Oklahoma Statewide Intelligent Transportation Systems (ITS) Architecture

Oklahoma Department of Transportation

In Coordination With:

U.S. Department of Transportation

April 2005

Oklahoma Statewide Intelligent Transportation Systems Architecture

April 2005

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1. Introduction

The purpose of this report is to define the ITS Architecture for the State of Oklahoma. Various ITS projects have already been deployed in the state and many more are planned in the future. This architecture will help to serve as a guide for agencies in planning and implementing projects and identifying integration opportunities with other agencies. The Statewide ITS Architecture is based on the National ITS Architecture. The architecture is a living document similar to the Statewide Transportation Improvement Plan. The architecture has a defined timeframe of 15 years, but should be updated periodically to allow for policy or technological changes.

The architecture defines "how" information is transferred between transportation systems (Communication Layer), what transportation systems transfer what information (Transportation Layer), and the supporting institutional structure, policy and strategies (Institutional Layer) so that the desired user services are implemented.

Subsystems, composed of equipment packages, are the foundation of the physical architecture. The physical architecture forms a high-level structure around the processes and data flows in the logical architecture. The physical architecture defines the physical entities (Subsystems and Terminators) that make up an intelligent transportation system. The physical architecture defines the Architecture Flows that connect the various Subsystems and Terminators into an integrated system. Equipment packages implement transportation services and architecture flows allowing the exchange of information between the subsystems and terminators within the state. A related element of the architecture is market packages. A market package is a collection of equipment packages and architecture flows grouped together that implement a transportation service.

This document consists of two sections: introduction and the statewide architecture. The architecture chapter defines the physical architecture subdivided into the three layers (transportation, institutional and communications).

2. Development of the Statewide ITS Architecture

2.1 Conformity with the ITS National Architecture

The Oklahoma Statewide architecture must conform to federal guidelines, if agencies wish to remain eligible for Federal funds to support ITS projects.

Certain outcomes are required by the Rule at the planning level. The following section is organized to indicate the rule language in italics, with interpretation following. The NIA Rule reference number is also noted.

Rule: *The regional ITS architecture shall include, at a minimum, the following* (940.9(d)):

1. A description of the region (940.9(d)(1));

The rule defines a region as the geographical area that identifies the boundaries of the regional ITS architecture and is defined by and based on the needs of the participating agencies and other stakeholders.

The regional description for this project is the entire state of Oklahoma.

Rule: *2. Identification of participating agencies and other stakeholders* (940.9(d)(2));

All agencies contacted, and if pertinent, those contacted that did not respond will be listed. The stakeholder interviews are included in the Appendix of the Oklahoma Statewide ITS Strategic Plan. The stakeholders include:

- Oklahoma DOT (Planning and Research Division, Traffic Engineering Division, Division 4 Maintenance, Division 8 Traffic, Division 8 Maintenance, Division 3)
- Oklahoma Transportation Authority (OTA)
- Oklahoma Highway Patrol (OHP) / Department of Public Safety (DPS)
- Oklahoma Corporation Commission (OCC)
- Oklahoma City RTMC
- Tulsa RTMC
- Association of Central Oklahoma Governments (ACOG)
- Indian Nations Council of Governments (INCOG)
- University of Oklahoma
- Oklahoma Department of Civil Emergency Management
- Transit Agencies

The typical roles and responsibilities of these agencies are described in the subsystems and terminators section of this report.

Rule: *3. An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture* (940.9(d)(3)).

An operational concept identifies the who, what, when and where of integrated operations. This architecture includes an Institutional layer which defines portions of the concept of operations. The overall concept of operations is supplied in the Oklahoma Statewide ITS Strategic Plan.

Rule: *4. Any agreements (existing or new) required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture* (940.9(d)(4));

Currently, no agreements have been identified as specifically required by the Statewide ITS Architecture. Often, the architecture itself constitutes the agreement between agencies to integrate and operate together. Funding agreements for capital or operations funding, data privacy agreements, and operations agreements can sometimes be required. With the exception of funding agreements, many regions find that they can integrate and operate together without written agreements. There was a Memorandum of Understanding Signed for the Statewide ITS Strategic Plan.

Rule: *5. System functional requirements* (940.9(d)(5));

This architecture provides planning level system functional requirements, based on the user service requirements.

Rule: *6. Interface requirements and information exchanges with planned and existing systems and subsystems (for example, subsystems and architecture flows as defined in the National ITS Architecture)* (940.9(d)(6));

All selected market package data flows and system interface requirements have been identified and referenced to the National ITS Architecture.

Rule: *7. Identification of ITS standards supporting regional and national interoperability* (940.9(d)(7));

Each data flow is identified in the diagrams in this report. The standards that are related to these flows will support regional and national systems interoperability. Some of the standards may become USDOT-adopted "critical" standards that specifically support national interoperability. As of this writing, there are no critical standards currently adopted by USDOT. If USDOT does adopt any standards, they will require that they be implemented on Federally-funded ITS projects.

Rule: *8. The sequence of projects required for implementation* (940.9(d)(8)).

The Oklahoma Statewide ITS Implementation plan will identify any required sequencing. The NIA Rule emphasizes that the region ensure that projects be implemented in a logical sequence. For example, a communications backbone may be required before field devices can be connected.

Rule: *9. The agencies and other stakeholders participating in the development of the regional ITS architecture shall develop and implement procedures and responsibilities for maintaining it, as needs evolve within the region* (940.9(f)).

The region has identified that ODOT will be the agency with primary responsibility for architecture maintenance, to incorporate new proposals developed by existing or new partners, and to reflect changes that may develop as projects are implemented. This version of the architecture is an update from the original March 2003 version.

This document and other activities already completed by the state of Oklahoma are intended to conform to the requirements of the Rule on ITS Architecture Consistency.

2.2 Physical Architecture

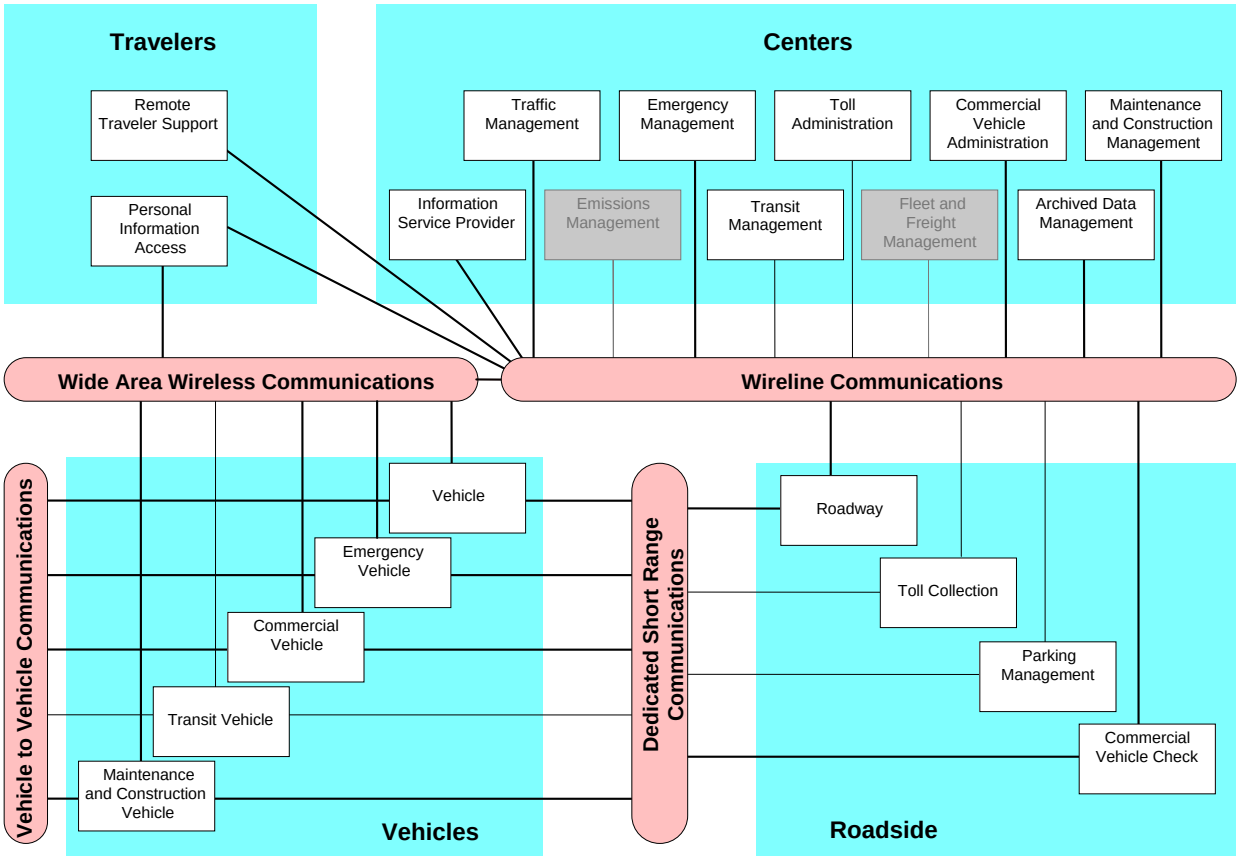
This section describes the physical architecture for implementation of a Traffic Management System for the state of Oklahoma. It is based on the National ITS Architecture providing a common framework for planning, defining, and integrating intelligent transportation systems. The architecture defines:

- The functions (e.g., gather traffic information or request a route) that are required for ITS; and
- The physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle).

The Physical Architecture provides agencies with a physical representation, independent of technology and design, of important ITS interfaces and major system components. Its principal elements are the 21 subsystems, the related communications flows that connect these

subsystems, and the terminators that demarcate the subsystems. A physical architecture takes the processes and assigns them to subsystems. In addition, the data flows are grouped together into architecture flows. These architecture flows and their communication requirements define the interfaces required between subsystems, which form the basis for much of the ongoing standards work in the National ITS program. The architecture flows which were selected for the Statewide Architecture are provided in Appendix A of this report. Figure 1 depicts a high level physical architecture identifying the subsystems involved in the statewide architecture. The subsystems that are in gray were not selected for this architecture.

Figure 1: Oklahoma Statewide ITS Architecture Sausage Diagram



2.2.1 *Subsystems*

The following describes in detail the subsystems that are relevant to the statewide ITS architecture depicted in Figure 1.

