectors, within its monitored area, whose emissions exceed the emission standard.
1.9.1.1.3	WAPM shall be capable of automatic self-calibration.
1.9.1.2	WAPM shall be capable of providing air quality statistical data to the TMC.
1.9.1.2.1	WAPM shall be capable of providing the air quality data on the monitored values of pollution.
1.9.1.2.2	WAPM shall be capable of providing the necessary data on emission standards violators for enforcement of air quality standards.
1.9.2	ETAM shall include roadside pollution assessment (RPA) capabilities.
1.9.2.1	RPA shall be capable of detecting the level of emission of ozone precursors with a high degree of accuracy.
1.9.2.1.1	RPA shall be capable of detecting moving vehicles, within its monitored area, whose emissions violate the emission standard.
1.9.2.1.2	RPA shall be capable of automatic self-calibration.
1.9.2.1.3	RPA shall be capable of reading suitably equipped vehicle's diagnostic data to determine that vehicle's operational status.
1.9.2.1.4	RPA shall be capable of determining suspected vehicle's registration data either by license plate or via automatic vehicle identification.
1.9.2.1.5	RPA shall be capable of determining which suspected vehicles are not in compliance with emission standards for that vehicle from the vehicle's registration data.
1.9.2.2	RPA shall be capable of providing air quality statistical data to the TMC.
1.9.2.2.1	RPA shall be capable of providing the air quality data on the monitored values of pollution.
1.9.2.2.2	RPA shall be capable of providing the necessary data to alert non-complaint vehicle drivers of their violation via roadside message signs or in-vehicle devices.
1.9.2.2.3	RPA shall be capable of providing the necessary data on violating vehicles for enforcement of air quality standards.
2.0	PUBLIC TRANSPORTATION MANAGEMENT
2.1	PUBLIC TRANSPORTATION MANAGEMENT
2.1.0	ITS shall include a Public Transportation Management (PTM) function.
2.1.1	PTM shall include an Operation of Vehicles and Facilities (OVF) function that provides computer assisted control of the operation of vehicles and their associated facilities.

2.1.1.1	To enable the automation of the vehicle and facilities operations OVF shall provide the capability to gather the needed data to include, but not be limited to, the following:
2.1.1.1(a)	Vehicle passenger loading by bus stop and trip segment.
2.1.1.1(b)	Bus running times between time points.
2.1.1.1(c)	Fare collection by fare category.
2.1.1.1(d)	Drive-line operating condition.
2.1.1.1(e)	Mileage accumulated by individual buses.
2.1.1.1(f)	Real-time vehicle location reports.
2.1.1.2	OVF shall include a Command and Control (CC) capability.
2.1.1.2.1	CC shall provide the capability for real-time Vehicle Command and Control (VCC).
2.1.1.2.1.1	VCC shall provide the capability to compare received information with predetermined operating condition specifications and note any deviations.
2.1.1.2.1.2	VCC shall provide the capability to transmit noted deviations to central control.
2.1.1.2.1.3	VCC shall provide the capability to display any noted deviations.
2.1.1.2.1.4	VCC shall provide the capability to automatically issue corrective instructions to the operator including, but not limited to, the following:
2.1.1.2.1.4(a)	Route corrections.
2.1.1.2.1.4(b)	Changes in stops.
2.1.1.2.2	When CC detects a vehicle(s) has deviated from schedule it shall provide the capability to automatically determine the optimum scenario for returning the vehicle or fleet to schedule.
2.1.1.2.3	CC shall include an integrated traffic control capability that provides traffic signal preemption when required for schedule adjustment to Transit Vehicles at traffic signals (i.e., centralized or distributed).
2.1.1.2.4	CC shall include the capability for its computational capabilities to be located either on-vehicle and/or at remote locations.
2.1.2	PTM shall include a Planning and Scheduling Services (PSS) function to automate the planning and scheduling of public transit operations.
2.1.2.1	The PSS shall include a Planning capability.
2.1.2.1.1	PSS Planning shall be performed off-line from stored data that were collected in real-time.
2.1.2.1.2	PSS Planning shall include processing of the data in a manner that will permit improvements in routes and services.
2.1.2.2	The PSS shall include a Schedule Generation capability.
2.1.2.2.1	The PSS Schedule Generation function shall collect data for schedule generation including, but not limited to, the following:
2.1.2.2.1(a)	Route segment running-time.
2.1.2.2.1(b)	Passenger loading at each stop.
2.1.2.2.1(c)	Revenue information.
2.1.2.2.2	The PSS Schedule Generation function shall use the collected data in the automatic or semiautomatic development of transportation system schedules.
2.1.2.2.3	The PSS Schedule Generation function shall provide the capability to print schedules.
2.1.2.2.4	The PSS Schedule Generation function shall provide the capability to disseminate schedules to, but not be limited to, the following:
2.1.2.2.4(a)	Kiosks.
2.1.2.2.4(b)	Transportation Management Centers.
2.1.2.2.5	The PSS Schedule Generation function shall provide the capability to automatically update the customer service operator system with the most current schedule and schedule adherence information.
2.1.3	PTM shall include a Personnel Management (PM) function to facilitate the management of operator, and maintenance personnel.
2.1.3.1	PM shall include a Maintenance Personnel Management (MPM) function.

2.1.3.1.1	MPM shall automatically track vehicle miles on each bus in real-time.
2.1.3.1.2	MPM shall use bus mileage data to automatically generate preventative maintenance schedules for each specific bus.
2.1.3.1.3	MPM shall automatically ensure that proper service personnel are provided information for bus maintenance activities.
2.1.3.1.4	MPM shall automatically assign service technicians by skill level to work on individual buses.
2.1.3.1.5	MPM shall provide the capability to record and verify that maintenance work was performed.
2.1.3.2	PM shall include an Operator Personnel Management (OPM) function.
2.1.3.2.1	OPM shall automatically generate assignments of individual vehicle operators to route, runs and individual vehicles.
2.1.3.2.2	OPM shall assign vehicle operators to routes and runs in a fair manner while minimizing labor and overtime costs.
2.1.3.2.3	In generating fair vehicle operator assignments, OPM shall include factors relating to operators' preferences and qualifications to include, but not be limited to, the following:
2.1.3.2.3(a)	Seniority.
2.1.3.2.3(b)	Operator schedule preference.
2.1.3.2.3(c)	Garage assignment.
2.1.3.2.3(d)	Vehicle qualification.
2.1.3.2.4	OPM shall automatically track and validate the number of work hours performed by each individual vehicle operator.
2.1.3.2.5	OPM shall provide the capability for authentication of vehicle operators prior to operating a transit bus or rail vehicle.
2.1.4	PTM shall include a Communications function.
2.1.4.1	PTM Communications shall provide the capability to establish two-way voice communication between vehicle operators and the central facility.
2.1.4.2	PTM Communications shall provide the capability for two-way data communications between individual buses and the control facility (e.g., sensor data and bus position).
2.1.4.3	OVF Communications shall provide the capability to send information from individual facilities to a central facility for processing and analysis.
2.1.4.4	As support for responding to the detection of an on-board emergency, the OVF Communications shall provide dispatchers with the capability to inform the following:
2.1.4.4(a)	Police.
2.1.4.4(b)	Fire department.
2.1.4.4(c)	Paramedic.
2.1.4.4(d)	Vehicle operator (initiation of silent or audible alarm notification).
2.1.4.5	PTM shall use an open vehicle communication network standard for all on-board electronic equipment.
2.2	EN-ROUTE TRANSIT INFORMATION
2.2.0	ITS shall include an En-Route Transit Information (TI) function. En-Route Transit Information provides travelers with real-time transit and high-occupancy vehicle information allowing travel alternatives to be chosen once the traveler is en-route. It consists of three major functions, which are, (1) Information Distribution, (2) Information Receipt, and (3) Information Processing. This capability integrates information from different transit modes and presents it to travelers for decision making.
2.2.1	TI shall include an Information Distribution function that disseminates information to travelers.
2.2.1.1	Information Distribution shall include an Information Network capability.
2.2.1.1.1	The Information Network shall provide the capability to furnish users with real-time travel related information while they are traveling.
2.2.1.1.2	The Information Network shall provide the capability to disseminate information to travelers that will assist them in making decisions about transfers.

2.2.1.1.3	The Information Network shall provide the capability to disseminate information to travelers that will assist them in making decisions in the modification (includes both intermode and intramode) of their trips.
2.2.1.1.4	The Information Network shall provide all users with information that is from a single source in order to ensure consistency across all users.
2.2.1.2	Information Distribution shall include a User Interface feature.
2.2.1.2.1	User Interface shall provide the capability for users to access travel related information at fixed locations.
2.2.1.2.1.1	Fixed location user interfaces shall be provided at transit stops.
2.2.1.2.1.1.1	Transit stop user interfaces shall have interactive visual displays.
2.2.1.2.1.1.2	Transit stop user interfaces shall provide audio messages containing the following:
2.2.1.2.1.1.2(a)	Notification of imminent transit arrival.
2.2.1.2.1.1.2(b)	Identification of route of arriving transit vehicles.
2.2.1.2.1.1.3	Transit stop user interfaces shall provide the capability to provide information to individuals who are physically impaired.
2.2.1.2.1.2	Fixed location user interface shall provide interactive video (e.g., cable TV) interfaces in kiosks at the following:
2.2.1.2.1.2(a)	Travel information centers.
2.2.1.2.1.2(b)	Transfer points.
2.2.1.2.1.2(c)	Wayside stops.
2.2.1.2.1.3	Fixed location user interface shall provide the capability to utilize local ATM networks to provide travel information to users.
2.2.1.2.2	User Interface shall provide the capability for users to access travel related information at mobile locations.
2.2.1.2.2.1	Mobile Location user interfaces shall provide the capability for users, either one passenger at a time or to a group environment, to access travel related information while on board transit vehicles.
2.2.1.2.2.2	Mobile user interfaces shall provide the capability for users to access travel related information while in transit vehicles through the use of variable message signs.
2.2.1.2.2.3	Mobile user interfaces shall provide the capability for users to access travel related information via personal portable devices.
2.2.1.2.2.4	Mobile user interfaces shall include the capability to provide audible messages to the on-board users.
2.2.2	TI shall include an Information Receipt function for acquiring that data that are used for generation of the En-Route Transit Information.
2.2.2.1	Information Receipt shall provide the capability to be continuously updated with real-time information from each transit system within the local area of jurisdiction.
2.2.2.2	Information Receipt shall provide the capability to be updated with information that is inclusive of all possible transportation modes within the local area of jurisdiction.
2.2.2.3	Information Receipt shall provide the capability to be updated with information from all providers of transportation services in the local area of jurisdiction to include:
2.2.2.3(a)	Regional paratransit services.
2.2.2.3(b)	Public providers.
2.2.2.3(c)	Private providers.
2.2.3	TI shall include an Information Processing function for processing that data used for generation of the En-Route Transit Information.
2.2.3.1	Information Processing shall include an information collection feature.