Archived Data Management Subsystem Represented by INCOG, ACOG, ODOT, OTA, RTMCs
The Archived Data Management Subsystem collects, archives, manages, and distributes data generated from ITS sources for use in transportation administration, policy evaluation, safety, planning, performance monitoring, program assessment, operations, and research applications. The data received is formatted, tagged with attributes that define the data source, conditions under which it was collected, data transformations, and other information (i.e. meta data) necessary to interpret the data. The subsystem can fuse ITS generated data with data from non-ITS sources and other archives to generate information products utilizing data from multiple functional areas, modes, and jurisdictions. The subsystem prepares data products that can

serve as inputs to Federal, State, and local data reporting systems. This subsystem may be implemented in many different ways. It may reside within an operational center and provide focused access to a particular agency's data archives. Alternatively, it may operate as a distinct center that collects data from multiple agencies and sources and provides a general virtual data warehouse service for a region.

Commercial Vehicle Administration Represented by OCC, OTA, OHP/DPS, and ODOT

The Commercial Vehicle Administration Subsystem will operate at one or more fixed locations within a region. This subsystem performs administrative functions supporting credentials, tax, and safety regulations. It issues credentials, collects fees and taxes, and supports enforcement of credential requirements. This subsystem communicates with the Fleet Management Subsystems associated with the motor carriers to process credentials applications and collect fuel taxes, weight/distance taxes, and other taxes and fees associated with commercial vehicle operations. The subsystem also receives applications for, and issues special Oversize/Overweight and HAZMAT permits in coordination with other cognizant authorities. The subsystem coordinates with other Commercial Vehicle Administration Subsystems (in other states/regions) to support nationwide access to credentials and safety information for administration and enforcement functions. This subsystem supports communications with Commercial Vehicle Check Subsystems operating at the roadside to enable credential checking and safety information collection. The collected safety information is processed, stored, and made available to qualified stakeholders to identify carriers and drivers that operate unsafely.

Commercial Vehicle Check Represented by OCC, OTA, and OHP/DPS

The Commercial Vehicle Check Subsystem supports automated vehicle identification at mainline speeds for credential checking, roadside safety inspections, and weigh-in-motion using two-way data exchange. These capabilities include providing warnings to the commercial vehicle drivers, their fleet managers, and proper authorities of any safety problems that have been identified, accessing and examining historical safety data, and automatically deciding whether to allow the vehicle to pass or require it to stop with operator manual override. The Commercial Vehicle Check Subsystem also provides supplemental inspection services to current capabilities by supporting expedited brake inspections, the use of operator hand-held devices, on-board safety database access, and the enrollment of vehicles and carriers in the electronic clearance program.

Commercial Vehicle Subsystem

This subsystem resides in a commercial vehicle and provides the sensory, processing, storage, and communications functions necessary to support safe and efficient commercial vehicle operations. The Commercial Vehicle Subsystem provides two-way communications between the commercial vehicle drivers, their fleet managers, and roadside officials, and provides HAZMAT response teams with timely and accurate cargo contents information after a vehicle incident. This subsystem provides the capability to collect and process vehicle, cargo, and driver safety data and status and alert the driver whenever there is a potential safety problem. Basic identification and safety status data are supplied to inspection facilities at mainline speeds. In addition, the subsystem will automatically collect and record mileage, fuel usage, and border crossings.

Emergency Management Subsystem Represented by OHP/DPS and ODCEM

The Emergency Management Subsystem operates in various emergency centers supporting public safety including police and fire stations, search and rescue special detachments, and HAZMAT response teams. This subsystem interfaces with other Emergency Management Subsystems to support coordinated emergency response involving multiple agencies. The subsystem creates, stores, and utilizes emergency response plans to facilitate coordinated

response. The subsystem tracks and manages emergency vehicle fleets using automated vehicle location technology and two way communications with the vehicle fleet. Real-time traffic information received from the other center subsystems is used to further aide the emergency dispatcher in selecting the emergency vehicle(s) and routes that will provide the most timely response. Interface with the Traffic Management Subsystem allows strategic coordination in tailoring traffic control to support en-route emergency vehicles. Interface with the Transit Management Subsystem allows coordinated use of transit vehicles to facilitate response to major emergencies.

Emergency Vehicle Subsystem Represented by OHP/DPS

This subsystem resides in an emergency vehicle and provides the sensory, processing, storage, and communications functions necessary to support safe and efficient incident response. The subsystem represents a range of vehicles including those operated by police, fire, and emergency medical services. In addition, this subsystem represents other incident response vehicles including towing and recovery vehicles and freeway service patrols. The Emergency Vehicle Subsystem includes two-way communications to support coordinated response to emergencies in accordance with an associated Emergency Management Subsystem. Emergency vehicles are equipped with automated vehicle location capability for monitoring by vehicle tracking and fleet management functions in the Emergency Management Subsystem. Using these capabilities, the appropriate emergency vehicle to respond to each emergency is determined. Route guidance capabilities within the vehicle enable safe and efficient routing to the emergency. In addition, the emergency vehicle may be equipped to support signal preemption through communications with the Roadway Subsystem.

Information Service Provider Subsystem (ISP) Represented by Media, ODOT and Transit Agencies

This subsystem collects, processes, stores, and disseminates transportation information to system operators and the traveling public. The subsystem can play several different roles in an integrated ITS. In one role, the ISP provides a general data warehousing function, collecting information from transportation system operators and redistributing this information to other system operators in the region and other ISPs. In this information redistribution role, the ISP provides a bridge between the various transportation systems that produce the information and the other ISPs and their subscribers that use the information. The second role of an ISP is focused on delivery of traveler information to subscribers and the public at large. Information provided includes basic advisories, traffic and road conditions, transit schedule information, yellow pages information, ridematching information, and parking information. The subsystem also provides the capability to provide specific directions to travelers by receiving origin and destination requests from travelers, generating route plans, and returning the calculated plans to the users. In addition to general route planning for travelers, the ISP also supports specialized route planning for vehicle fleets. In this third role, the ISP function may be dedicated to, or even embedded within, the dispatch system. Reservation services are also provided in advanced implementations. The information is provided to the traveler through the Personal Information Access Subsystem, Remote Traveler Support Subsystem, and various Vehicle Subsystems through available communications links. Both basic one-way (broadcast) and personalized two-way information provision are supported. The subsystem provides the capability for an informational infrastructure to connect providers and consumers, and gather the market information needed to assist in the planning of service improvements and in maintenance of operations.

Maintenance and Construction Management Represented by ODOT

This subsystem resides in a maintenance, construction, or other specialized service vehicles or equipment and provides the sensory, processing, storage, and communications functions necessary to support highway maintenance and construction. All types of maintenance and construction vehicles are covered, including heavy equipment and supervisory vehicles. The subsystem provides two-way communications between drivers/operators and dispatchers and maintains and communicates current location and status information. A wide range of operational status is monitored, measured, and made available, depending on the specific type of vehicle or equipment. For example, for a snow plow, the information would include whether the plow is up or down and material usage information. The subsystem may also contain capabilities to monitor vehicle systems to support maintenance of the vehicle itself and other sensors that monitor environmental conditions including the road condition and surface weather information. This subsystem can represent a diverse set of mobile environmental sensing platforms, including wheeled vehicles and any other vehicle that collects and reports environmental information.

Maintenance and Construction Vehicle

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Personal Information Access Subsystem (PIAS) Represented by Travelers

This subsystem provides the capability for travelers to receive formatted traffic advisories from their homes, place of work, major trip generation sites, personal portable devices, and over multiple types of electronic media. These capabilities shall also provide basic routing information and allow users to select those transportation modes that allow them to avoid congestion, or more advanced capabilities to allow users to specify those transportation parameters that are unique to their individual needs and receive travel information. This subsystem shall provide capabilities to receive route planning from the infrastructure at fixed locations such as in their homes, their place of work, and at mobile locations such as from personal portable devices and in the vehicle or perform the route planning process at a mobile information access location. This subsystem shall also provide the capability to initiate a distress signal and cancel a prior issued manual request for help.

Parking Management Subsystem Represented by Airports and Transit Agencies

The Parking Management Subsystem provides electronic monitoring and management of parking facilities. It supports a dedicated short-range communications (DSRC) link to the Vehicle Subsystem that allows electronic collection of parking fees. It also includes the instrumentation, signs, and other infrastructure that monitors parking lot usage and provides local information about parking availability and other general parking information. This portion of

the subsystem functionality must be located in the parking facility where it can monitor, classify, and share information with customers and their vehicles. The subsystem also interfaces with the financial infrastructure and broadly disseminates parking information to other operational centers in the region. Note that the latter functionality may be located in a back office, remote from the parking facility.

Roadway Subsystem Represented by Local Traffic Operations and ODOT

The Roadway subsystem includes the equipment distributed on and along the roadway, which monitors and controls traffic. Equipment includes highway advisory radios, dynamic message signs, cellular call boxes, CCTV cameras and video image processing systems for incident detection and verification, vehicle detectors, traffic signals, grade crossing warning systems and freeway ramp metering systems. The subsystem also provides the capability for emissions and environmental condition monitoring including weather sensors, pavement icing sensors, fog, etc. HOV lane management and reversible lane management functions are also available. In advanced implementations, this subsystem supports automated vehicle safety systems by safely controlling access to and egress from an Automated Highway System (AHS) through monitoring of and communications with AHS vehicles. Intersection collision avoidance functions are provided by determining the probability of a collision in the intersection and sending appropriate warnings and/or control actions to the approaching vehicles.

Remote Traveler Support

This subsystem provides access to traveler information at transit stations, transit stops, other fixed sites along travel routes (e.g., rest stops, merchant locations), and at major trip generation locations such as special event centers, hotels, office complexes, amusement parks, and theaters. Traveler information access points include kiosks and informational displays supporting varied levels of interaction and information access. At transit stops, simple displays providing schedule information and imminent arrival signals can be provided. This basic information may be extended to include multi-modal information including traffic conditions and transit schedules along with yellow pages information to support mode and route selection at major trip generation sites. Personalized route planning and route guidance information can also be provided based on criteria supplied by the traveler. In addition to traveler information provision, this subsystem also supports public safety monitoring using CCTV cameras or other surveillance equipment and emergency notification within these public areas. Fare card maintenance, and other features which enhance traveler convenience may also be provided at the discretion of the deploying agency.

Toll Administration Subsystem Represented by OTA

The Toll Administration Subsystem provides general payment administration capabilities and supports the electronic transfer of authenticated funds from the customer to the transportation system operator. This subsystem supports traveler enrollment and collection of both pre-payment and post-payment transportation fees in coordination with the existing, and evolving financial infrastructure supporting electronic payment transactions. The system may establish and administer escrow accounts depending on the clearinghouse scheme and the type of payments involved. This subsystem posts a transaction to the customer account and generates a bill (for post-payment accounts), debits an escrow account, or interfaces to the financial infrastructure to debit a customer designated account. It supports communications with the Toll Collection Subsystem to support fee collection operations. The subsystem also sets and administers the pricing structures and includes the capability to implement road pricing policies in coordination with the Traffic Management Subsystem. The electronic financial transactions in which this subsystem is an intermediary between the customer and the financial infrastructure

shall be cryptographically protected and authenticated to preserve privacy and ensure authenticity and auditability.

Toll Collection Subsystem Represented by OTA

The Toll Collection Subsystem provides the capability for vehicle operators to pay tolls without stopping their vehicles using locally determined pricing structures and includes the capability to implement various variable road pricing policies. Each transaction is accompanied by feedback to the customer indicating the general status of the customer account. A record of the transactions is provided to the Toll Administration Subsystem for reconciliation and so that the customer can periodically receive a detailed record of the transactions.

Traffic Management Subsystem Represented by ODOT, OTA, and RTMCs

The Traffic Management Subsystem operates within a traffic management center or other fixed location. This subsystem communicates with the Roadway Subsystem to monitor and manage traffic flow. Incidents are detected and verified and incident information is provided to the Emergency Management Subsystem, travelers (through Roadway Subsystem Highway Advisory Radio and Dynamic Message Signs), and to third party providers. The subsystem supports HOV lane management and coordination, road pricing, and other demand management policies that can alleviate congestion and influence mode selection. The subsystem monitors and manages maintenance work and disseminates maintenance work schedules and road closures. The subsystem also manages reversible lane facilities, and processes probe vehicle information. The subsystem communicates with other Traffic Management Subsystems to coordinate traffic information and control strategies in neighboring jurisdictions. It also coordinates with rail operations to support safer and more efficient highway traffic management at highway-rail intersections. Finally, the Traffic Management Subsystem provides the capabilities to exercise control over those devices utilized for automated highway system (AHS) traffic and vehicle control.

Transit Management Represented by Transit Agencies

The Transit Management Subsystem manages transit vehicle fleets and coordinates with other modes and transportation services. It provides operations, maintenance, customer information, planning and management functions for the transit property. It spans distinct central dispatch and garage management systems and supports the spectrum of fixed route, flexible route, paratransit services, transit rail, and bus rapid transit (BRT) service. The subsystem's interfaces allow for communication between transit departments and with other operating entities such as emergency response services and traffic management systems. This subsystem receives special event and real-time incident data from the traffic management subsystem. It provides current transit operations data to other center subsystems. It interfaces with the Emergency Management Subsystem to allow coordinated use of transit vehicles to facilitate response to major emergencies or evacuations. The Transit Management Subsystem collects and stores accurate ridership levels and implements corresponding fare structures. It collects operational and maintenance data from transit vehicles, manages vehicle service histories, and assigns vehicle operators and maintenance personnel to vehicles and routes. The Transit Management Subsystem also provides the capability for automated planning and scheduling of public transit operations. It furnishes travelers with real-time travel information, continuously updated schedules, schedule adherence information, transfer options, and transit routes and fares. In addition, the subsystem supports transit security features. This includes monitoring silent alarms, both passenger and operator initiated, on-board transit vehicles. It also includes the capability to support transit vehicle operator authentication and the capability to remotely disable a transit vehicle. The subsystem includes the capability to monitor for a transit vehicle being off

the assigned route. The subsystem also includes the capability to alert operators and police to potential incidents identified by these security features.

Transit Vehicle Subsystem

This subsystem resides in a transit vehicle and provides the sensory, processing, storage, and communications functions necessary to support safe and efficient movement of passengers. The types of transit vehicles containing this subsystem include buses, paratransit vehicles, light rail vehicles, other vehicles designed to carry passengers, and supervisory vehicles. The subsystem collects accurate ridership levels and supports electronic fare collection. The subsystem supports a traffic signal prioritization function that communicates with the roadside subsystem to improve on-schedule performance. Automated vehicle location functions enhance the information available to the Transit Management Subsystem enabling more efficient operations. On-board sensors support transit vehicle maintenance. The subsystem supports on-board security and safety monitoring. This monitoring includes transit user or vehicle operator activated alarms (silent or audible), as well as surveillance and sensor equipment. The surveillance equipment includes video (e.g. CCTV cameras), audio systems and/or event recorder systems. The sensor equipment includes threat sensors (e.g. chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors) and object detection sensors (e.g. metal detectors). In addition, the subsystem supports vehicle operator authentication prior to operation of the vehicle and remote vehicle disabling. The subsystem also furnishes travelers with real-time travel information, continuously updated schedules, transfer options, routes, and fares.

Vehicle Subsystem

This subsystem provides the sensory, processing, storage, and communications functions necessary to support efficient, safe, and convenient travel. These functions reside in general vehicles including personal automobiles, commercial vehicles, emergency vehicles, transit vehicles, or other vehicle types. Information services provide the driver with current travel conditions and the availability of services along the route and at the destination. Both one-way and two-way communications options support a spectrum of information services from low-cost broadcast services to advanced, pay for use personalized information services. Route guidance capabilities assist in formulation of an optimal route and step by step guidance along the travel route. More advanced functions assume limited control of the vehicle to maintain safe headway. Ultimately, this subsystem supports completely automated vehicle operation through advanced communications with other vehicles in the vicinity and in coordination with supporting infrastructure subsystems. Pre-crash safety systems are deployed and emergency notification messages are issued when unavoidable collisions do occur.

The table below maps the subsystems shown above to their respective architecture elements

Table 1: Subsystem Mapped to Element

Entity Kind	Subsystem Name	Element Name
Subsystem	Archived Data Management	ODOT Division Information Centers
		Oklahoma City RTMC
		Oklahoma Transportation Authority
		Statewide Transportation Information Center
		MPOs (INCOG, ACOG)
		Tulsa RTMC
	Commercial Vehicle Administration	Oklahoma CVIEW Statewide Transportation Information Center
	Commercial Vehicle Check	Oklahoma Inspection Facilities
	Commercial Vehicle	Commercial Vehicles
	Emergency Management	Oklahoma Department of Civil Emergency Management Center
		Oklahoma Highway Patrol
	Emergency Vehicle	Emergency Vehicles
	Information Service Provider	Oklahoma Division Information Centers
		Oklahoma City RTMC
		Statewide Transportation Information Center
		Tulsa RTMC
		Transit Agency Information Centers
	Maintenance and Construction Management	Statewide Transportation Information Center
	Maintenance and Construction Vehicle	Maintenance Vehicles
	Personal Information Access	User Personal Computing Devices
	Parking Management	Airports
		Transit Agencies
	Remote Traveler Support	Statewide Transportation Information Center_Kiosks
	Roadway	Maintenance Field Devices
		Oklahoma Division Information Centers Roadside Equipment
		Oklahoma City RTMC_Roadside Equipment
		Statewide Transportation Information Center_Roadside Equipment
		Tulsa RTMC_Roadside Equipment
	Toll Administration	Oklahoma Transportation Authority
	Toll Collection	Oklahoma Transportation Authority _Field Equipment
	Traffic Management	Oklahoma Division Information Centers
		Oklahoma City RTMC
		Statewide Transportation Information Center
		Tulsa RTMC
	Transit Management	Transit Agencies Dispatch
	Transit Vehicle	Transit Agency Buses
	Vehicle	Vehicles

2.2.2 *Terminators*

Archive Data Administrators
This terminator represents the human operator who provides overall data management, administration, and monitoring duties for the ITS data archive. Unlike the manager of the operational databases, the archive data administrator's role is focused on the archive and covers areas such as establishing user authentication controls, monitoring data quality, and initiating data import requests.

Archive Data User Systems
This terminator represents the systems users employ to access archived data. The general interface provided from this terminator allows a broad range of users (e.g. planners, researchers, analysts, operators) and their systems (e.g. databases, models, analytical tools, user interface devices) to acquire data and analyses results from the archive.

CVO Inspector
This terminator represents the human entities who perform regulatory inspection of Commercial Vehicles in the field. CVO Inspectors support the roadside inspection, weighing, and checking of credentials either through automated pre-clearance or manual methods. The CVO Inspector is an inspection and enforcement arm of the regulatory agencies with frequent direct interface with the Commercial Vehicles and their Drivers.

ISP Operator
This terminator is the human entity that may be physically present at the ISP to monitor the operational status of the facility and provide human interface capabilities to travelers and other ISP subsystems.

Other Archives
This terminator represents distributed archived data systems or centers whose data can be accessed and shared with a local archive. The interface between the Other Archives Terminator and the Archived Data Management Subsystem allows data from multiple archives to be accessed on demand or imported and consolidated into a single repository.

Other CVAS
This terminator is intended to provide a source and destination for ITS data flows between peer (e.g. inter-regional) commercial vehicle administration functions. It enables commercial vehicle administration activities to be coordinated across different jurisdictional areas. In the Physical Architecture, this terminator is a reciprocal Commercial Vehicle Administration Subsystem (CVAS). This terminator encompasses all functions associated with commercial vehicle safety, registration, and operating authority for non-U.S. based commercial motor vehicle carriers. The agencies represented herein may include Federal, state, provincial, and local regulatory entities outside the U.S.

Other EM
Representing other Emergency Management centers, systems or subsystems, this terminator provides a source and destination for ITS data flows between various communications centers operated by public safety agencies as well as centers operated by other allied agencies and private companies that participate in coordinated management of highway-related incidents. The interface represented by this terminator enables emergency management activities to be coordinated across jurisdictional boundaries and between functional areas. In the Physical Architecture this terminator is a reciprocal Emergency Management Subsystem (EM) implying the requirements for general networks connecting many allied agencies. The interface between this

terminator and the EM supports coordination of incident management information between many different centers providing Public Safety Answering Point (both public or private sector implementations), Public Safety Dispatch, Emergency Operations, and other functions that participate in the detection, verification, response, and clearance of highway incidents. This terminator also supports interface to other allied agencies like utility companies that also participate in the coordinated response to selected highway-related incidents.

Other ISP
Representing other distinct Information Service Providers, this terminator is intended to provide a source and destination for ITS data flows between peer information and service provider functions. It enables cooperative information sharing between providers as conditions warrant. In the Physical Architecture this terminator is a reciprocal Information Service Provider (ISP) Subsystem.

Other Roadway
Representing another roadway system or subsystem, this terminator provides a source and destination for information that may be exchanged between peer roadway subsystems. The interface to this terminator enables direct coordination between field equipment. Examples include the direct interface between sensors and other roadway devices (e.g., Dynamic Message Signs) and the direct interface between roadway devices (e.g., adjacent traffic control equipment).