2.2.3.1.1	Information collection shall acquire transit operations information to include, but not be limited to, the following type:
2.2.3.1.1(a)	Schedule.
2.2.3.1.1(b)	Actual service provided.
2.2.3.1.1(c)	Next available vehicle, based on actual operating conditions.
2.2.3.1.1(d)	Transfer options describing available services and their associated schedules.
2.2.3.1.2	Information collection shall acquire transit situation conditions to include, but not be limited to, the following type:
2.2.3.1.2(a)	Actual road data.
2.2.3.1.2(b)	Traffic data.
2.2.3.2	Information Processing shall include an information integration feature.
2.2.3.2.1	Information integration shall collect data, store it and maintain it on-line.
2.2.3.2.2	Information integration shall collect data from traffic and transit systems including, but not limited to, the following:
2.2.3.2.2(a)	Transit systems.
2.2.3.2.2(b)	Traffic management services.
2.2.3.2.2(c)	Rideshare programs.
2.3	PERSONALIZED PUBLIC TRANSIT
2.3.0	ITS shall include a Personalized Public Transit (PPT) function.
2.3.1	The PPT shall include a Rider Request function.
2.3.1.1	Rider Request shall provide the capability for an individual rider to request a trip by specifying the trip origin and destination, time and date.
2.3.1.2	Rider Request shall provide the capability for an individual to specify a rider's special equipment or handling requirements.
2.3.1.3	Rider Request shall provide the capability to notify a requester of the fact that a trip assignment has been made including the time at which the vehicle is expected at the point of
2.3.1.4	Rider Request shall include the capability to notify the requester that the transit vehicle's arrival is imminent.
2.3.2	The PPT shall include a Vehicle Assignment function.
2.3.2.1	Vehicle Assignment shall utilize vehicle availability, special requirements and rides requested information to determine vehicle assignments and routing.
2.3.2.10	Vehicle Assignment shall provide the capability to accommodate immediate trip requests when enough capacity is available for the added rider pickup and delivery.
2.3.2.2	For random route operations Vehicle Assignment shall assign trip origin and destination.
2.3.2.3	For flexible route operations Vehicle Assignment shall control how fixed route buses are detoured.
2.3.2.4	For reservation based random-route operations Vehicle Assignment shall provide the capability to plan routes that optimize vehicle schedules while considering passengers' needs.
2.3.2.5	Vehicle Assignment shall provide the capability to select the best match between riders' needs and the available vehicles.
2.3.2.6	Vehicle Assignment shall provide services to both publicly owned and privately owned, publicly licensed vehicles.
2.3.2.7	In order to service travelers in low-demand time (e.g., night time and weekends) Vehicle Assignment shall provide services 24 hours per day, 7 days per week.
2.3.2.8	Vehicle Assignment shall assign vehicle routes within 4 blocks of rider's trip origin point.
2.3.2.9	Vehicle Assignment shall be a real-time system.
2.3.3	The PPT shall include a Data Collection function.

2.3.3.1	Data Collection shall include on-board sensors to monitor, but not be limited to, the following:
2.3.3.1(a)	Vehicle location.
2.3.3.1(b)	Passenger loading.
2.3.3.1(c)	Fare collection.
2.3.3.2	Data Collection shall process and store collected data so that it is available for:
2.3.3.2(a)	Real-time schedule adjustments.
2.3.3.2(b)	Off-line analysis and planning.
2.3.3.3	Data Collection shall support the off-line billing for fares paid by agencies.
2.3.4	The PPT shall include an Information Processing function.
2.3.4.1	PPT shall be implemented such that Information Processing may be located either centrally or distributed.
2.3.4.2	Information Processing shall use information to attempt to minimize the amount of time each passenger must ride.
2.3.4.3	Information Processing shall provide the capability to automate the assignment of drivers to vehicles.
2.3.5	The PPT shall include a Communications function.
2.3.5.1	The Communications function shall provide the capability to link all PPT services into a single entity.
2.3.5.2	The Communications function shall provide a two-way communications capability between vehicles and a central base for:
2.3.5.2(a)	Voice communications.
2.3.5.2(b)	Data communications.
2.3.5.3	The Communications function shall provide the capability for sensor data (either raw or processed) to be transmitted from vehicles to a central headquarters or dispatch station.
2.3.5.4	The Communications function shall provide the capability for data to be transferred between dispersed points and central base including:
2.3.5.4(a)	Data from vehicles.
2.3.5.4(b)	Data from locations where passengers are located.
2.4	PUBLIC TRAVEL SECURITY
2.4.0	ITS shall include a Public Travel Security (PTS) function to create an environment of safety in public transportation, including bus transit systems and passenger rail systems.
2.4.1	PTS shall include specific Secure Areas.
2.4.1.1	The Secure Areas shall encompass all physical areas related to public transit travel including the following:
2.4.1.1(a)	Transit (bus and rail) stop areas, including Bus Rapid Transit stops.
2.4.1.1(b)	Transit (bus and rail) stations.
2.4.1.1(c)	Park and Ride areas.
2.4.1.1(d)	Riding on transit vehicles (bus and rail cars).
2.4.1.1(e)	Kiosks.
2.4.1.1(f)	Transit transfer locations.
2.4.1.1(g)	Transit facilities (e.g. transit yards and shops).
2.4.1.1(h)	Transit infrastructure (rail tracks, tunnels, bridges, bus guideways, etc.).
2.4.1.2	All public Secure Areas shall have traveler activated alarms monitored by central dispatch or local police.
2.4.1.3	There shall be silently activated alarms and/or audible alarms on board public transit vehicles which are capable of activation by the operator, monitored by central dispatch or local police.
2.4.2	PTS shall include a Security Sensors (SS) function.
2.4.2.1	SS shall provide sensor technology required to alert operators and police of potential incidents.

2.4.2.10	SS shall include sharing of sensor information with appropriate security agencies or systems to assist in analysis of possible threats.
2.4.2.11	SS shall include notification of appropriate security agencies or systems regarding potential threats.
2.4.2.2	SS shall include video and audio systems at key locations, including rest areas, transit stops and stations, and transit facilities (i.e., transit yards and shops), to monitor activities, incidents, and potential threats. These systems and sensors shall be monitored by central
2.4.2.3	SS shall include threat sensors such as chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors on board transit vehicles (bus, rail car) and at key locations, including transit stations, and transit facilities (i.e., transit yards and shops), to monitor activities, incidents, and potential threats. These systems shall be monitored by
2.4.2.4	SS shall include systems on board the public transit vehicle (bus, rail car) for video, audio (including covert microphones that can be triggered by the transit vehicle operator), and event recorder (i.e., "black box") outputs to monitor activities, incidents, and potential threats. These systems and sensors shall be monitored by central dispatch.
2.4.2.5	SS shall include sensors for metal (and other object) detection on board the public transit vehicle (bus, rail car), and at key locations, including rest areas, transit stops and stations, and transit facilities (i.e., transit yards and shops), to detect contraband, such as knives, guns, and other potential weapons.
2.4.2.6	SS shall include a method of intrusion detection (or motion detection) at transit facilities (i.e., transit yards and shops).
2.4.2.7	SS shall include video, audio, intrusion (or motion) detection, and infrastructure integrity monitoring of transit infrastructure (rail track, bridges, tunnels, bus guideways, etc.).
2.4.2.8	SS shall include the capability for biometric analysis of video images.
2.4.2.9	SS shall include integration of sensor inputs and possible threat analysis.
2.4.3	PTS shall include a Personal Sensors Items (PSI) function.
2.4.3.1	PSI for ridematching shall include the capability for participants to be identified.
2.4.3.2	PSI shall provide the capability for riders to use electronic payment to eliminate the need for passengers to carry cash and to reduce cash handling.
2.4.4	PTS shall include a Security Management and Control (SMC) function.
2.4.4.1	SMC shall provide the capability to receive alarm information through electronic communication systems.
2.4.4.2	SMC shall include monitoring equipment to assist in responding to terrorist incidents.
2.4.4.3	SMC shall include the capability for transit operators to direct and control fleet operations in a manner that supports law enforcement and emergency response agencies with flexible and responsive transportation for large numbers of people.
2.4.4.4	SMC shall include the capability to generate coordinated preplanned responses for incidents.
2.4.4.5	SMC shall include the capability to support coordinated multiple agency responses to incidents.
2.4.4.6	SMC shall include the capability to remotely disable a transit vehicle (bus or transit rail).
2.4.4.7	SMC shall include the capability to identify when a transit vehicle has deviated from its assigned route.
3.0	ELECTRONIC PAYMENT
3.1	ELECTRONIC PAYMENT SERVICES
3.1.0	ITS shall include an Electronic Payment capability. Electronic Payment Services allows travelers to pay for transportation services by electronic means. Four functions are provided, which are, (1) Electronic Toll Collection, (2) Electronic Fare Collection, (3) Electronic Parking Payment, and (4) Electronic Payment Services Integration.
3.1.1	Electronic Payment shall provide an Electronic Toll Collection (ETC) capability.
3.1.1.1	ETC shall provide the capability for vehicle operators to pay tolls without stopping their vehicles.
3.1.1.2	ETC shall provide the capability to implement pricing structures for locally determined needs.
3.1.1.3	ETC shall provide confirmation of the transaction to each customer.

3.1.1.4	ETC shall include the capability to identify those vehicles and/or operators that violate its toll collection process.
3.1.1.5	ETC shall accommodate single billing to commercial carriers.
3.1.1.6	ETC shall provide the capability to automatically access and process each commercial vehicle's required documentation.
3.1.1.7	ETC shall be implemented in a manner that reduces the cost of toll collection.
3.1.1.8	ETC shall be implemented in a manner that seeks to minimize the opportunities for fraud.
3.1.2	Electronic Payment shall include an Electronic Fare Collection (EFC) capability.
3.1.2.1	EFC shall be implemented in a manner that the traveler is able to use a compatible fare medium for all applicable surface transportation services.
3.1.2.2	EFC shall provide the capability to implement variable and flexible fare structures.
3.1.2.3	EFC shall be capable of identifying voided and/or invalid payment media.
3.1.2.4	EFC shall provide the capability for third party payment of transportation services.
3.1.2.5	For those systems requiring special eligibility, EFC shall provide the capability to verify the eligibility of riders.
3.1.2.6	EFC shall be implemented in a manner that permits expansion into other uses for the payment medium such as payment of retail, telephone, etc.
3.1.2.7	EFC shall include the capability to collect the data required to determine accurate ridership levels.
3.1.2.8	EFC shall provide the capability for passengers to pay fares without stopping.
3.1.3	Electronic Payment shall include an Electronic Parking Payment (EPP) capability.
3.1.3.1	EPP shall provide the capability to pay for parking without the use of cash.
3.1.3.2	EPP shall include the capability for transit operators to utilize a single medium to charge for both transit related charges and parking charges.
3.1.3.3	EPP shall provide the capability to provide flexible pricing parking fee structures based upon factors including, but not limited to, vehicle classification.
3.1.4	ITS shall include an Electronic Payment Services Integration (EPSI) feature.
3.1.4.1	EPSI shall provide the capability to combine electronic payments made for use of various transportation modes into a single integrated system.
3.1.4.2	EPSI shall provide the capability to integrate fare and toll pricing structures of multiple agencies.
3.1.4.3	EPSI shall collect and provide usage data to develop pricing strategies that favor certain transportation modes or routes.
3.1.4.4	EPSI shall be implemented in a manner that ensures that it may be deployed across multiple agency political boundaries without degrading the services it provides.
3.1.5	ITS shall provide a Roadway Pricing (RP) capability.
3.1.5.1	RP shall provide the capability to implement various road pricing policies.
3.1.5.1.1	Road pricing policies capable of being implemented by RP shall include variable pricing.
3.1.5.2	RP shall provide the capability to implement roadway pricing strategies, developed by other services, that alleviate congestion.
3.1.5.3	RP shall provide the capability to implement roadway pricing, developed by other services, that can be used to influence mode selection.
4.0	COMMERCIAL VEHICLE OPERATIONS
4.1	COMMERCIAL VEHICLE ELECTRONIC CLEARANCE
4.1.0	ITS shall include a Commercial Vehicle Electronic Clearance (CVEC) capability.
4.1.1	CVEC shall include a Fixed Facility consisting of those structures and equipment to include Ports Of Entry, Inspection Stations, Weigh Stations and Toll Booths.
4.1.1.1	Fixed Facility shall provide the capability for state participation in the CVEC program to be voluntary.
4.1.1.2	Fixed Facility shall provide the capability to support the enrollment of vehicles/carriers in the CVEC program.