Other Traffic Management
Representing another Traffic Management center, system or subsystem, this terminator is intended to provide a source and destination for ITS data flows between peer (e.g. inter-regional) traffic management functions. It enables traffic management activities to be coordinated across different jurisdictional areas. In the Physical Architecture this terminator is a reciprocal Traffic Management Subsystem (TMS).

Other Transit Management
Representing another Transit Management center, system or subsystem, this terminator is intended to provide a source and destination for ITS data flows between peer (e.g. inter-regional) transit management functions. It enables transit management activities to be coordinated across geographic boundaries or different jurisdictional areas. In the Physical Architecture this terminator represents a reciprocal Transit Management Subsystem (TRMS).

Traffic Operations Personnel
This terminator represents the human entity that directly interfaces with vehicle traffic operations. These personnel interact with traffic control systems, traffic surveillance systems, incident management systems, work zone management systems, and travel demand management systems to accomplish ITS services. They provide operator data and command inputs to direct systems' operations to varying degrees depending on the type of system and the deployment scenario. All functionality associated with these services that might be automated in the course of ITS deployment is modeled as internal to the architecture.

Transit System Operators
This terminator represents the human entities that are responsible for all aspects of the transit system operation including fleet management, maintenance operations, and scheduling. These different roles represent a variety of individuals in the transit industry. Within the transit industry the person responsible for fleet management is known by many names: Street Supervisor (most common), Starter, Dispatcher, Supervisor, Traffic Controller, or Transportation Coordinator. This entity actively monitors, controls, and modifies the transit fleet routes and schedules on a day to

day basis (dynamic scheduling). The modifications will be to take account of abnormal situations such as vehicle breakdown, vehicle delay, detours around work zones or incidents (detour management and service restoration), and other causes of route or schedule deviations. This entity may also be responsible for demand responsive transit operation and for managing emergency situations within the transit network such as silent alarms on board transit vehicles, or the remote disabling of the vehicle. In addition the Transit System Operator may be responsible for assigning vehicle operators to routes, checking vehicle operators in and out, and managing transit stop issues. The Transit System Operator terminator also represents the human entity in the transit garage that is responsible for maintenance of the transit fleets, including monitoring vehicle status, matching vehicles with operators, and maintenance checking of transit vehicles. Finally, the Transit System Operator terminator represents the human entity responsible for planning, development, and management of transit routes and schedules.

Transit Vehicle Operator

This terminator represents the human entity that receives and provides additional information that is specific to operating the ITS functions in all types of transit vehicles. To support transit vehicle security features, the Transit Vehicle Operator can input to the Transit Vehicle Subsystem a silent alarm. The operator can also be required to enter an authentication command (used to enable operation of the vehicle). The information received by the operator would include status of on-board systems. Additional information received depends upon the type of transit vehicle. In the case of fixed route transit vehicles, the Transit Vehicle Operator would receive operator instructions that might include actions to take to correct schedule deviations. In the case of flexible fixed routes and demand response routes the information would also include dynamic routing or passenger pickup information.

Weather Service

This terminator provides weather, hydrologic, and climate information and warnings of hazardous weather including thunderstorms, flooding, hurricanes, tornadoes, winter weather, tsunamis, and climate events. It provides atmospheric weather observations and forecasts that are collected and derived by the National Weather Service, private sector providers, and various research organizations. The interface provides formatted weather data products suitable for on-line processing and integration with other ITS data products as well as Doppler radar images, satellite images, severe storm warnings, and other products that are formatted for presentation to various ITS users.

The table below maps the terminators shown above to their respective architecture elements.

Table 2: Terminator Mapped to Element

Entity Kind	Terminator Name	Element Name
Terminator	Archive Data Administrators	Local MPOs
	Archive Data User Systems	Planners and Researchers
	CVO Inspector	CVO Inspector
	ISP Operator	Local TOCs_Personnel
		Oklahoma City RTMC_Personnel
		Statewide Transportation Information Center_Personnel
		Tulsa RTMC_Personnel
	Other Archives	Local TOCs
		Oklahoma City RTMC
		Oklahoma Transportation Authority
		Statewide Transportation Information Center
		Tulsa RTMC
	Other CVAS	Oklahoma CVIEW
	Other Emergency Management	Oklahoma Highway Patrol_Personnel
	Other ISP	Local TOCs
	Other Roadway	Local TOCs_Roadside Equipment
	Other TM	Local TOCs
	Other Transit Management	
	Traffic Operations Personnel	Local TOCs_Personnel
		Oklahoma City RTMC_Personnel
		Oklahoma Division Information Centers_Personnel
		Statewide Transportation Information Center_Personnel
		Tulsa RTMC_Personnel
	Transit System Operators	Transit System Dispatcher
	Transit Vehicles Operator	Transit System Bus Driver
	Weather Service	Weather Services

2.2.3 ***Market Packages***

Market Packages provide an accessible, deployment oriented perspective to the national architecture. They provide the framework that links the subsystems and terminators to ensure a seamless transportation network. Market Packages identify the pieces of the Physical Architecture that are required to implement a particular transportation service. The following table lists the Market Packages that were selected for the State of Oklahoma.

Table 3: Selected Market Packages

Market Package Name	Description
AD01: ITS Data Mart	This market package provides a focused archive that houses data collected and owned by a single agency, district, private sector provider, research institution, or other organization. This focused archive typically includes data covering a single transportation mode and one jurisdiction that is collected from an operational data store and archived for future use. It provides the basic data quality, data privacy, and meta data management common to all ITS archives and provides general query and report access to archive data users.
AD02: ITS Data Warehouse	This market package includes all the data collection and management capabilities provided by the ITS Data Mart, and adds the functionality and interface definitions that allow collection of data from multiple agencies and data sources spanning across modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this market package in addition to the basic query and reporting user access features offered by the ITS Data Mart.
AD03: ITS Virtual Data Warehouse	This market package provides the same broad access to multimodal, multidimensional data from varied data sources as in the ITS Data Warehouse Market Package, but provides this access using enhanced interoperability between physically distributed ITS archives that are each locally managed. Requests for data that are satisfied by access to a single repository in the ITS Data Warehouse Market Package are parsed by the local archive and dynamically translated to requests to remote archives which relay the data necessary to satisfy the request.
APTS01-Transit Vehicle Tracking	This market package monitors current transit vehicle location using an Automated Vehicle Location System. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real-time. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Transit Management Subsystem is used for relaying vehicle position and control measures. Fixed route transit systems may also employ beacons along the route to enable position determination and facilitate communications with each vehicle at fixed intervals. The Transit Management Subsystem processes this information, updates the transit schedule and makes real-time schedule information available to the ISP.
APTS02-Transit Fixed-Route Operations	This market package performs vehicle routing and scheduling, as well as automatic operator assignment and system monitoring for fixed-route and flexible-route transit services. This service determines current schedule performance using AVL data and provides information displays at the Transit Management Subsystem. Static and real time transit data is exchanged with Information Service Providers where it is integrated with that from other transportation modes (e.g. rail, ferry, air) to provide the public with integrated and personalized dynamic schedules.

Market Package Name	Description
APTS03-Demand Response Transit Operations	This market package performs vehicle routing and scheduling as well as automatic operator assignment and monitoring for demand responsive transit services. In addition, this market package performs similar functions to support dynamic features of flexible-route transit services. This package monitors the current status of the transit fleet and supports allocation of these fleet resources to service incoming requests for transit service while also considering traffic conditions. The Transit Mgmt Subsystem provides the necessary data processing and information display to assist the transit operator in making optimal use of the transit fleet.
APTS04-Transit Passenger and Fare Management	This market package manages passenger loading and fare payments on-board transit vehicles using electronic means. It allows transit users to use a traveler card or other electronic payment device. Sensors mounted on the vehicle permit the operator and central operations to determine vehicle loads, and readers located either in the infrastructure or on-board the transit vehicle. They also allow electronic fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Subsystem. Two other market packages, ATMS10: Electronic Toll Collection and ATMS16: Parking Facility Management also provide electronic payment services. These three market packages in combination provide an integrated electronic payment system for transportation services.
APTS05-Transit Security	This market package provides for the physical security of transit passengers and transit vehicle operators. On-board equipment is deployed to perform surveillance and sensor monitoring in order to warn of potentially hazardous situations. The surveillance equipment includes video (e.g., CCTV cameras), audio systems and/or event recorder systems. The sensor equipment includes threat sensors (e.g., chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors) and object detection sensors (e.g., metal detectors). Transit user or transit vehicle operator activated alarms are provided on-board. Public areas (e.g., transit stops, park and ride lots, stations) are also monitored with similar surveillance and sensor equipment and provided with transit user activated alarms. In addition this market package provides surveillance and sensor monitoring of non-public areas of transit facilities (e.g., transit yards) and transit infrastructure such as bridges, tunnels, and transit railways or bus rapid transit (BRT) guideways.
APTS06-Transit Maintenance	This market package supports automatic transit maintenance scheduling and monitoring. On-board condition sensors monitor system status and transmit critical status information to the Transit Management Subsystem. Hardware and software in the Transit Management Subsystem processes this data and schedules preventative and corrective maintenance.
APTS07-Multi-modal Coordination	This market package establishes two way communications between multiple transit and traffic agencies to improve service coordination. Multimodal coordination between transit agencies can increase traveler convenience at transit transfer points and clusters (a collection of stops, stations, or terminals where transfers can be made conveniently) and also improve operating efficiency. Transit transfer information is shared between Multimodal Transportation Service Providers, Transit Agencies, and ISPs. Coordination between traffic and transit management is intended to improve on-time performance of the transit system to the extent that this can be accommodated without degrading overall performance of the traffic network. More limited local coordination between the transit vehicle and the individual intersection for signal priority is also supported by this package.