4.1.1.3	Fixed Facility shall provide the capability to accommodate both interstate and intrastate vehicles/carriers.
4.1.1.4	Fixed Facility shall include processing to issue pull-in for safety inspection signals of the following type:
4.1.1.4(a)	Automatically generated from Pass/Need To Stop tests.
4.1.1.4(b)	Randomly generated.
4.1.1.4(c)	Manually generated.
4.1.1.5	Fixed Facility shall provide the facility operator the capability to manually override the issuance of automatically and randomly generated Pull-In requests.
4.1.1.6	When making the "Pass/Need To Stop" determination the Fixed Facility shall perform checks on the following:
4.1.1.6(a)	Vehicle/Carrier Safety Information.
4.1.1.6(b)	Vehicle Credentials.
4.1.1.6(c)	Driver Credentials/Status.
4.1.1.6(d)	Vehicle Weight Information.
4.1.1.6(e)	Tax Payment Account.
4.1.1.7	Fixed Facility shall provide the capability to establish two-way communications with each vehicle approaching the facility.
4.1.1.8	Fixed Facility shall include the capability to access and quickly update information on vehicle problems that are detected.
4.1.2	CVEC shall include a Vehicle System capability
4.1.2.1	Vehicle System shall provide the capability to accommodate both interstate and intrastate carriers.
4.1.2.2	Vehicle System shall provide the capability for each vehicle to establish two-way communications with fixed facilities.
4.1.2.3	Vehicle System shall provide the capability for each individual vehicle's or carrier's participation in the process to be on a voluntary basis.
4.2	AUTOMATED ROADSIDE SAFETY INSPECTION
4.2.0	ITS shall include an Automated Roadside Safety Inspection (ARSI) capability.
4.2.1	The ARSI capability shall include a Roadside Facility (RF) function that improves the ability to perform safety inspection through the use of automation.
4.2.1.1	RF shall provide a processing capability that automates the roadside inspection tasks.
4.2.1.2	RF shall include the capability to perform brake inspections at the roadside.
4.2.1.3	RF shall include the capability for operators to use hand held devices to rapidly inspect vehicle and driver components that produce the following:
4.2.1.3(a)	Pass/Fail results.
4.2.1.3(b)	Data on actual condition.
4.2.1.3(c)	Data on expected life projections.
4.2.1.4	RF shall collect, store, maintain and provide real-time on-line interactive access to historical safety data at the roadside facility.
4.2.1.5	RF shall provide the capability to continuously update information flags for the following:
4.2.1.5(a)	Office of Motor Carriers (OMC) carrier ratings.
4.2.1.5(b)	Vehicle/driver inspection and maintenance data.
4.2.1.5(c)	Verification of repairs and out-of-service records.
4.2.1.5(d)	Driver status (including licensing and citations).
4.2.1.6	RF shall provide the capability to automatically identify to the enforcement personnel approaching vehicles that have been flagged as potentially needing maintenance or put out of

4.2.1.7	RF shall provide the capability to receive identification data from each vehicle that is stopped at the inspection station that enables the access and receipt at the roadside of historical safety records to include the following:
4.2.1.7(a)	Carrier.
4.2.1.7(b)	Vehicle.
4.2.1.7(c)	Driver.
4.2.1.7(d)	Cargo.
4.2.2	The ARSI capability shall include a Vehicle System (VS) function.
4.2.2.1	VS shall provide a processing capability that automates the roadside inspection tasks.
4.2.2.2	The VS architecture shall provide the capability to be developed and integrated as a phased implementation.
4.2.2.3	The VS shall include sensors to efficiently check vehicle systems and driver condition.
4.2.2.4	The VS shall include the capability for continuous updates to vehicle safety records or an "electronic decal/record" on the vehicle.
4.2.2.5	The VS shall include an on-board safety status monitoring system that is accessible from the roadside.
4.2.2.6	The VS shall provide an initial automated inspection capability that will expedite and supplement the existing visual and manual inspection processes.
4.2.2.7	The VS shall provide a two-way Communications capability that facilitates the roadside inspection tasks.
4.3	ON-BOARD SAFETY AND SECURITY MONITORING
4.3.0	ITS shall include an On-Board Safety and Security Monitoring (OBSSM) function, that provides monitoring and warnings of safety and security problems. For safety related issues, the primary importance is to inform the driver, as soon as possible, of any problem that has been detected. Of secondary importance is notifying the carrier of detected safety problems. Last in importance is the notification of appropriate enforcement agencies. For security related issues, the commercial vehicle driver and authorized freight data users are informed of any problems related to freight container, trailer or commercial vehicle integrity. For commercial vehicle driver/commercial vehicle/freight container or trailer assignment mismatches, authorized freight data users are informed of a potential problem. Requirements for On-Board Safety and Security Monitoring are given below:
4.3.1	OBSSM shall include a Fixed Facility (FF) capability for the analysis and control of safety information.
4.3.1.1	The FF shall provide the capability to analyze data received from each vehicle approaching and determine the identification of:
4.3.1.1(a)	Vehicle.
4.3.1.1(b)	Driver.
4.3.1.2	The FF shall provide the capability to provide warnings of any safety problem that has been identified.
4.3.1.3	The FF shall provide capability to log the passing of each vehicle and the associated results from the decision of whether to request the vehicle to pull in or continue without stopping.
4.3.1.4	The FF shall provide the capability to automatically make a decision as to whether to allow each vehicle to pass or require them to stop for a check.
4.3.1.5	The FF shall provide the capability for enforcement officials to manually override the automatically generated decision for vehicles to pull-in for safety inspection.
4.3.1.6	The FF shall provide the capability to perform pre-trip and post-trip inspections of each vehicle.
4.3.1.7	The FF shall provide the capability to have two-way data exchange between the Roadside facility and each vehicle.
4.3.2	OBSSM shall include a Vehicle System (VS) that is a part of each vehicle.

4.3.2.1	The VS shall provide the capability to collect and process information to supply those roadside facilities being encountered at mainline speeds with each vehicle's safety status to include the following:
4.3.2.1(a)	Vehicle safety status.
4.3.2.1(b)	Cargo safety status.
4.3.2.1(c)	Driver safety status.
4.3.2.1(d)	Vehicle Identification.
4.3.2.1(e)	Driver Identification.
4.3.2.2	The VS shall provide the capability to alert the vehicle driver whenever there is a critical safety problem or potential emergency.
4.3.2.3	The VS shall provide the capability to have two-way data exchange between each Roadside facility encountered and the vehicle.
4.3.2.4	The VS shall include a Vehicle Integrity (VI) function.
4.3.2.4.1	The VI shall monitor on-board sensors to detect a breach or tamper event.
4.3.2.4.2	The VI shall provide the capability to collect and process vehicle integrity information.
4.3.2.4.3	The VI shall provide integrity event information to the driver and carrier's dispatch function.
4.3.3	OBSSM shall include a Freight Security Management (FSM) function
4.3.3.1	FSM shall include a Freight container or trailer Integrity (FI) function
4.3.3.1.1	FI shall monitor freight container or trailer data to detect a breach or tamper event.
4.3.3.1.2	FI shall provide the capability to process freight container or trailer integrity data.
4.3.3.1.3	FI shall support the transmission of freight integrity data to freight data users.
4.3.3.2	FSM shall include a commercial vehicle driver/commercial vehicle/freight container or trailer Assignment Integrity (AI) function.
4.3.3.2.1	AI shall provide the capability to plan a driver/commercial vehicle/freight container or trailer assignment for a specific trip.
4.3.3.2.2	AI shall include the capability to store the driver/commercial vehicle/freight container or trailer assignment information.
4.3.3.2.3	AI shall include the capability to monitor the identity of the driver.
4.3.3.2.4	AI shall include the capability to monitor the identity of the commercial vehicle.
4.3.3.2.5	AI shall include the capability to monitor the identity of the freight container or trailer.
4.3.3.2.6	AI shall provide the capability to correlate the identity of the driver, commercial vehicle and freight container or trailer with the planned assignment.
4.3.3.2.7	AI shall alert authorized freight data users when a driver/commercial vehicle/freight container or trailer mismatch has been detected and verified.
4.4	COMMERCIAL VEHICLE ADMINISTRATIVE PROCESSES
4.4.0	ITS shall include a Commercial Vehicle Administrative Process (CVAP) function consisting of 3 subservices to include Electronic Purchase Of Credentials, Automated Mileage and Fuel Reporting and Auditing, and International Border Electronic Clearance.
4.4.1	CVAP shall include an Electronic Purchase Of Credentials (EPC) function with capabilities that include but are not limited to the following:
4.4.1(a)	Annual Electronic Credentials.
4.4.1(b)	Temporary Electronic Credentials.
4.4.1(c)	Order Forms Computer Input Screens.
4.4.1(d)	Multiple Permits.
4.4.1(e)	Specific Situation Permits.
4.4.1(f)	Electronic Payment.
4.4.1(g)	Automated Processing of Applications.

4.4.2	CVAP shall include an Automated Mileage and Fuel Reporting and Auditing (AMFRA) function that includes but is not limited to the following:
4.4.2(a)	Quarterly Reports Submission.
4.4.2(b)	Electronic Vehicle Log.
4.4.2(c)	Fuel Purchase Data.
4.4.2(d)	Create And Audit Tax Reports.
4.4.3	CVAP shall include an International Border Electronic Clearance (IBEC) function.
4.4.3.1	IBEC provides the capability to electronically clear vehicles crossing international borders with those countries adjacent to the United States. IBEC shall provide the capability to clear the following:
4.4.3.1(a)	Driver Clearance.
4.4.3.1(b)	Cargo Clearance.
4.4.3.1(c)	Vehicle.
4.4.3.2	IBEC shall have an Electronic Records function that enables certification of border crossing shipment with the verification capabilities to include but not be limited to the following:
4.4.3.2(a)	Verify driver identity.
4.4.3.2(b)	Verify shipper.
4.4.3.2(c)	Verify Nature of cargo.
4.4.3.2(d)	Verify Carrier safety.
4.4.3.2(e)	Verify credential records.
4.4.3.2(f)	Verify Duties Paid.
4.4.3.2(g)	Verify Vehicle Identity.
4.4.3.2(h)	Verify Vehicle Weight.
4.5	HAZARDOUS MATERIAL SECURITY AND INCIDENT RESPONSE
4.5.0	ITS shall include a Hazardous Materials (HAZMAT) Security and Incident Response (HSIR) service.
4.5.1	HSIR shall include a HAZMAT Incident Notification (HIN) function.
4.5.1.1	HIN shall include the capability to provide enforcement and HAZMAT response teams with timely and accurate information on cargo contents when the vehicle is involved in an incident.
4.5.1.2	HIN shall be capable of providing the following Information :
4.5.1.2(a)	Time of incident.
4.5.1.2(b)	Location of the incident.
4.5.1.2(c)	The material(s) involved.
4.5.2	HSIR shall provide an Operation Focal Point (OFP) for initiating appropriate responses.
4.5.2.1	OFP shall be capable of being implemented as either a centralized dispatch or several de-centralized dispatch units or vehicles.
4.5.2.2	OFP shall provide the capability for existing dispatch centers to receive the calls, determine response requirements, and route distress calls to predesignated responding agencies.
4.5.2.3	OFP shall provide the capability for operators to coordinate with other agencies and response services to include, but not be limited to, the following:
4.5.2.3(a)	State and/or local transportation officials.
4.5.2.3(b)	Police departments.
4.5.2.3(c)	Highway patrol.
4.5.2.3(e)	Emergency medical services.
4.5.2.3(f)	Environmental protection agencies.
4.5.2.3(g)	HAZMAT teams.
4.5.2.3(h)	Towing and other "courtesy" services.
4.5.3	HSIR shall include a Communications (COMM) function.
4.5.3.1	COMM shall provide the capability for distress signals to be sent to a focal point.

4.5.3.2	COMM shall provide the capability for relay of distress information to response units in real-time.
4.5.3.3	COMM shall provide the capability for data to be sent from any location covering all areas of the contiguous United States.
4.5.3.4	COMM shall provide the capability for linkages/interfaces with various existing networks.
4.5.3.5	COMM shall provide the capability for the motorist to travel from region to region without performing manual adjustment of equipment.
4.5.4	HSIR shall include a HAZMAT Security (HS) function.
4.5.4.1	HS shall include a security sensitive HAZMAT shipment tracking function (HSTF).
4.5.4.1.1	HSTF shall allow tracking of the location of a vehicle with a security sensitive HAZMAT shipment by the vehicle's dispatch function.
4.5.4.1.2	HSTF shall include the capability to store the planned route of the vehicle carrying the security sensitive HAZMAT shipment.
4.5.4.1.3	HSTF shall identify when the security sensitive HAZMAT shipment has deviated from the planned route.
4.5.4.1.4	HSTF shall have the capability of identifying sensitive (or geofenced) geographic areas.
4.5.4.1.5	HSTF shall identify when the security sensitive HAZMAT shipment has entered a sensitive geographic area.
4.5.4.1.6	HSTF shall include the capability to notify public safety agencies, including those having jurisdiction over the location, when a significant security sensitive HAZMAT route deviation has been detected and verified.
4.5.4.1.7	HSTF shall include the capability to notify traffic management agencies when a significant security sensitive HAZMAT route deviation has been detected and verified.
4.5.4.2	HS shall provide a roadside security sensitive HAZMAT security (RHS) function.
4.5.4.2.1	RHS shall include the capability for detection of security sensitive HAZMAT shipments.
4.5.4.2.2	RHS shall include the capability for classification of security sensitive HAZMAT shipments.
4.5.4.2.3	RHS shall provide the capability to correlate a security sensitive HAZMAT vehicle detection with its authorized activity.
4.5.4.2.4	RHS shall include the capability to notify public safety agencies, including those having jurisdiction over the location, when unauthorized security sensitive HAZMAT activity has been detected and verified.
4.5.4.2.5	RHS shall include the capability to notify traffic management agencies when unauthorized security sensitive HAZMAT activity has been detected and verified.
4.5.4.3	HS shall include a Driver Authentication function (DA)
4.5.4.3.1	DA shall include the capability to store the identities of authorized drivers for a specific trip or set of trips or class of trips.
4.5.4.3.2	DA shall include the capability to determine the identity of a driver.
4.5.4.3.3	DA shall include the capability to notify the vehicles dispatch function if an unauthorized driver attempts to operate the vehicle.
4.5.4.3.4	DA shall include the capability to safely disable a vehicle if an unauthorized driver attempts to operate the vehicle.
4.5.4.3.5	DA shall include the capability to allow a vehicles dispatch function to safely disable the vehicle.
4.5.4.3.6	DA shall include the capability to notify public safety if an unauthorized driver attempts to operate the vehicle.
4.5.4.3.7	DA shall include the capability to notify traffic management if an unauthorized driver attempts to operate the vehicle.
4.6	FREIGHT MOBILITY
4.6.0	ITS shall include a Freight Mobility (FM) function.
4.6.1	FM shall include a Commercial Vehicle Fleet Management (CVFM) function.
4.6.1.1	CVFM shall include the capability for users to provide commercial drivers and dispatchers with real-time routing information in response to congestion or incidents.

4.6.1.2	CVFM shall provide the capability for real-time communication between the following:
4.6.1.2(a)	Vehicle Drivers.
4.6.1.2(b)	Dispatchers.
4.6.1.2(c)	Intermodal Transportation Providers.
4.6.1.3	CVFM shall be capable of monitoring information regarding commercial vehicle fleets, including but not limited to:
4.6.1.3(a)	Location.
4.6.1.3(b)	Driver hours of service.
4.6.1.3(c)	Estimated and actual delivery times.
4.6.1.3(d)	Fuel consumption.
4.6.1.3(e)	General trip condition information.
4.6.2	FM shall include a Freight Operations Management (FOM) function
4.6.2.1	FOM shall include a Freight Asset Management (FAM) function.
4.6.2.1.1	FAM shall provide the capability to monitor and track the location and movements of freight containers or trailers by authorized freight data users.
4.6.2.1.2	FAM shall be capable of collecting and storing information on the operating conditions of freight container or trailer to support equipment maintenance planning, including but not limited
4.6.2.1.2(a)	Mileage.
4.6.2.1.2(b)	Tire wear.
4.6.2.1.2(c)	Brake wear.
4.6.3	FM shall include a Route Management (RM) function
4.6.3.1	RM shall provide the capability to plan routes or trip itineraries for an asset (i.e. freight container, trailer, and/or commercial vehicle).
4.6.3.2	RM shall include the capability to store the planned route or trip itinerary for an asset.
4.6.3.3	RM shall identify when the asset has deviated from the planned route or trip itinerary.
4.6.3.4	RM shall notify authorized freight data users when an asset deviates from its planned route or trip itinerary.
4.6.3.5	RM shall notify authorized freight data users of changes to a planned route or trip itinerary.
5.0	EMERGENCY MANAGEMENT
5.1	EMERGENCY NOTIFICATION AND PERSONAL SECURITY
5.1.0	ITS shall include an Emergency Notification and Personal Security (ENPS) function that provides for automated notification when travelers are involved in an incident and security in remote areas frequented by travelers and of critical transportation infrastructure.
5.1.1	ENPS shall include a Driver and Personal Security (DPS) function.
5.1.1.1	DPS shall include an in-vehicle manually initiated distress signal capability to provide a first-alert that an incident has occurred to include the following:
5.1.1.1(a)	Medical services required.
5.1.1.1(b)	Minor property damage only crashes.
5.1.1.1(c)	Breakdowns.
5.1.1.1(d)	Vehicle location.
5.1.1.1(e)	Vehicle identification.
5.1.1.2	DPS shall include the capability to cancel a previously issued manual request for help.
5.1.1.3	DPS shall include the capability to send an acknowledge signal to the motorist to indicate that the signal was received and help is on the way.
5.1.1.4	DPS shall include the capability for in-vehicle sensors to automatically detect vehicle problems and in certain cases, automatically send the appropriate distress signal.
5.1.2	ENPS shall include an Automated Collision Notification (ACN) function.
5.1.2.1	ACN shall provide the capability to automatically identify that a collision has occurred.

5.1.2.1.1	ACN shall provide the capability to instantly transmit information about the occurrence of a collision.
5.1.2.1.2	The ACN crash sensors shall include the capability to provide information about the extent of crash damage.
5.1.2.2	When sending notification of a collision ACN shall send pertinent information about the collision including the following:
5.1.2.2(a)	That vehicle has been in a collision.
5.1.2.2(b)	Accurate vehicle location.
5.1.2.2(c)	Severity of collision and/or injuries.
5.1.3	ENPS shall include a Remote Security and Emergency Monitoring (RSEM) function to create an environment of safety in secure areas.
5.1.3.1	RSEM shall include specific Secure Areas.
5.1.3.1.1	The Secure Areas shall encompass physical areas related to travel including but not limited to the following: critical infrastructure (such as bridges, tunnels, interchanges, management centers, etc.), rest stops and picnic areas, park-and-ride areas, tourism and travel information areas and emergency pull off areas.
5.1.3.2	RSEM shall include a Surveillance and Sensors (SS) function.
5.1.3.2.1	SS shall provide surveillance and sensor technology and the data processing required to alert operators and appropriate agencies of potential incidents and threats at the Secure Areas.
5.1.3.2.1.1	SS shall include both video and audio surveillance systems at key locations in the Secure Area to monitor activities.
5.1.3.2.1.2	SS shall provide sensors that may include, but are not limited to acoustic, environmental threat (such as nuclear, biological, chemical, and explosives), infrastructure condition and integrity, motion and object sensors.
5.1.3.2.1.3	SS shall provide data processing based on surveillance and sensor inputs to determine when an anomaly or suspicious activity (vehicle or human) has been detected in the Secure Area and alert the operators, travelers, appropriate agencies and organizations of a security threat.
5.1.3.2.2	SS shall allow operators to monitor and control operation of surveillance and sensor devices including operator override.
5.1.3.2.3	SS shall allow operators to verify an alarm.
5.1.3.3	RSEM shall include a Security Alarm (SA) function.
5.1.3.3.1	Secure Areas shall have traveler-activated alarms.
5.1.3.3.2	Secure areas shall include automatically activated alarms for natural disasters, terrorist threats, fire, theft, vandalism, etc.
5.1.3.3.3	Secure Areas shall have operator-activated alarms.
5.1.3.3.4	Alarms for Secure Areas shall be received from other agencies.
5.1.3.4	RSEM shall include a Monitor Alert Levels (MAL) function.
5.1.3.4.1	MAL shall monitor alert levels and threat information provided by federal, state, and local emergency management and public safety agencies.
5.1.3.4.2	MAL shall assess risk based on current activities and conditions.
5.1.3.4.3	MAL shall increase system preparedness as the likelihood of an incident increases, including:
5.1.3.4.3(a)	Activating physical security systems and implementing security procedures
5.1.3.4.3(b)	Adjusting parameters of surveillance and sensor devices.
5.1.3.5	RSEM shall include a Physical Security System (PSS) function.
5.1.3.5.1	PSS shall include systems such as:
5.1.3.5.1(a)	barriers, lock gates and other automatic or remotely controlled security systems intended to deter attack on the Secure Area or control access to the Secure Area during and after an
5.1.3.5.1(b)	blast shielding, exhaust systems and other automatic or remotely controlled systems intended to mitigate the impact of an incident.

5.1.3.5.2	PSS shall allow system operators to monitor and control operation of the physical security system devices, including operator override.
5.1.3.5.3	PSS shall provide current status of the system including readiness and activation to operators.
5.1.3.5.4	PSS shall warn travelers of impending security system deployment via local information systems.
5.1.4	ENPS shall include a Wide Area Alert (WAA) function to notify the public in emergency situations using ITS driver information and traveler information capabilities.
5.1.4.1	WAA shall notify transportation operators and information providers when an emergency situation occurs that requires public notification.
5.1.4.1.1	The WAA notification shall identify the originator, the nature of the emergency, the geographic area affected by the emergency, the effective time period, and information and instructions necessary for the public to respond to the alert.
5.1.4.1.2	The WAA shall provide necessary information for emergencies including, but not limited to, child abductions, severe weather watches and warnings, military activities, civil emergencies, other natural and human-caused disaster advisories, and law enforcement warnings.
5.1.4.2	WAA shall use available dynamic message signs, highway advisory radio, in-vehicle displays, 511 and other telephone information systems, traveler information web sites, transit vehicle information systems, message display boards, and other information systems to provide the WAA information to the public.
5.1.4.2.1	WAA shall tailor the information provided for individual driver and traveler information systems, limiting messages to short notifications for human-factors limited devices like dynamic message signs.
5.1.4.3	WAA shall keep the WAA initiator apprised of the current status of public notification, including an accounting of the driver and traveler information resources that are being utilized.
5.1.4.4	WAA shall notify transportation operators and information providers when public notification is no longer required.
5.1.5	ENPS shall include a Protect Sensitive Traveler Information (PSTI) function to inhibit distribution of traveler information that is deemed to be sensitive.
5.1.5.1	PSTI shall notify transportation operators and information providers when access to information from ITS surveillance and sensor systems must be restricted.
5.1.5.2	The PSTI notification shall identify the geographic area, time, specific devices, and/or other information necessary to determine the traveler information that must be protected.
5.1.5.3	PSTI shall restrict access to traveler information for the affected area until access restrictions are removed.
5.1.5.4	PSTI shall notify transportation operators and information providers when traveler information access restrictions are removed.
5.2	EMERGENCY VEHICLE MANAGEMENT
5.2.0	ITS shall include an Emergency Vehicle Management (EVM) Service.
5.2.1	EVM Service shall include an Emergency Vehicle Fleet Management System.
5.2.1.1	Emergency Vehicle Fleet Management System shall maintain the availability status of relevant emergency vehicles.
5.2.1.2	Emergency Vehicle Fleet Management System shall determine the emergency response vehicles best suited to respond to an incident.
5.2.1.3	Emergency Vehicle Fleet Management System shall dispatch the appropriate emergency response vehicle (s) to the incident.
5.2.2	EVM Service shall include a Route Guidance System.
5.2.2.1	Route Guidance System shall maintain real-time information on traffic conditions in urban and rural areas, emergency response vehicle locations, and emergency response vehicle
5.2.2.2	Route Guidance System shall advise emergency response vehicles of appropriate routes.
5.2.3	EVM Service shall include a Signal Priority System.
5.2.3.1	Signal Priority System shall maintain real-time information on signal timing, emergency vehicle locations and emergency vehicle routing.
5.2.3.2	Signal Priority System shall determine signal prioritize timing sequences for relevant signals.