Market Package Name	Description
APTS08 – Transit Traveler Information	This market package provides transit users at transit stops and on-board transit vehicles with ready access to transit information. The information services include transit stop annunciation, imminent arrival signs, and real-time transit schedule displays that are of general interest to transit users. Systems that provide custom transit trip itineraries and other tailored transit information services are also represented by this market package.
ATIS01: Broadcast Traveler Information	This market package collects traffic conditions, advisories, general public transportation, toll and parking information, incident information, air quality and weather information, and broadly disseminates this information through existing infrastructures and low cost user equipment (e.g., FM subcarrier, cellular data broadcast). The information may be provided directly to travelers or provided to merchants and other traveler service providers so that they can better inform their customers of travel conditions. Different from the market package ATMS6 - Traffic Information Dissemination, which provides localized HAR and DMS information capabilities, ATIS1 provides a wide area digital broadcast service. Successful deployment of this market package relies on availability of real-time traveler information from roadway instrumentation, probe vehicles or other sources.
ATMS01: Network Surveillance	This market package includes traffic detectors, other surveillance equipment, the supporting field equipment, and wireline communications to transmit the collected data back to the Traffic Management Subsystem. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this market package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to users and the Information Service Provider Subsystem.
ATMS02: Probe Surveillance	This market package provides an alternative approach for surveillance of the roadway network. Two general implementation paths are supported by this market package: 1) wide-area wireless communications between the vehicle and Information Service Provider is used to communicate current vehicle location and status, and 2) dedicated short range communications between the vehicle and roadside is used to provide equivalent information directly to the Traffic Management Subsystem. The market package enables traffic managers to monitor road conditions, identify incidents, analyze and reduce the collected data, and make it available to users and private information providers. It requires one of the communications options identified above, roadside beacons and wireline communications for the short range communications option, data reduction software, and utilizes wireline links between the Traffic Management Subsystem and Information Service Provider Subsystem to share the collected information.
AMTS03: Surface Street Control	This market package provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. A range of traffic signal control systems are represented by this market package ranging from static pre-timed control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. Additionally, general advisory and traffic control information can be provided to the driver while en route. This market package is generally an intra-jurisdictional package that does not rely on real-time communications between separate control systems to achieve area-wide traffic signal coordination. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would be represented by this package. This market package is consistent with typical urban traffic signal control systems.

Market Package Name	Description
ATMS04: Freeway Control	This market package provides the communications and roadside equipment to support ramp control, lane controls, and interchange control for freeways. Coordination and integration of ramp meters are included as part of this market package. This package is consistent with typical urban traffic freeway control systems. This package incorporates the instrumentation included in the Network Surveillance Market Package to support freeway monitoring and adaptive strategies as an option. This market package also includes the capability to utilize surveillance information for detection of incidents. Typically, the processing would be performed at a traffic management center; however, developments might allow for point detection with roadway equipment. For example, a CCTV might include the capability to detect an incident based upon image changes. Additionally, this market package allows general advisory and traffic control information to be provided to the driver while en route.
ATMS05: HOV Lane Management	This market package manages HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals. Preferential treatment is given to HOV lanes using special bypasses, reserved lanes, and exclusive rights-of-way that may vary by time of day. Vehicle occupancy detectors may be installed to verify HOV compliance and to notify enforcement agencies of violations.
ATMS06: Traffic Information Dissemination	This market package allows traffic information to be disseminated to drivers and vehicles using roadway equipment such as dynamic message signs or highway advisory radio. This package provides a tool that can be used to notify drivers of incidents; careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), Transit Management, Emergency Management, and Information Service Providers. A link to the Maintenance and Construction Management subsystem allows real time information on road/bridge closures due to maintenance and construction activities to be disseminated.
ATMS07: Regional Traffic Control	This market package provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy. This market package advances the Surface Street Control and Freeway Control Market Packages by adding the communications links and integrated control strategies that enable integrated Interjurisdictional traffic control. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Surface Street Control and Freeway Control Market Packages and adds hardware, software, and wireline communications capabilities to implement traffic management strategies that are coordinated between allied traffic management centers. Several levels of coordination are supported from sharing of information through sharing of control between traffic management centers.
ATMS08: Incident Management System	This market package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The market package includes incident detection capabilities through roadside surveillance devices (e.g. CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers as well as weather service entities and event promoters. Information from these diverse sources are collected and correlated by this market package to detect and verify incidents and implement an appropriate response. This market package supports traffic operations personnel in developing an appropriate response in coordination with emergency management, maintenance and construction management, and other incident response personnel to confirmed

Market Package Name	Description
	incidents. The response may include traffic control strategy modifications or resource coordination between center subsystems. Incident response also includes presentation of information to affected travelers using the Traffic Information Dissemination market package and dissemination of incident information to travelers through the Broadcast Traveler Information or Interactive Traveler Information market packages. The roadside equipment used to detect and verify incidents also allows the operator to monitor incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other allied response agencies and field service personnel.
ATMS10: Electronic Toll Collection	This market package provides toll operators with the ability to collect tolls electronically and detect and process violations. The fees that are collected may be adjusted to implement demand management strategies. Dedicated short range communication between the roadway equipment and the vehicle is required as well as fixed-point to fixed-point interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Vehicle tags of toll violators are read and electronically posted to vehicle owners. Standards, inter-agency coordination, and financial clearinghouse capabilities enable regional and ultimately national interoperability.
ATMS16-Parking Facility Management	This market package provides enhanced monitoring and management of parking facilities. It assists in the management of parking operations, coordinates with transportation authorities, and supports electronic collection of parking fees. This market package collects current parking status, shares this data with Information Service Providers and Traffic Management, and collects parking fees using the same in-vehicle equipment utilized for electronic toll collection or contact or proximity traveler cards used for electronic payment.
CVO03: Electronic Clearance	This market package provides for automated clearance at roadside check facilities. The roadside check facility communicates with the Commercial Vehicle Administration subsystem to retrieve infrastructure snapshots of critical carrier, vehicle, and driver data to be used to sort passing vehicles. This allows a good driver/vehicle/carrier to pass roadside facilities at highway speeds using transponders and dedicated short range communications to the roadside. Results of roadside clearance activities will be passed on to the Commercial Vehicle Administration. The roadside check facility may be equipped with Automated Vehicle Identification (AVI), weighing sensors, transponder read/write devices and computer workstations.
CVO04: CV Administrative Processes	This market package provides for electronic application, processing, fee collection, issuance, and distribution of CVO credential and tax filing. Through this process, carriers, drivers, and vehicles may be enrolled in the electronic clearance program provided by a separate market package which allows commercial vehicles to be screened at mainline speeds at roadside check facilities. Through this enrollment process, current profile databases are maintained in the Commercial Vehicle Administration subsystem and snapshots of this database are made available to the roadside check facilities at the roadside to support the electronic clearance process.
CVO06: Weigh-in-Motion	This market package provides for high speed weigh-in-motion with or without Automated Vehicle Identification (AVI) capabilities. This market package provides the roadside equipment that could be used as a stand-alone system or to augment the Electronic Clearance (CVO03) market package.

Market Package Name	Description
CVO07 Roadside CVO Safety	This market package provides for automated roadside safety monitoring and reporting. It automates commercial vehicle safety inspections at the roadside check facilities. The capabilities for performing the safety inspection are shared between this market package and the On-Board CVO Safety (CVO08) Market Package which enables a variety of implementation options. The basic option, directly supported by this market package, facilitates safety inspection of vehicles that have been pulled in, perhaps as a result of the automated screening process provided by the Electronic Clearance (CVO03) Market Package. In this scenario, only basic identification data and status information is read from the electronic tag on the commercial vehicle. The identification data from the tag enables access to additional safety data maintained in the infrastructure which is used to support the safety inspection, and may also inform the pull-in decision if system timing requirements can be met. More advanced implementations, supported by the On-Board CVO Safety (CVO08) market package, utilize additional on-board vehicle safety monitoring and reporting capabilities in the commercial vehicle to augment the roadside safety check.
CVO10: HAZMAT Management	This market package integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem. The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response. The response is tailored based on information that is provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.
EM01: Emergency Response	This market package includes emergency vehicle equipment, equipment used to receive and route emergency calls, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. Coordination between Emergency Management Subsystems supports emergency notification and coordinated response between agencies. Existing wide area wireless communications would be utilized between the Emergency Management Subsystem and an Emergency Vehicle to enable an incident command system to be established and supported at the emergency location. Public safety, traffic management, and many other allied agencies may each participate in the coordinated response managed by this package.
EM02: Emergency Routing	This market package supports automated vehicle location and dynamic routing of emergency vehicles. The service also supports coordination with the Traffic Management Subsystem, collecting detailed road network conditions and requesting special priority or other specific emergency traffic control strategies on the selected route(s). The Emergency Management Subsystem provides the routing for the emergency fleet based on real-time traffic conditions. The Emergency Vehicle may also be equipped with dedicated short range communications for local signal preemption. The service provides for information exchange between care facilities and both the Emergency Management Subsystem and emergency vehicles.
EM08-Disaster Response and Recovery	This market package enhances the ability of the surface transportation system to respond to and recover from disasters. It addresses the most severe incidents that require an extraordinary response from outside the local community. All types of disasters are addressed including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents, nuclear power plant accidents, national security emergencies such as nuclear, chemical, biological, and radiological weapons attacks).

Market Package Name	Description
MC01: Maintenance and Construction Vehicle Tracking	This market package will track the location of maintenance and construction vehicles and other equipment to ascertain the progress of their activities. These activities can include ensuring the correct roads are being plowed and work activity is being performed at the correct locations.
MC03: Road Weather Data Collection	This market package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway (or guideway in the case of transit related rail systems). In addition to fixed sensor stations at the roadside, sensing of the roadway environment can also occur from sensor systems located on Maintenance and Construction Vehicles and on-board sensors provided by auto manufacturers. The collected environmental data is used by the Weather Information Processing and Distribution Market Package to process the information and make decisions on operations.
MC04: Weather Information Processing and Distribution	This market package processes and distributes the environmental information collected from the Road Weather Data Collection market package. This market package uses the environmental data to detect environmental hazards such as icy road conditions, high winds, dense fog, etc. so system operators and decision support systems can make decision on corrective actions to take. The continuing updates of road condition information and current temperatures can be used by system operators to more effectively deploy road maintenance resources, issue general traveler advisories, issue location specific warnings to drivers using the Traffic Information Dissemination market package, and aid operators in scheduling work activity.
MC06: Winter Maintenance	This market package supports winter road maintenance including snow plow operations, roadway treatments (e.g., salt spraying and other anti-icing material applications), and other snow and ice control activities. This package monitors environmental conditions and weather forecasts and uses the information to schedule winter maintenance activities, determine the appropriate snow and ice control response, and track and manage response operations.
MC07: Roadway Maintenance and Construction	This market package supports numerous services for scheduled and unscheduled maintenance and construction on a roadway system or right-of-way. Maintenance services would include landscape maintenance, hazard removal (roadway debris, dead animals), routine maintenance activities (roadway cleaning, grass cutting), and repair and maintenance of both ITS and non-ITS equipment on the roadway (e.g., signs, traffic controllers, traffic detectors, dynamic message signs, traffic signals, CCTV, etc.). Environmental conditions information is also received from various weather sources to aid in scheduling maintenance and construction activities.
MC08: Work Zone Management	This market package directs activity in work zones, controlling traffic through portable dynamic message signs (DMS) and informing other groups of activity (e.g., ISP, TM, other maintenance and construction centers) for better coordination management. Work zone speeds and delays are provided to the motorist prior to the work zones.
MC10: Maintenance and Construction Activity Coordination	This market package supports the dissemination of maintenance and construction activity to centers which can utilize it as part of their operations, or to the Information Service Providers who can provide the information to travelers.