5.3	DISASTER RESPONSE AND EVACUATION
5.3.0	ITS shall provide a Disaster Response and Evacuation (DRE) function that provides for effective, coordinated management of the surface transportation system during all types of disasters including natural disasters (hurricanes, earthquakes, floods, severe winter storms, tsunamis, etc.), terrorist acts, and other catastrophic events (e.g., nuclear power plant disasters). Two primary subservices are provided: (1) Disaster Response and (2) Evacuation Coordination. The Disaster Response Subservice provides support for planning, transportation management, resource sharing, and information coordination between transportation agencies and principal responding agencies (emergency management, public safety, and other allied agencies) to improve the effectiveness and safety of a disaster response. The Disaster Response Subservice consists of eight major functions: 1) Coordinate Response Plans, 2) Monitor Alert Levels, 3) Detect and Verify Emergency, 4) Assess Infrastructure Status, 5) Coordinate Response, 6) Critical Service Restoration, 7) Manage Area Transportation, and 8) Disaster Traveler Information. The Evacuation Coordination (EC) Subservice efficiently manages an evacuation and provides evacuees with the information they need during evacuation and subsequent reentry to the evacuated area. The Evacuation Coordination (EC) subservice includes four additional major functions: 9) Evacuation Planning Support, 10) Evacuation Traveler Information, 11) Evacuation Transportation Management, and 12) Evacuation Resource Sharing.
5.3.1	Disaster Response shall provide a Coordinate Response Plans (CRP) function to support dissemination and coordination of emergency response plans, continuity of operations plans, and other emergency plans between agencies in preparation for a potential future disaster.
5.3.10	Evacuation Coordination shall include an Evacuation Traveler Information (ETI) function.
5.3.10.1	ETI shall be accessible to users from multiple distributed locations, including, but not limited to:
5.3.10.1(a)	homes,
5.3.10.1(b)	public buildings,
5.3.10.1(c)	evacuation shelters,
5.3.10.1(d)	rest areas,
5.3.10.1(e)	hotels,
5.3.10.1(f)	restaurants,
5.3.10.1(g)	airports and other mode terminals, and
5.3.10.1(h)	wireless devices (in-vehicle and handheld).
5.3.10.10	ETI shall provide general evacuation guidance information to travelers, including guidance/tips for trip preparation, trip duration and trip return.
5.3.10.11	ETI shall provide information regarding traveler services available along evacuation routes and at evacuation destinations including:
5.3.10.11(a)	Lodging,
5.3.10.11(b)	Restaurants,
5.3.10.11(c)	Stores,
5.3.10.11(d)	Hospitals and medical services
5.3.10.11(e)	Rest areas
5.3.10.11(f)	Vehicle fueling stations
5.3.10.12	ETI shall provide emergency public information including diversion information and information on refuges of last resort and other safe havens if emergency termination of an in-progress evacuation is necessary.
5.3.10.2	ETI shall identify mandatory and voluntary evacuation zones and any special evacuation requirements for each zone.
5.3.10.3	ETI shall provide a list of alternative evacuation destinations.

5.3.10.4	ETI shall provide shelter information including:
5.3.10.4(a)	Location
5.3.10.4(b)	Time of operation
5.3.10.4(c)	Vacancy
5.3.10.4(d)	Available facilities including accommodations for people with special needs, such as pets, disabilities and elderly.
5.3.10.5	ETI shall provide recommended evacuation and reentry route(s) based on:
5.3.10.5(a)	Real-time and forecast traffic and road conditions.
5.3.10.5(b)	Traveler-specified route parameters.
5.3.10.6	ETI shall provide the recommended evacuation start time for a selected evacuation origin and destination based on:
5.3.10.6(a)	The travel time required for the trip.
5.3.10.6(b)	The capability of the evacuation network to handle evacuation demand based on current and future network conditions.
5.3.10.6(c)	The existing and forecast conditions at the evacuation origin and destination.
5.3.10.7	ETI shall identify reentry times for those jurisdictions that have cleared an area for reentry.
5.3.10.8	ETI shall provide road and traffic conditions on evacuation routes including:
5.3.10.8(a)	Current and forecast speed and travel times
5.3.10.8(b)	Incident information
5.3.10.8(c)	Current and forecast road, bridge and lane closure information.
5.3.10.8(d)	Advisories of hazardous conditions such as flooding, malfunctioning traffic signals, debris and falling objects.
5.3.10.8(e)	Current and forecast weather information
5.3.10.9	ETI shall provide information for transportation modes including buses, airlines, trains, ferries, and ships Including:
5.3.10.9(a)	The availability of transportation mode services.
5.3.10.9(b)	Arrival and departure information for available transportation services.
5.3.11	Evacuation Coordination shall provide an Evacuation Transportation Management (ETM) function to assist evacuation coordination personnel as they manage evacuation operations.
5.3.11.1	ETM shall have a real-time data collection process to assist in the selection of evacuation strategies and to monitor the operations of the selected evacuation strategies.
5.3.11.10	ETM shall have a lane reversal management function.
5.3.11.10.1	It shall be possible to collect real-time data for traffic moving in all traveling lanes, with and without lane reversal.
5.3.11.11	ETM shall have the capability to monitor the location and status of transit vehicles participating in evacuation operations.
5.3.11.12	ETM shall implement special traffic control strategies including traffic diversions and closures if emergency termination of an in-process evacuation is required.
5.3.11.2	ETM shall have a demand forecasting function that takes into consideration current traffic flows, current and historical evacuation trends, the size of the area to be evacuated and expected human responses.
5.3.11.3	ETM shall include a strategy selection function that maximizes efficiency during evacuation and reentry operations and supports the overall response plan of the principal responding
5.3.11.3.1	The strategy shall integrate the control of freeways and surface streets.
5.3.11.3.10	The strategy shall consider the use of transit and school bus fleets during mandatory evacuations.
5.3.11.3.11	The strategy shall consider current maintenance and construction activities and their impact on evacuation route capacity.
5.3.11.3.12	The strategy shall consider quarantine requirements.
5.3.11.3.2	The strategy shall consider traffic movement over the entire evacuation network.
5.3.11.3.3	The strategy shall be responsive to current demand as well as the forecast demand.

5.3.11.3.4	The strategy shall optimize the movement of emergency, public safety, and other vehicles associated with the disaster response and evacuation.
5.3.11.3.5	The strategy shall consider the operation of the access to and from the evacuation routes.
5.3.11.3.6	The strategy shall consider the impacts to local traffic along evacuation routes.
5.3.11.3.7	The strategy shall consider the time available for evacuation, time required for evacuation and time required for implementing the evacuation strategy.
5.3.11.3.8	The strategy shall consider the availability of the resources required for the evacuation strategy.
5.3.11.3.9	The strategy shall consider the severity of the expected disaster and the size of the area affected by the disaster.
5.3.11.4	ETM shall provide the control of devices as required by the evacuation management plan, including:
5.3.11.4(a)	traffic signals,
5.3.11.4(b)	dynamic message signs,
5.3.11.4(c)	ramp meters,
5.3.11.4(d)	reversible lane signs,
5.3.11.4(e)	turning restriction signs,
5.3.11.4(f)	road closure devices,
5.3.11.4(g)	lane closure devices,
5.3.11.4(h)	HAR,
5.3.11.4(j)	shoulder use signs.
5.3.11.5	ETM shall provide the operator with the capability to manually override the system automatic control.
5.3.11.6	ETM shall manage incidents on evacuation routes.
5.3.11.7	ETM shall discontinue current work zone activities on evacuation routes where possible.
5.3.11.8	ETM shall manage the evacuation of special needs populations including matching transit resources with locations/individuals, planning evacuation routes, and managing the special needs evacuation.
5.3.11.9	ETM shall have the capability to eliminate tolls and transit fares.
5.3.12	Evacuation Coordination shall provide a Resource Sharing (RS) Function that allows information and resource sharing between agencies involved in the evacuation including transportation, emergency management, law enforcement and other emergency service
5.3.12.1	RS shall allow information sharing between agencies at local, state, multi-state, and federal levels, covering all jurisdictions affected by the evacuation
5.3.12.1.1	RS shall provide information sharing capabilities among transportation agencies and between these agencies and the emergency management, public safety, and other allied response agencies.
5.3.12.1.2	RS shall provide information to assist evacuation management personnel in making decisions including traffic management and shelter operations.
5.3.12.2	RS shall assist evacuation management personnel in making decisions regarding deployment of resources and sharing of resources based on existing and forecast demand for these
5.3.12.2.1	RS shall identify the resources required for the current and forecast evacuation scenarios.
5.3.12.2.2	RS shall identify the resources required to implement alternative evacuation management strategies.
5.3.12.2.3	RS shall identify the resource deployment stages, in time and space, for each evacuation scenario.
5.3.12.2.4	RS shall assist local, state, multi-state, and federal agencies in sharing resources between agencies.
5.3.2	Disaster Response shall provide a Monitor Alert Levels (MAL) function.
5.3.2.1	MAL shall monitor alert levels and threat information provided by federal, state, and local agencies to include the Homeland Security Advisory System (HSAS) and related systems for terrorist alerts, the weather forecasts, watches, and warnings issued by the National Hurricane Center, other National Weather Service components and other weather service providers, and the various early warning systems operated by federal, state, and local emergency management agencies.

5.3.2.2	MAL shall increase system preparedness as the alert level or the likelihood of a disaster increases, taking actions including:
5.3.2.2(a)	Activating physical security systems and implementing security procedures,
5.3.2.2(b)	Pre-staging activities
5.3.2.2(c)	Review and update resource inventories
5.3.2.2(d)	Stage resources
5.3.2.2(e)	Assign personnel
5.3.2.2(f)	Clear obstructions
5.3.2.2(g)	Implement traffic management strategies and traffic control plans
5.3.3	Disaster Response shall provide a Detect and Verify Emergency (DVE) function that provides initial emergency situation information to all allied agencies.
5.3.3.1	DVE shall use available sensors, weather information, and field reports to detect potential emergencies.
5.3.3.2	DVE shall verify the emergency and collect available information to include location, nature of the emergency, nature and extent of the damage, nature and extent of the impact area, and potential hazards.
5.3.3.3	DVE shall notify emergency management, public safety, and other allied response agencies and provide available information about the emergency situation.
5.3.3.4	DVE shall alert transportation agencies to disasters that have been identified by other agencies
5.3.3.5	DVE shall alert transportation agencies of safe reentry conditions following a disaster.
5.3.4	Disaster Response shall provide an Assess Infrastructure Status (AIS) function.
5.3.4.1	AIS shall assess the impact of the disaster on the transportation infrastructure and associated ITS systems using:
5.3.4.1(a)	Asset Management Systems
5.3.4.1(b)	Surveillance systems and sensors
5.3.4.1(c)	Built-in-test of electronic systems
5.3.4.1(d)	On-scene reports and inspections
5.3.4.1(e)	Information gathered by aerial surveillance.
5.3.4.2	AIS shall provide an assessment of transportation infrastructure damage to transportation, emergency management, public safety, and other allied agencies.
5.3.5	Disaster Response shall include a Manage Area Transportation (MAT) function that manages the transportation system in the vicinity of the disaster. Depending on the nature of the disaster and the status of the infrastructure, the following actions may be taken.
5.3.5.1	Detours or alternative transportation resources, including transit systems, shall be identified to mitigate the transportation impacts of the disaster.
5.3.5.2	Closures and detours shall be implemented. Closures may exclude all vehicles except for emergency vehicles or other special vehicles.
5.3.5.3	Transit and transit fare schedules and toll schedules shall be modified.
5.3.5.4	Special traffic control strategies to manage traffic in the vicinity of the disaster shall be implemented to limit and/or manage traffic in the area to include signal timing modifications and special traffic signal modes used in conjunction with personnel manually directing traffic.
5.3.5.5	Special traffic management strategies shall be implemented in surrounding areas to support efficient movement of personnel and resources into the disaster area.
5.3.6	Disaster Response shall include a Critical Service Restoration function that will coordinate with allied agencies to restore critical transportation and utility services.
5.3.6.1	Emergency construction and maintenance shall be planned, coordinated, and initiated to restore critical transportation infrastructure.
5.3.6.2	Emergency access to right-of-way, permits, and needed equipment and resources shall be coordinated as necessary to support restoration of other critical public works.

5.3.7	Disaster Response shall include a Coordinate Response (CR) function to coordinate the disaster response between transportation, public safety, emergency management, and other allied agencies. Information may be shared with individual agency centers, emergency operations centers, and unified command systems at the scene.
5.3.7.1	CR shall provide information about the transportation system including:
5.3.7.1(a)	Egress and ingress routes for the scene and staging areas.
5.3.7.1(b)	Transportation system condition information including video surveillance information as appropriate
5.3.7.1(c)	Traffic management strategies in effect, including closures, detours, tolls, and HOV restrictions.
5.3.7.1(d)	Routes for specific origins and destinations on request
5.3.7.2	CR shall provide Information on transportation resources and personnel that are available, en-route, or deployed at the scene. Transportation resources include construction and maintenance equipment used at the scene and transit vehicles that may be used to move emergency response personnel to and from the scene.
5.3.7.3	CR shall receive information from emergency operations centers and other emergency management systems including:
5.3.7.3(a)	Current situation information
5.3.7.3(b)	Requests for resources
5.3.7.3(c)	Requests for transportation information, including video surveillance
5.3.7.3(d)	Requests for ingress and egress routes
5.3.7.3(e)	Requests for special traffic management strategies, including detours and closures, tolls lifted and HOV restrictions lifted.
5.3.8	Disaster Response shall include a Disaster Traveler Information (DTI) function that will coordinate with public information offices of the principal responding agencies in providing traveler information for the disaster scene and surrounding area to include:
5.3.8(a)	Special traffic restrictions,
5.3.8(b)	Detours and closures,
5.3.8(c)	Special transit schedules,
5.3.8(d)	Traffic conditions at and around the scene.
5.3.8(e)	Special traffic allowances (HOV restrictions lifted, tolls lifted, shoulder use, reverse lane operation).
5.3.9	Evacuation Coordination shall provide an Evacuation Planning Support (EPS) function.
5.3.9.1	EPS shall provide archived evacuation data such as traffic flows, travel speed, vehicle occupancy, road closures, network geometry, traveler behavior, travel origins, travel destinations and evacuation traffic management strategies.
5.3.9.2	EPS shall support the development of regional and multi-regional evacuation plans.
5.3.9.3	EPS shall assist in identifying required modifications to transportation network geometry to accommodate evacuation strategies.
5.3.9.4	EPS shall assist in defining the required resources for evacuation strategies.
5.3.9.5	EPS shall avoid simultaneous work zones on parallel routes in case evacuation without warning is required
6.0	ADVANCED VEHICLE SAFETY SYSTEMS
6.1	LONGITUDINAL COLLISION AVOIDANCE
6.1.0	ITS shall include a Longitudinal Collision Avoidance Service.
6.1.1	Longitudinal Collision Avoidance Service shall include a Rear-End Subservice.
6.1.1.1	Rear-End Subservice shall include a Headway Maintenance System which assists in maintaining a safe relative longitudinal separation between vehicles.
6.1.1.1.1	Headway Maintenance System shall include a Manual Operations Subsystem.
6.1.1.1.1.1	Manual Operations Subsystem shall determine impending situations that are inconsistent with safe headway.

6.1.1.1.1.2	Manual Operations Subsystem shall alert the vehicle's driver of the need for speed control to maintain a safe headway.
6.1.1.1.2	Headway Maintenance System shall include an Autonomous Intelligence Cruise Control (AICC) Subsystem.
6.1.1.1.2.1	Autonomous Intelligence Cruise Control Subsystem shall determine actions necessary to maintain the vehicle at a safe distance behind a lead vehicle.
6.1.1.1.2.2	Autonomous Intelligence Cruise Control Subsystem shall implement necessary vehicle speed control.
6.1.1.1.3	Headway Maintenance System shall include a Cooperative Intelligence Cruise Control (CICC) Subsystem.
6.1.1.1.3.1	Cooperative Intelligence Cruise Control Subsystem shall be capable of operating the vehicle in a follow-lead-vehicle mode or a "platoon" mode.
6.1.1.2	Rear-End Subservice shall include a Driver Action System
6.1.1.2.1	Driver Action System shall inform the driver of the need for immediate collision avoidance action.
6.1.1.3	Rear-End Subservice shall include an Automatic Control System.
6.1.1.3.1	Automatic Control System shall automatically implement needed collision avoidance action.
6.1.2	Longitudinal Collision Avoidance Service shall include a Backing Subservice.
6.1.2.1	Backing Subservice shall include an Advisory System.
6.1.2.1.1	Advisory System shall notify the driver of the presence of potentially hazardous situations.
6.1.2.2	Backing Subservice shall include a Driver Action System
6.1.2.2.1	Driver Action System shall inform the driver of the need for immediate collision avoidance action.
6.1.2.3	Backing Subservice shall include an Automatic Control System.
6.1.2.3.1	Automatic Control System shall automatically implement needed collision avoidance action.
6.1.3	Longitudinal Collision Avoidance Service shall include a Head-On/Passing Subservice.
6.1.3.1	Head-On/Passing Subservice shall include an Advisory System.
6.1.3.1.1	Advisory System shall notify the driver of the presence of potentially hazardous situations.
6.1.3.2	Head-On /Passing Subservice shall include a Driver Action System.
6.1.3.2.1	Driver Action System shall inform the driver of the need for immediate collision avoidance action.
6.1.3.3	Head-On/Passing Subservice shall include an Automatic Control System.
6.1.3.3.1	Automatic Control System shall automatically implement needed collision avoidance action.
6.2	LATERAL COLLISION AVOIDANCE
6.2.0	ITS shall include a Lateral Collision Avoidance Service.
6.2.1	Lateral Collision Avoidance Service shall include a Lane Change/Merge Subservice.
6.2.1.1	Lane Change/Merge Subservice shall include an Advisory System.
6.2.1.1.1	Advisory System shall notify the driver of the presence of potentially hazardous situations.
6.2.1.2	Lane Change/Merge Subservice shall include a Driver Action System.
6.2.1.2.2	Driver Action System shall inform the driver of the need for immediate collision avoidance action.
6.2.1.3	Lane Change/Merge Subservice shall include an Automatic Control System.
6.2.1.3.1	Automatic Control System shall automatically implement needed collision avoidance action.
6.2.2	Lateral Collision Avoidance Service shall include a Single Vehicle Roadway Departure (SVRD) Subservice.
6.2.2.1	Single Vehicle Roadway Departure Subservice shall include an Advisory System.
6.2.2.1.1	Advisory System shall notify the driver of the presence of a potentially hazardous situation.
6.2.2.2	Single Vehicle Roadway Departure Subservice shall include a Driver Action System.
6.2.2.2.1	Driver Action System shall inform the driver of the need for immediate collision avoidance action.
6.2.2.3	Single Vehicle Roadway Departure Subservice shall include an Automatic Control System.
6.2.2.3.1	Automatic Control system shall automatically implement needed collision avoidance action.

6.3	INTERSECTION COLLISION AVOIDANCE
6.3.0	ITS shall include an Intersection Collision Avoidance Service.
6.3.1	Intersection Collision Avoidance Service shall include an Advisory System.
6.3.1.1	Advisory System shall notify the driver of the presence of potentially hazardous situations.
6.3.2	Intersection Collision Avoidance Service shall include a Driver Action System.
6.3.2.1	Driver Action System shall notify the driver of the need for immediate collision avoidance action.
6.3.3	Intersection Collision Avoidance Service shall include an Automatic Control System.
6.3.3.1	Automatic Control system shall automatically implement needed collision avoidance action.
6.4	VISION ENHANCEMENT FOR CRASH AVOIDANCE
6.4.0	ITS shall include a Vision Enhancement for Crash Avoidance Service.
6.4.1	Vision Enhancement for Crash Avoidance Service shall include an Enhanced Vision System, which augments the vehicle operator's capability to see pedestrians and hazardous situations, where driving visibility is low.
6.5	SAFETY READINESS
6.5.0	ITS shall include a Safety Readiness Service.
6.5.1	Safety Readiness Service shall include a Driver Monitor Subservice.
6.5.1.1	Driver Monitor Subservice shall include an Advisory/Control System
6.5.1.1.1	Advisory/Control System shall determine the driver's readiness.
6.5.1.1.2	Advisory/Control System shall notify the driver of need to take corrective action.
6.5.1.1.3	Advisory/Control System shall automatically counteract insufficient driver's readiness to operate the vehicle by safely stopping the vehicle.
6.5.2	Safety Readiness Service shall include a Vehicle Condition Subservice.
6.5.2.1	Vehicle Condition Subservice shall include an Advisory System.
6.5.2.1.1	Advisory System shall determine the condition of critical vehicle components.
6.5.2.1.2	Advisory System shall notify the driver of need to take corrective action.
6.5.3	Safety Readiness Service shall include an Infrastructure Condition Subservice.
6.5.3.1	Infrastructure Condition Subservice shall include an In-Vehicle Infrastructure Advisory System.
6.5.3.1.1	In-Vehicle Infrastructure Advisory System shall determine unsafe roadway conditions.
6.5.3.1.2	In-Vehicle Infrastructure Advisory System shall notify the driver of the need to take corrective action.
6.6	PRE-CRASH RESTRAINT DEPLOYMENT
6.6.0	ITS shall include the Pre-Crash Restraint Deployment Service.
6.6.1	Pre-Crash Restraint Deployment Service shall include an Automatic Activation System.
6.6.1.1	Automatic Activation System shall detect an impending collision with a moving or a stationary object prior to crash impact.
6.6.1.2	Automatic Activation System shall initiate pre-impact deployment of restraint devices when appropriate to reduce injury severity.
6.7	AUTOMATED VEHICLE OPERATION
6.7.0	ITS shall include an Automated Vehicle Operation Service (AVO).
6.7.1	AVO service shall include an Automated Highway System (AHS), the Target Level System.
6.7.1.1	AHS shall include an Automated Check-In Subsystem (ACIS).
6.7.1.1.1	The ACIS shall include the capability for the driver to initiate a transaction, including indication of destination, with the AHS.
6.7.1.1.2	The ACIS shall be capable of determining the vehicle qualifications for access to AHS.
6.7.1.1.3	The ACIS shall be capable of safely controlling access to AHS.
6.7.1.2	AHS shall include a Vehicle Control Subsystem (VCS).
6.7.1.2.1	VCS shall be capable of determining the condition, location, and motion of each vehicle on the automated lanes.

6.7.1.2.2	VCS shall determine the conditions for safe operation of vehicles on the automated lanes.
6.7.1.2.3	VCS shall automatically control the vehicles on AHS.
6.7.1.3	AHS shall include an Automated Check-Out Subsystem (ACOS).
6.7.1.3.1	ACOS shall determine the readiness of the vehicle operator to resume control of the vehicle.
6.7.1.3.2	ACOS shall be capable of safely controlling egress from AHS.
6.7.2	AVO service shall include a Partially Automated Highway System (PAHS) as a Transitional System.
6.7.2.1	PAHS shall include Vehicle Subsystems which utilize capabilities of collision avoidance systems and other systems to implement safe "platooning" and other transitional levels of
6.7.2.2	PAHS shall include a Highway Subsystem which utilizes capabilities of Advanced Highway Infrastructure systems to assist in providing better control of vehicle routes.
6.7.2.3	PAHS shall include a Driver Subsystem which utilizes capabilities of driver alertness systems and other systems to assist in managing vehicles in situations other than full automatic
7.0	INFORMATION MANAGEMENT
7.1	ARCHIVED DATA FUNCTION
7.1.0	ITS shall provide an Archived Data Function to control the archiving and distribution of ITS data. The Archived Data User Service provides the Historical Data Archive Repositories and controls the archiving functionality for all ITS data with five major functions: 1) the Operational Data Control function to manage operations data integrity; 2) the Data Import and Verification function to acquire historical data from the Operational Data Control function; 3) the Automatic Data Historical Archive function for permanently archiving the data; 4) the Data Warehouse Distribution function, which integrates the planning, safety, operations, and research communities into ITS and processes data products for these communities; and 5) the ITS Community Interface which provides the ITS common interface to all ITS users for data products specification and retrieval. ADUS helps achieve the ITS information goal of unambiguous interchange and reuse of data and information throughout all functional areas.
7.1.1	The Archived Data Function shall provide a Historical Data Archive (HDA) system for ITS data.
7.1.1.1	HDA shall include repositories of operational data received from field equipment or data collection devices.
7.1.1.2	HDA shall provide permanent historical data repositories.
7.1.1.3	HDA repositories shall include meta data and meta-attributes repositories.
7.1.1.4	HDA shall provide ITS data system security.
7.1.1.4.1	HDA shall be capable of employing security solutions.
7.1.1.4.2	HDA shall be capable of preventing data loss.
7.1.1.4.3	HDA shall be capable of preventing unauthorized access to ITS data repositories
7.1.1.4.4	HDA shall be capable of providing a secure interface for online support of the ITS user interface.
7.1.1.5	HDA shall be capable of supporting online analytical functions to enable users to analyze data across multiple sources or acquire data for their off-line applications.
7.1.2	The Archived Data Function shall include an Operational Data Control (ODC) function to ensure integrity of operational data as received from field equipment or data collection
7.1.2.1	ODC shall be capable of receiving and storing all ITS operational data, as received from the source.
7.1.2.1.1	ODC shall ensure ITS operational data are in proper format.
7.1.2.1.2	ODC shall maintain the meta data schema for all ITS data entering the system.
7.1.2.1.3	ODC shall be capable of assigning the following meta attributes, when available, to ITS operational data during the archive process.
7.1.2.1.3(a)	The equipment used to collect the data.
7.1.2.1.3(b)	The conditions under which the data were collected.
7.1.2.1.3(c)	The status of the equipment at the time of collection.
7.1.2.1.4	ODC shall be capable of applying user-defined quality control verification on ITS data and annotating results in the appropriate meta files.