2.2.4 ***Physical Architecture Layers***

The Physical Architecture is composed of three layers: the Institutional Layer, the Transportation Layer, and the Communications Layer. The Institutional Layer represents the existing and emerging institutional constraints and arrangements that are the context for all ITS deployments. The Transportation Layer shows the relationships among the transportation-related elements. It is composed of subsystems for travelers, vehicles, transportation management centers, and field devices, as well as external system interfaces (terminators) at the boundaries. The

Communications Layer shows the different methods of relaying information between subsystems and with terminators.

The Transportation Layer and Communications Layer together provide the technical framework within which interoperable systems may be implemented. The Institutional Layer introduces the policies, funding incentives, working arrangements, and jurisdictional structure that support the technical layers of the architecture. This Institutional Layer provides the basis for understanding who the implementers will be and the roles these implementers could take in implementing architecture-based ITS systems.

The Communications Layer includes all of the communications equipment (e.g., wireline and wireless transmitters and receivers) and the information management and transport capabilities necessary to transfer information among entities in the Transportation Layer. The application data content and the transportation application requirements are generally transparent to the Communications Layer. The Communication Layer's view of ITS is that of many distributed users, some of them mobile, which require communication services.

2.2.4.1 Transportation Layer

The transportation layer is comprised of the information flows within various interconnected subsystems and terminators. These information flows make up the interfaces between the agencies that manage the transportation system.

These components were created based on the foundation provided in the National ITS Architecture. A diagram is also given for each component displaying the relationships between the participating agencies. The information that is exchanged between these agencies is described as architecture flows. Every architecture flow is defined in the National ITS Architecture CD-ROM Version 4 documentation in Table 2.3-6 Architecture Flow Descriptions.

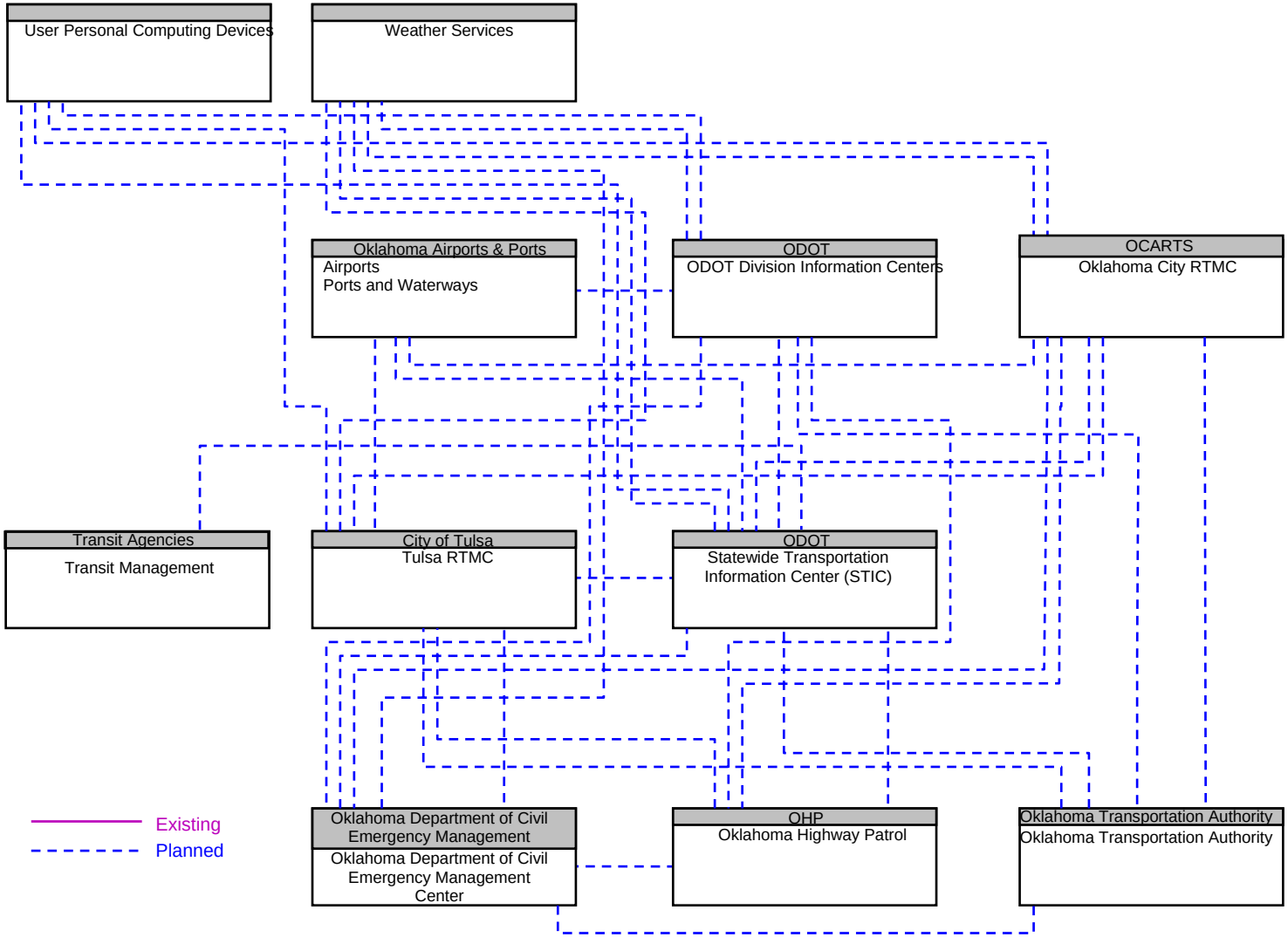
Statewide Traffic Information Center (STIC)

The Statewide Traffic Information Center (STIC) communicates with the Regional Transportation Management Centers (RTMCs) and transit agencies to coordinate traffic and transit information and control strategies. The information from incidents that are detected and verified is provided to the Oklahoma Highway Patrol, travelers and to ISP's. The STIC also monitors and manages maintenance work and disseminates maintenance work schedules and road closures. The STIC as well as the RTMCs will be the primary sources of traffic information that will be distributed to the public and the following agencies:

- Weather Service
- Oklahoma Highway Patrol
- Oklahoma Transportation Authority
- Tulsa RTMC
- Oklahoma City RTMC
- Other ODOT Divisions (1-8)
- Oklahoma Department of Civil Emergency Management
- Airports
- Transit Agencies

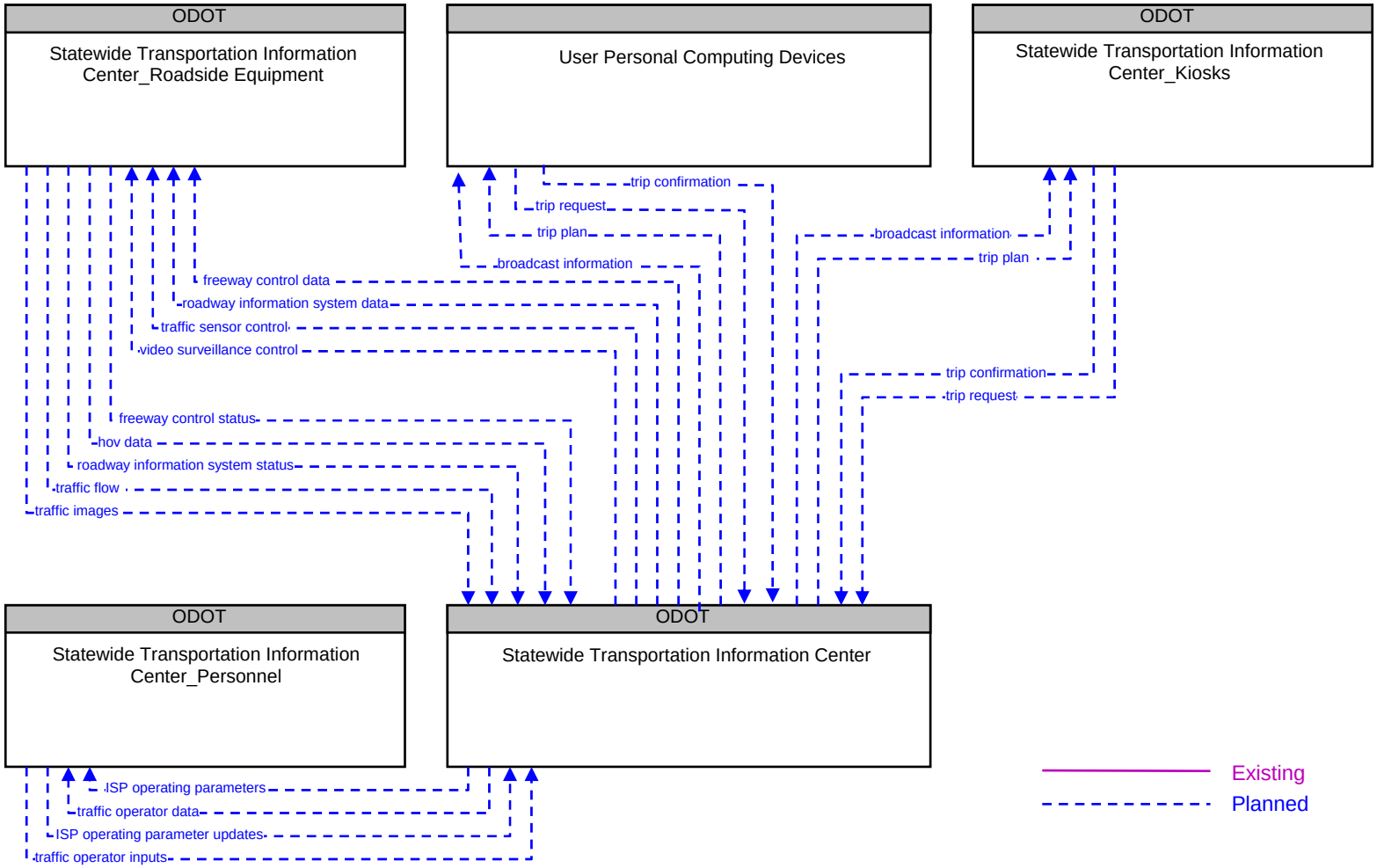
Figure 2 shows the interconnects between the participating agencies.

Figure 2: Oklahoma Statewide Interconnect Diagram



Data is also exchanged among the elements that compose the STIC. The figure below identifies the data flows that are internally exchanged at ODOT.