7.1.2.1.5	ODC shall be capable of assigning meta-attributes to the data indicating the methods used to perform:
7.1.2.1.5(a)	summarization and aggregation
7.1.2.1.5(b)	transformations (i.e., reconstructing original data or constructing new data elements)
7.1.2.2	ODC shall be capable of collecting user-selected data.
7.1.2.3	ODC shall be capable of archiving, in data repositories, ITS operational data as received from field equipment or data collection devices.
7.1.2.4	ODC shall be capable of maintaining the integrity of all received operational data.
7.1.2.5	ODC shall be capable of disseminating data replicates to ITS operational users in real-time.
7.1.2.6	ODC shall be capable of performing data fusion on replicated data for operational users in near real-time.
7.1.3	The Archived Data Function shall include a Data Import and Verification (DIV) function to acquire historical data from the Operational Data Control function.
7.1.3.1	DIV shall be capable of importing selected ITS Operational data from the ITS Operational Repositories.
7.1.3.1.1	DIV shall be capable of importing ITS Freeway Operations data to include:
7.1.3.1.1(a)	Freeway traffic flow surveillance data.
7.1.3.1.1(b)	Ramp meter preemptions.
7.1.3.1.1(c)	Ramp meter operational data.
7.1.3.1.1(d)	Freeway visual and video surveillance data.
7.1.3.1.1(e)	Traffic Management Center generated freeway flow metrics.
7.1.3.1.10	DIV shall be capable of importing ITS Parking Management data.
7.1.3.1.11	DIV shall be capable of importing Intermodal Operational data.
7.1.3.1.2	DIV shall be capable of importing ITS Electronic Toll Collection data.
7.1.3.1.3	DIV shall be capable of importing ITS Arterial data to include:
7.1.3.1.3(a)	Traffic signal preemptions.
7.1.3.1.3(b)	Traffic signal operational data.
7.1.3.1.3(c)	Arterial visual and video surveillance data.
7.1.3.1.3(d)	Traffic Management Center generated arterial flow metrics.
7.1.3.1.3(e)	Arterial traffic flow surveillance data.
7.1.3.1.4	DIV shall be capable of importing ITS Transit and Ridesharing data to include:
7.1.3.1.4(a)	Transit usage data.
7.1.3.1.4(b)	Transit route data including schedule deviations.
7.1.3.1.4(c)	Rideshare requests.
7.1.3.1.4(d)	Multimodal Origin/Destination.
7.1.3.1.4(e)	Fares
7.1.3.1.4(f)	Vehicle maintenance
7.1.3.1.4(g)	Personnel management data
7.1.3.1.5	DIV shall be capable of importing ITS Incident Management data to include:
7.1.3.1.5(a)	Incident characteristics.
7.1.3.1.5(b)	Train arrivals at highway rail intersections.
7.1.3.1.5(c)	Emergency vehicle dispatch data.
7.1.3.1.5(d)	Emergency vehicle location data.
7.1.3.1.5(e)	Construction and work zone identification.
7.1.3.1.5(f)	Emergency request data
7.1.3.1.5(g)	Video surveillance data
7.1.3.1.5(h)	Emergency response

7.1.3.1.6	DIV shall be capable of importing ITS Commercial Vehicle Operations data to include:
7.1.3.1.6(a)	Cargo identification data.
7.1.3.1.6(b)	Fleet activity data.
7.1.3.1.6(c)	Hazardous material packaging data.
7.1.3.1.6(d)	Border crossing data.
7.1.3.1.6(e)	Commercial vehicle on-board safety data.
7.1.3.1.6(f)	Truck Origin/Destination and Classification data
7.1.3.1.7	DIV shall be capable of importing ITS Environmental data to include:
7.1.3.1.7(a)	Emission data.
7.1.3.1.7(b)	Weather data.
7.1.3.1.8	DIV shall be capable of importing ITS Vehicle and Traveler data to include:
7.1.3.1.8(a)	Commercial and non-commercial vehicle probe data.
7.1.3.1.8(b)	VMS message set data.
7.1.3.1.8(c)	Vehicle trajectories.
7.1.3.1.8(d)	Route guidance data.
7.1.3.1.8(e)	Parking and roadway pricing change data.
7.1.3.1.8(f)	Origin/destination trip data.
7.1.3.1.8(g)	Service requests
7.1.3.1.8(h)	Information utilization
7.1.3.1.9	DIV shall be capable of importing data on ITS Physical Characteristics of Transportation Infrastructure to include:
7.1.3.1.9(a)	Roadway network attributes.
7.1.3.1.9(b)	Transit network attributes.
7.1.3.1.9(c)	Equipment maintenance status
7.1.3.1.9(d)	Transportation facilities.
7.1.3.1.9(e)	GIS map of network.
7.1.3.1.9(f)	Infrastructure maintenance data
7.1.3.2	DIV shall be capable of accepting pre-defined data inputs from transportation or other sources.
7.1.3.3	DIV shall be capable of applying pre-defined quality control verification on the imported ITS data and annotating results in the appropriate meta files.
7.1.3.4	DIV shall be capable of formatting the data to conform to the archive schema.
7.1.3.5	DIV shall be capable of cleansing imported data
7.1.3.5.1	Cleansing shall include the removal of source privacy attributes.
7.1.3.5.2	Cleansing shall be capable of assigning unique system-developed anonymous identifiers to data during archiving.
7.1.3.6	DIV shall be capable of performing pre-defined data mining functions to import data.
7.1.3.7	DIV shall be capable of performing pre-defined data fusion on imported data near real-time.
7.1.3.8	DIV shall be capable of assigning meta attributes to ITS operational data if data modification is required during the historical archive process.
7.1.3.9	DIV shall be capable of notifying source system owners of potential data or equipment errors.
7.1.4	The Archived Data function shall provide the Automatic Data Historical Archive (ADHA) function for permanently archiving the data.
7.1.4.1	ADHA shall provide an archive schema for all ITS data entering the archives.
7.1.4.1.1	The archive schema shall preclude the possibility of identifying or tracking either individual citizens or private firms.
7.1.4.1.2	ADHA shall strip all identifiers of individual citizens or private firms from all data before archiving.

7.1.4.1.3	ADHA shall be capable of assigning unique system-developed anonymous identifiers to data during archiving.
7.1.4.2	ADHA shall manage the ITS historical data archiving processes for all functional areas as follows:
7.1.4.2(a)	Format data to archive schema conformance.
7.1.4.2(b)	Maintain a centralized meta schema to specify how data is archived.
7.1.4.2(c)	Maintain data quality meta attributes.
7.1.4.2(d)	Schedule archiving of data.
7.1.4.3	ADHA shall permanently store historical archives and only provide data replicates to users.
7.1.4.4	ADHA shall be capable of supporting user-specified data archiving procedures as follows:
7.1.4.4(a)	When specified by a user, archive operational data as received in the user's storage files.
7.1.4.4(b)	When specified by a user, archive edited data in the User's storage files.
7.1.4.4(c)	When specified by a user, perform pre-defined data fusion before archiving in User's storage files.
7.1.4.5	ADHA shall be capable of assigning meta attributes to ITS operational data if data modification is required during the historical archive process.
7.1.5	The Archived Data Function shall provide a Data Warehouse Distribution (DWD) function as the ITS data source to support the ITS community user functions.
7.1.5.1	DWD shall be capable of supporting the generation of data products for the following transportation agencies:
7.1.5.1(a)	Planning
7.1.5.1(b)	Operations
7.1.5.1(c)	Safety
7.1.5.1(d)	Research
7.1.5.2	DWD shall include a User Data Products (UDP) function.
7.1.5.2.1	UDP shall provide an online analytical functionality to generate pre-defined data products for ITS users, to include:
7.1.5.2.1(a)	Reports
7.1.5.2.1(b)	Analyses
7.1.5.2.1(c)	Aggregations or summaries.
7.1.5.2.1(d)	User defined archiving of data concepts.
7.1.5.2.2	UDP shall be capable of recreating ITS operational data formats from the historical archives.
7.1.5.2.3	UDP shall be capable of providing user defined data mining functions on ITS data sources.
7.1.5.2.4	UDP shall be capable of performing user defined data fusion functions on data extracted from ITS Archives.
7.1.5.2.5	UDP shall be capable of supporting the Federal data system with user-defined data products, when the necessary data is available, to include the following systems:
7.1.5.2.5(a)	Highway Performance Monitoring System (HPMS)
7.1.5.2.5(b)	Truck Weight Study/VTRIS
7.1.5.2.5(c)	National Bridge Inventory
7.1.5.2.5(d)	Fatal Accident Reporting System (FARS)
7.1.5.2.5(e)	Highway Safety Information System (HSIS)
7.1.5.2.5(f)	Section 15 Transit Data
7.1.5.2.5(g)	Motor Carrier Management Information System (MCMIS)
7.1.5.2.5(h)	Hazardous Materials Incident Reporting System
7.1.5.2.5(i)	Grade Crossing Inventory System (GCIS)
7.1.5.2.5(j)	Railroad Accident/Incident Reporting System (RAIRS; grade crossing portion)
7.1.5.3	DWD shall have the single point of administration for the archived data system.
7.1.6	The Archived Data Function shall provide users with an ITS Community Interface (ICI) including all ITS users for the specification and retrieval of data products.

7.1.6.1	ICI shall be the common data interface for all ITS users to access the ITS Data Archives.
7.1.6.1.1	ICI shall provide users' systems with the data interface functionality.
7.1.6.2	ICI shall manage user access and security across the interface.
7.1.6.2.1	ICI shall be capable of cleansing data to remove source privacy attributes before archiving data.
7.1.6.2.2	ICI shall be capable of cleansing data to remove source privacy attributes before exporting data to users.
7.1.6.3	ICI shall provide a user-interface functionality to existing data warehouse data schema for users to define their data products.
7.1.6.3.1	The user-interface shall permit users to define access to multiple databases as data sources for their data products.
7.1.6.3.2	The user-interface shall permit users to select online analytical functions to produce their data products.
7.1.6.3.3	The user-interface shall permit the user to view sample data products.
7.1.6.4	ICI shall provide the user interface for ITS Transportation Agencies.
7.1.6.4.1	Transportation agencies shall include the following planning functions:
7.1.6.4.1(a)	Metropolitan Planning Organizations (MPO) and State Transportation Planning
7.1.6.4.1(b)	Transportation System Monitoring
7.1.6.4.1(c)	Air Quality Analysis
7.1.6.4.1(d)	MPO/State Freight and Intermodal Planning
7.1.6.4.1(e)	Land Use Regulation and Growth Management
7.1.6.4.1(f)	Transportation Administration and Policy Analysis.
7.1.6.4.1(g)	Transit Planning
7.1.6.4.2	Transportation agencies shall include the following ITS Operations functions:
7.1.6.4.2(a)	Traffic Management.
7.1.6.4.2(b)	Transit Management.
7.1.6.4.2(c)	Construction and Maintenance.
7.1.6.4.2(d)	The Private Sector.
7.1.6.4.3	Transportation functions shall include the following safety agencies:
7.1.6.4.3(a)	Safety Planning and Administration.
7.1.6.4.3(b)	Commercial Vehicle Operations.
7.1.6.4.3(c)	Emergency Management.
7.1.6.4.4	Transportation agencies shall include research agencies.
8.0	MAINTENANCE AND CONSTRUCTION MANAGEMENT
8.1	MAINTENANCE AND CONSTRUCTION OPERATIONS
8.1.0	ITS shall provide Maintenance and Construction Operations (MCO) functions to support monitoring, operating, maintaining, improving and managing the physical condition of roadways, the associated infrastructure equipment, and the required resources. MCO shall focus on four major functions: 1) the Maintenance Vehicle Fleet Management function, to monitor and track locations and conditions of fleets of maintenance, construction, and specialized service vehicles; 2) the Roadway Management function, to monitor and forecast conditions and manage treatment of roadways during various travel conditions; 3) the Work Zone Management and Safety function, to support effective and efficient roadway operations during work zone activities; and 4) the Roadway Maintenance Conditions and Work Plan Dissemination function, to coordinate work plans and to communicate conditions. This User Service will utilize ITS systems and processes to support interchange of information among diverse groups of users, to improve efficiency and effectiveness of operational, maintenance, and managerial activities.