Figure 3: Oklahoma DOT Internal Data Flows



Local Traffic Operations System

The Local Transportation Operations Systems, which are operated by the local public works departments, provide the capabilities to collect, process, and store traffic information on local streets. It also coordinates with the RTMC as well as disseminates traveler information to travelers and the public at large. The local transportation operations centers (TOC) will focus on local surface traffic control, traffic data collection on surface streets, parking management and coordination with the RTMC and other centers. Information provided may include basic advisories, real time traffic condition and transit schedule information.

The Local TOC will exchange information with the following agencies:

- RTMC
- MPO
- Local 911
- Weather Service

Figure 4 displays the interconnects between the participating agencies.

The local TOCs exchange data flows internally and among its agencies within the community. Figure 5 below displays the information that is exchanged among participating agencies.

Figure 4: Local TOC Interconnect Diagram

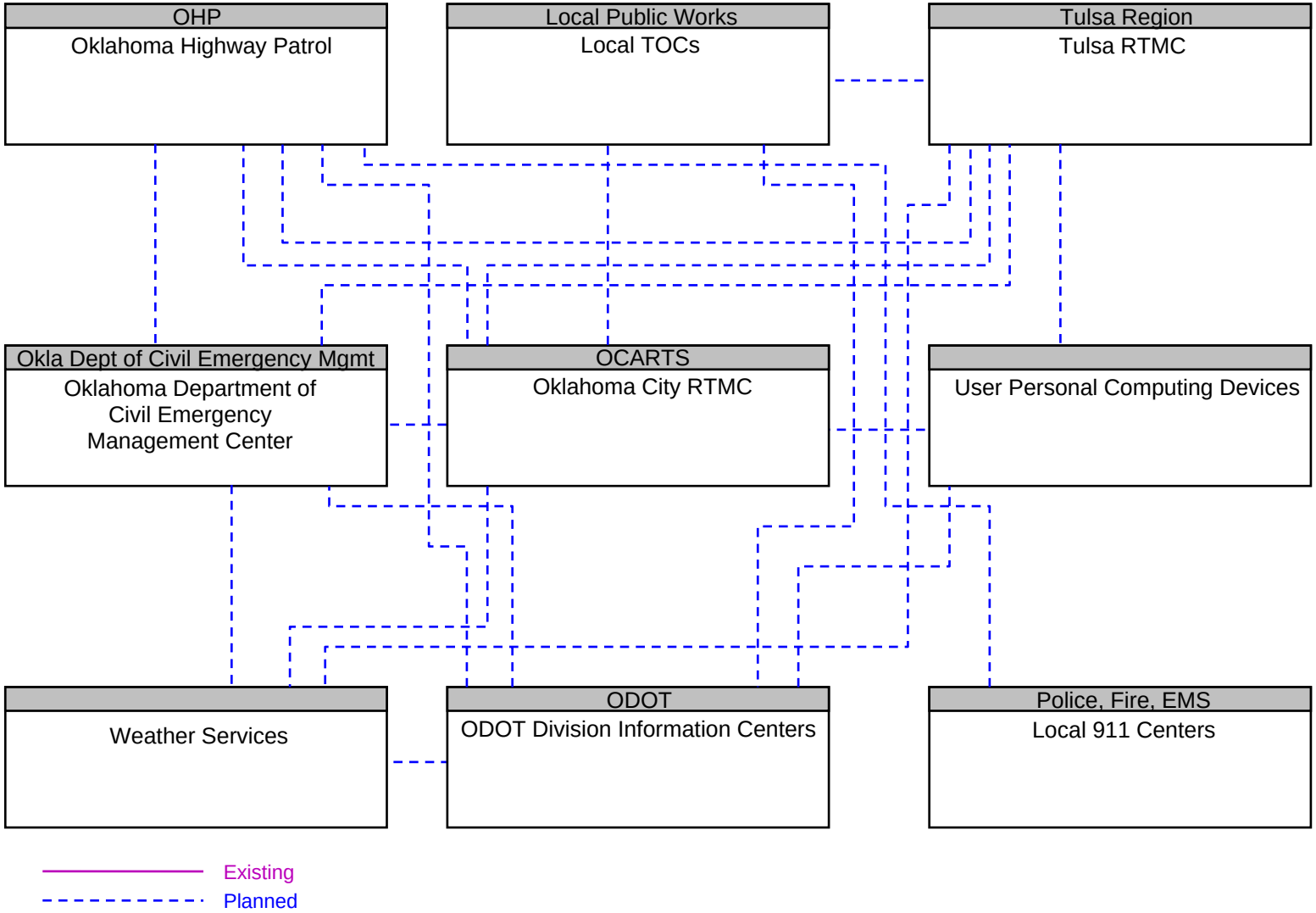
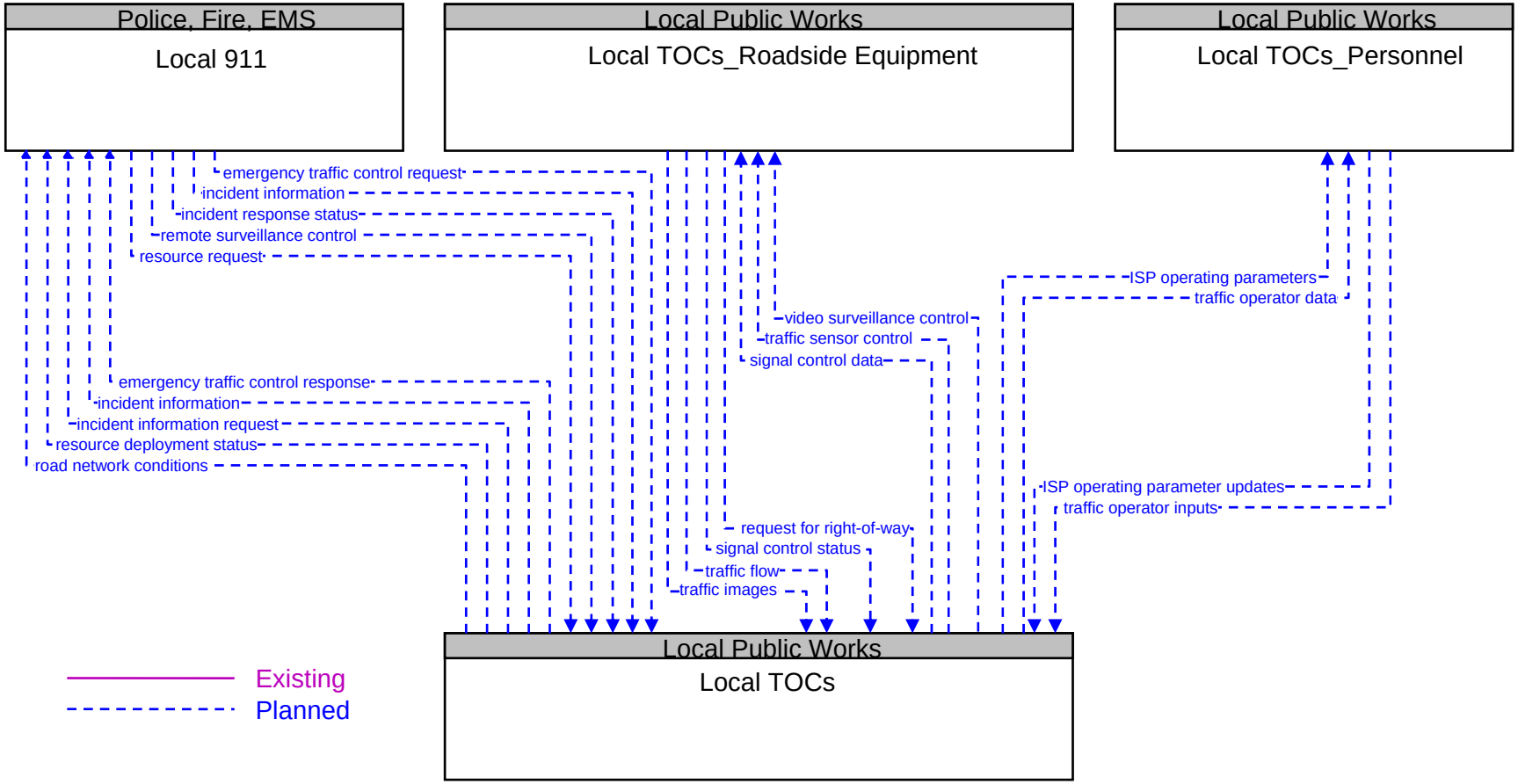


Figure 5: Local TOC Data Flow Diagram



The local TOCs also exchange data with the RTMC. The figure below displays the information that is exchanged between the local TOC and the RTMCs.