8.1.1	Maintenance and Construction Operations shall provide a Maintenance Vehicle Fleet Management (MVFM) function to schedule and dispatch, monitor and track location, and monitor operational condition and maintenance requirements of public and contracted fleets of maintenance, construction, and specialized service vehicles. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Vehicle Maintenance Crews, Equipment Maintenance Crews, Weather Services Organizations, and Information Service Providers.
8.1.1.1	MVFM shall be capable of monitoring and tracking the locations of public and contracted fleets of maintenance, construction, and specialized service vehicles to provide current location and status information.
8.1.1.1.1	MVFM shall be capable of monitoring and tracking the locations of fleets of maintenance, construction, and specialized service vehicles, including but not limited to:
8.1.1.1.1(a)	Roadway maintenance trucks
8.1.1.1.1(b)	Other motorized roadway maintenance equipment
8.1.1.1.1(c)	Roadway construction trucks
8.1.1.1.1(d)	Other motorized roadway construction equipment
8.1.1.1.1(e)	Roadway service patrols
8.1.1.1.1(f)	Snow plows
8.1.1.1.1(g)	Salt / sand trucks
8.1.1.1.1(h)	Bucket trucks
8.1.1.1.1(i)	Vegetation Control and Grass cutting equipment
8.1.1.1.1(j)	Traffic control vehicles
8.1.1.1.1(k)	Street and drainage cleaning vehicles
8.1.1.1.2	MVFM shall be capable of monitoring information regarding fleets of maintenance, construction, and specialized service vehicles, including but not limited to:
8.1.1.1.2(a)	Location
8.1.1.1.2(b)	Speed
8.1.1.1.3	MVFM shall be capable of tracking the past location and movement of maintenance, construction, and specialized vehicles.
8.1.1.2	MVFM shall be capable of supporting route scheduling and dispatching of public and contracted fleets of maintenance, construction, and specialized service vehicles.
8.1.1.3	MVFM shall be capable of supporting interactive data communications between dispatchers and operators of public and contracted maintenance, construction, and specialized service
8.1.1.3.1	MVFM shall be capable of communicating information to vehicle operators, including but not limited to:
8.1.1.3.1(a)	Routing information
8.1.1.3.1(b)	Scheduling data
8.1.1.3.1(c)	Dispatch instructions
8.1.1.3.1(d)	Corrective actions
8.1.1.3.1(e)	Environmental information (road and weather conditions)
8.1.1.3.2	MVFM shall be capable of communicating information from vehicle operators, including but not limited to:
8.1.1.3.2(a)	Work data
8.1.1.3.2(b)	Operator status
8.1.1.3.2(c)	Crew status
8.1.1.3.2(d)	Equipment status
8.1.1.4	MVFM shall be capable of using on-board vehicle sensors to monitor the vehicle diagnostics and operating conditions of public and contracted fleets of maintenance, construction, and specialized service vehicles.

8.1.1.4.1	MVFM shall be capable of collecting information on the operating conditions of vehicles, including but not limited to:
8.1.1.4.1(a)	System status (e.g. status of brake system, oil pressure, etc.)
8.1.1.4.1(b)	Engine temperature
8.1.1.4.1(c)	Mileage
8.1.1.4.1(d)	Tire wear
8.1.1.4.1(e)	Brake wear
8.1.1.4.1(f)	Belt wear
8.1.1.4.2	MVFM shall be capable of automatically scheduling preventive and corrective vehicle maintenance.
8.1.1.5	MVFM shall be capable of using on-board vehicle sensors to monitor roadway conditions and vehicle functions, including but not limited to:
8.1.1.5(a)	Environmental conditions
8.1.1.5(b)	Operating status (e.g. materials stored, materials usage, plow blade up/down, etc.)
8.1.1.6	MVFM shall be capable of providing dispatchers and operators of maintenance, construction, and specialized service vehicles with information regarding potential and actual roadway
8.1.1.6.1	MVFM shall provide information to dispatchers and vehicle operators, including but not limited to:
8.1.1.6.1(a)	Congestion
8.1.1.6.1(b)	Incidents
8.1.1.6.1(c)	Roadway restrictions
8.1.1.6.1(d)	Environmental conditions
8.1.1.6.2	MVFM shall be capable of filtering, fusing, processing, and presenting data from multiple weather and environmental sources.
8.1.1.6.3	MVFM shall be capable of receiving fused weather and roadway information from external sources, including but not limited to:
8.1.1.6.3(a)	Surface transportation sources
8.1.1.6.3(b)	Weather service organizations
8.1.1.6.4	MVFM shall be capable of using fused weather and roadway information from external sources to aid in scheduling roadway maintenance and construction activities.
8.1.1.6.5	MVFM shall provide information to the vehicle operators concerning roadway problem spots and alternate routes because of potential or actual roadway problems.
8.1.1.6.6	MVFM shall support transmission of fleet operations data to other Operations centers.
8.1.1.6.7	MVFM shall support transmission of fleet operations data to archives.
8.1.1.6.8	MVFM shall support the comparison of incident data with scheduled fleet activities.
8.1.1.7	MVFM shall be capable of communicating status information to other maintenance, construction or specialized service vehicles.
8.1.2	Maintenance and Construction Operations shall provide a Roadway Management (RWM) function to monitor traffic, road surface, and environmental conditions and forecast traffic and road surface conditions to support management of routine and hazardous road condition remediation and to communicate changes in conditions. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Asset Managers, Planning Agencies, and Weather Services Organizations.

8.1.2.1	RWM shall support a number of different services, including but not limited to:
8.1.2.1(a)	Winter maintenance (plowing, treating, anti-icing, de-icing, etc.)
8.1.2.1(b)	Hazard removal (removing trash, animals, etc.)
8.1.2.1(c)	Emergency activities (incident response, planning, alternate routing, etc.)
8.1.2.1(d)	Routine maintenance activities (cleaning, cutting, etc.)
8.1.2.1(e)	Repair activities
8.1.2.1(f)	Other weather related activities (fog dispersion, etc.)
8.1.2.10	RWM shall archive data for use in performance monitoring activities.
8.1.2.2	RWM shall support provision of efficient and effective roadway operations during normal and severe weather or adverse travel conditions.
8.1.2.3	RWM shall plan and forecast, proactive and reactive, year-round roadway management activities.
8.1.2.4	RWM shall determine the need for forecasted and scheduled roadway treatment.
8.1.2.4.1	RWM shall be capable of filtering, fusing, processing and presenting data from multiple weather and environmental sources.
8.1.2.4.2	RWM shall be capable of receiving and fusing weather and roadway information from external sources, including but not limited to:
8.1.2.4.2(a)	Surface transportation sources
8.1.2.4.2(b)	Weather service organizations
8.1.2.4.3	RWM shall make use of information on current and forecast weather.
8.1.2.4.4	RWM shall make use of information on usage of treatments and materials.
8.1.2.4.5	RWM shall support short-term weather prediction for winter maintenance.
8.1.2.5	RWM shall support management of resources to perform hazardous road condition remediation.
8.1.2.5.1	RWM shall support application of materials, plowing, and other means to counteract adverse winter weather conditions.
8.1.2.5.2	RWM shall support appropriate responses to other environmental conditions that effect travel.
8.1.2.6	RWM shall track the amount of materials applied to the roadway for comparison to planned / forecasted requirements.
8.1.2.7	RWM shall monitor the amount and availability of materials at storage facilities.
8.1.2.8	RWM shall support maintenance crew dispatching.
8.1.2.9	RWM shall monitor, manage, and control remotely located, automated systems, that affect the roadway surface (e.g. de-icing/anti-icing applications).
8.1.3	Maintenance and Construction Operations shall provide a Work Zone Management and Safety (WZMS) function, which provides support for the effectiveness, safety, and efficiency of roadway operations during all work zone activities. This function includes interactions among Traffic Managers, Supervisors, Dispatchers, Field Crews, Construction Crews, Public Safety Organizations, Information Service Providers, and Travelers.
8.1.3.1	WZMS shall monitor, control, and direct activity in the vicinity of work zones.
8.1.3.1.1	WZMS shall provide information about work zones, including but not limited to:
8.1.3.1.1(a)	Anticipated delays
8.1.3.1.1(b)	Alternate routes
8.1.3.1.1(c)	Suggested speed limit
8.1.3.1.2	WZMS shall provide support for automated speed enforcement around work zones.
8.1.3.1.3	WZMS shall be able to divert vehicles around work zones via automated lane changing techniques.

8.1.3.1.3.1	WZMS shall collect information used to support automated lane changing, including but not limited to:
8.1.3.1.3.1(a)	Volume
8.1.3.1.3.1(b)	Occupancy
8.1.3.1.3.1(c)	Speed
8.1.3.1.3.1(d)	Headways
8.1.3.1.3.1(e)	Vehicle characteristics
8.1.3.1.3.1(f)	Merging distance
8.1.3.1.3.2	WZMS shall support archiving of field data.
8.1.3.1.3.3	WZMS shall support use of field data for developing AHS-merging strategies.
8.1.3.2	WZMS shall support the management of data about work zones.
8.1.3.2.1	WZMS shall collect information concerning work zone activities, including but not limited to:
8.1.3.2.1(a)	Location
8.1.3.2.1(b)	Nature / type
8.1.3.2.1(c)	Scheduled start time
8.1.3.2.1(d)	Duration
8.1.3.2.1(e)	Lane shifts
8.1.3.2.1(f)	Staging areas
8.1.3.2.1(g)	Length of work zone
8.1.3.2.1(h)	Scheduled phases of work zone configuration
8.1.3.2.1(i)	Alternate routes
8.1.3.2.1(j)	Anticipated delays for travel route
8.1.3.2.1(k)	Anticipated delays for diversion route
8.1.3.2.2	WZMS shall correlate planned activities with actual work.
8.1.3.2.3	WZMS shall support preparation of reports on work zone activities.
8.1.3.2.4	WZMS shall provide information on work zone activities to other agencies, including but not limited to:
8.1.3.2.4(a)	Other maintenance and construction operations systems
8.1.3.2.4(b)	Commercial vehicle fleets
8.1.3.2.4(c)	Emergency vehicle fleets
8.1.3.2.4(d)	Traveler information systems
8.1.3.2.4(e)	Traffic management systems
8.1.3.3	WZMS shall provide systems that communicate reliable, accurate, and timely traveler information, including but not limited to:
8.1.3.3(a)	Location, including lane closure information
8.1.3.3(b)	Alternate route / detour
8.1.3.3(c)	Work zone speed limit
8.1.3.3(d)	Delay
8.1.3.4	WZMS shall support the provision of vehicle intrusion warnings.
8.1.3.5	WZMS shall be capable of tracking individual crew movements.
8.1.4	Maintenance and Construction Operations shall provide a Roadway Maintenance Conditions and Work Plan Dissemination (RMCWPD) function to provide Intra- and Inter-agency coordination of work plans. This function includes interactions among Traffic Managers, Supervisors, Planning Agencies, Public Safety Organizations, and Information Service
8.1.4.1	RMCWPD shall coordinate information on planned maintenance and construction activities, including work zone information, and unplanned remediation activities, such as inclement weather responses, so that routing, scheduling, and resource allocation can be accomplished.

8.1.4.2	RMCWP shall support inter-agency coordination of response and scheduling of resources for significant events with broad impact, like natural disasters, major incidents, and large planned or seasonal events.
8.1.4.3	RMCWPD shall coordinate information with other transportation agencies, including but not limited to:
8.1.4.3(a)	Public Safety
8.1.4.3(b)	Emergency Medical Management
8.1.4.3(c)	Transit
8.1.4.3(d)	Traffic Management
8.1.4.3(e)	Railroads
8.1.4.3(f)	Airports
8.1.4.3(g)	Information Service Providers
8.1.4.3(h)	Transportation Asset Management (Pavement management, bridge management, etc)