Figure 6: Oklahoma City RTMC Data Flow Diagram

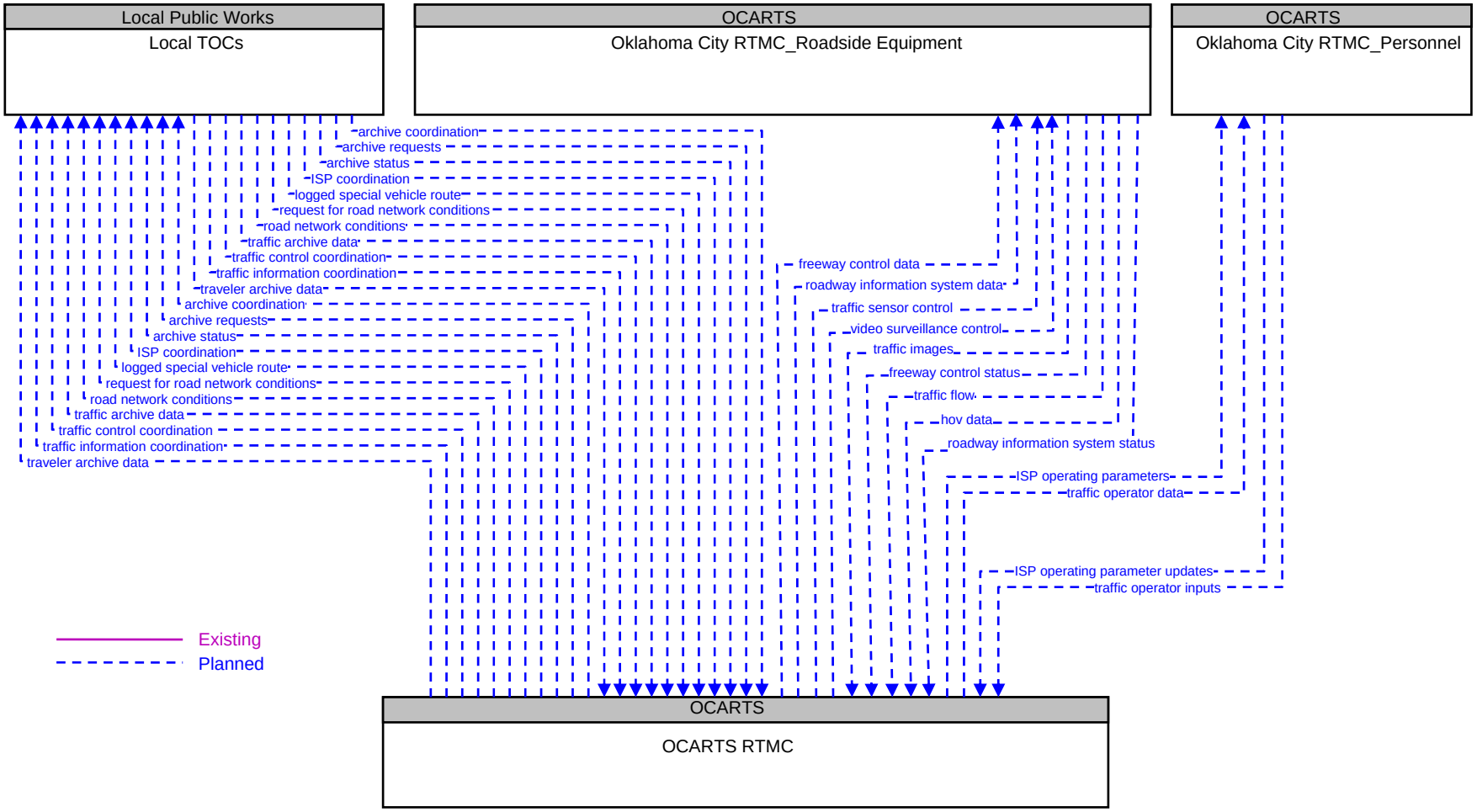
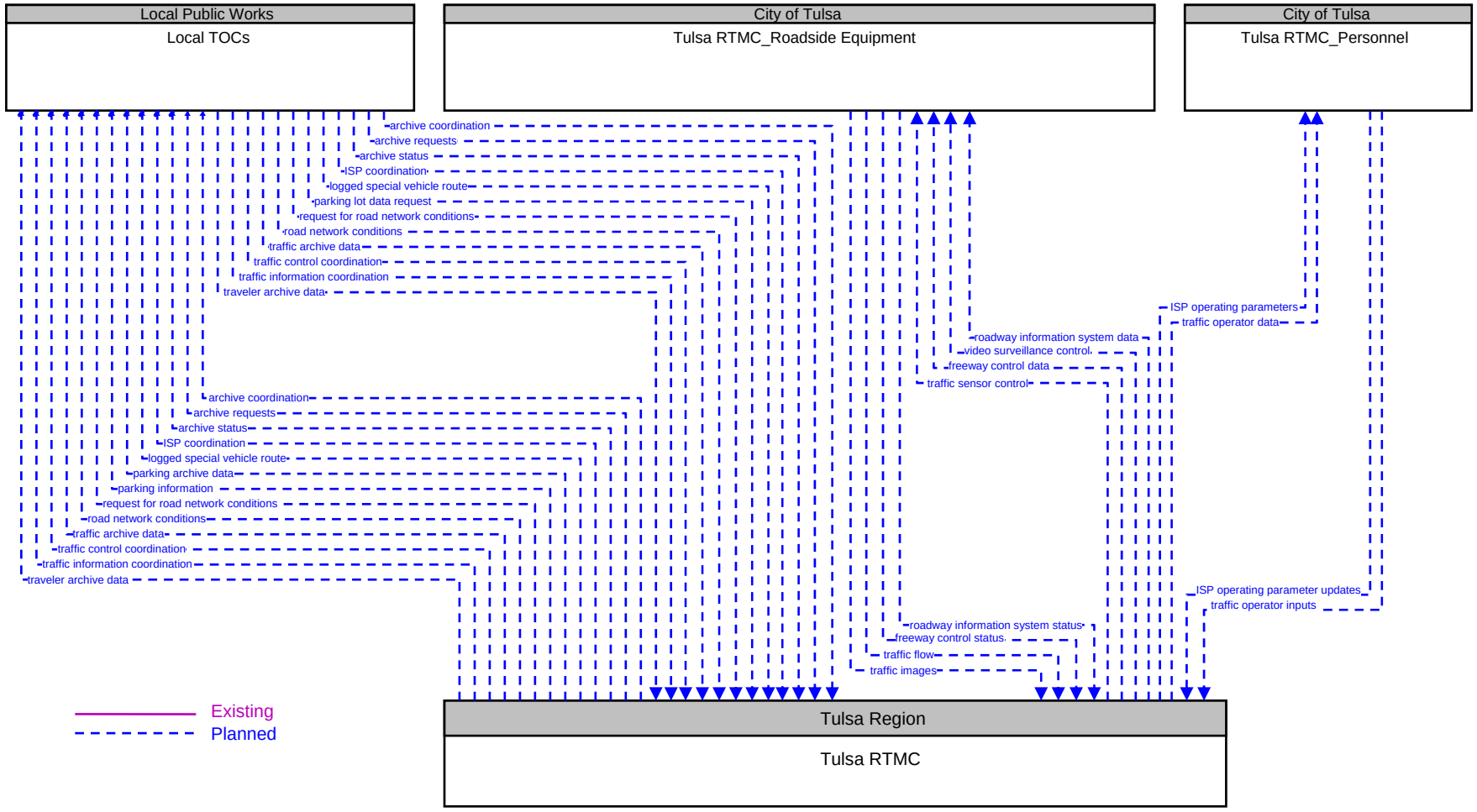


Figure 7: Tulsa RTMC Data Flow Diagram

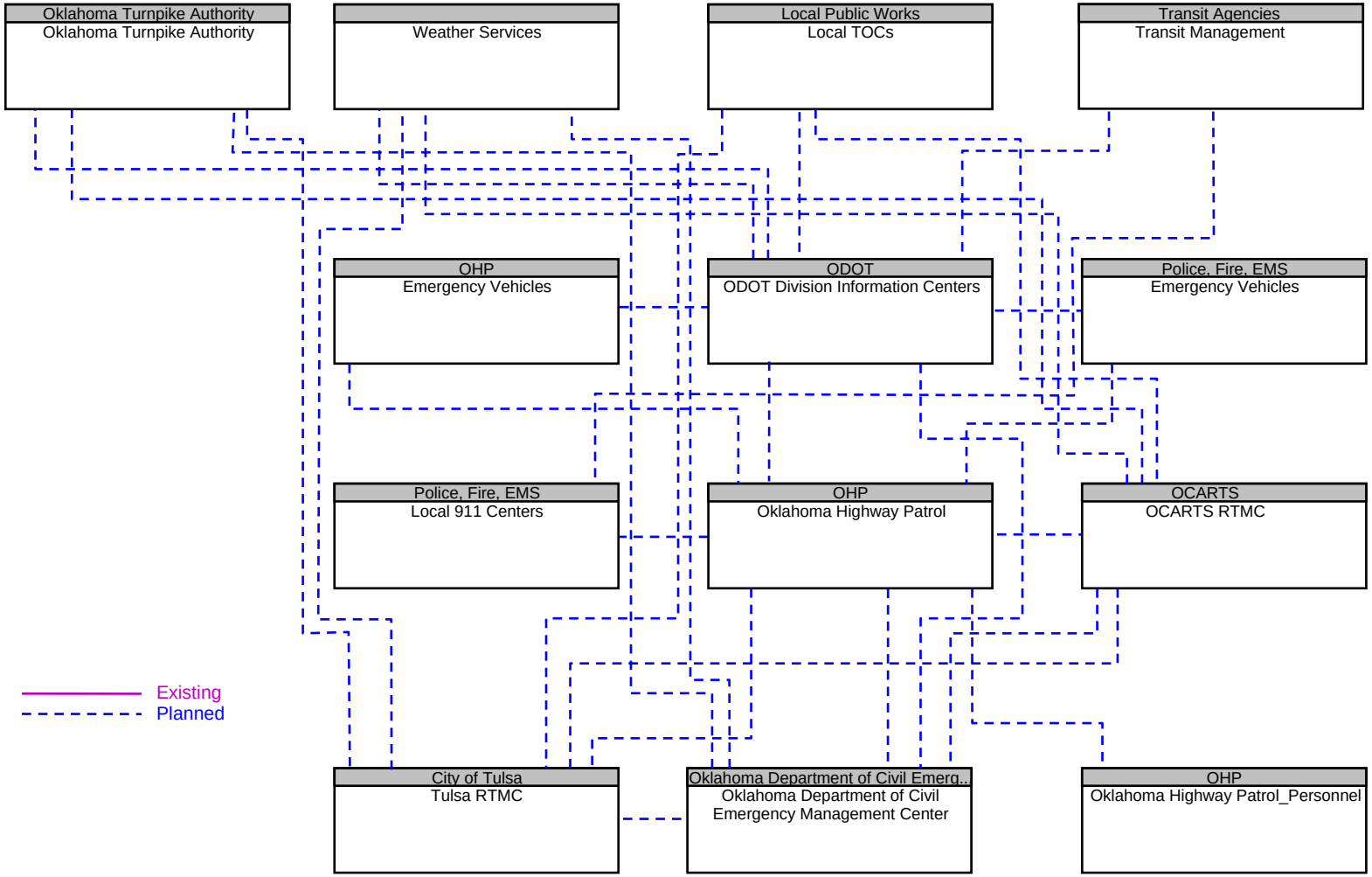


Local Emergency Response System

The Local Emergency Response System operates in various local emergency response centers supporting public safety including police and fire stations, search and rescue special detachments, and HAZMAT response teams. This system interfaces with other emergency management subsystems to support coordinated emergency response involving multiple agencies. The subsystem creates, stores and utilizes emergency response plans to facilitate coordinated response. It tracks and manages emergency vehicle fleets. Real-time traffic information received from the other center subsystems is used to further aid the emergency dispatcher in selecting the emergency vehicle(s) and routes that will provide the timeliest response. Interface with the Traffic Management subsystem (RTMC & TOC) allows strategic coordination in tailoring traffic control to support en-route emergency vehicles. Figure 8 shows the interconnect diagram for participating agencies which includes:

- Local 911
- Local TOC
- Oklahoma Highway Patrol
- Oklahoma Transportation Authority
- STIC
- RTMC
- Transit Management

Figure 8: Emergency Management Interconnect Diagram



Oklahoma Highway Patrol and the local 911 centers will also need to exchange data among its own elements. Figures 9 and 10 depict the data that will be exchanged internally.

Figure 9: OHP Data Flows Diagram

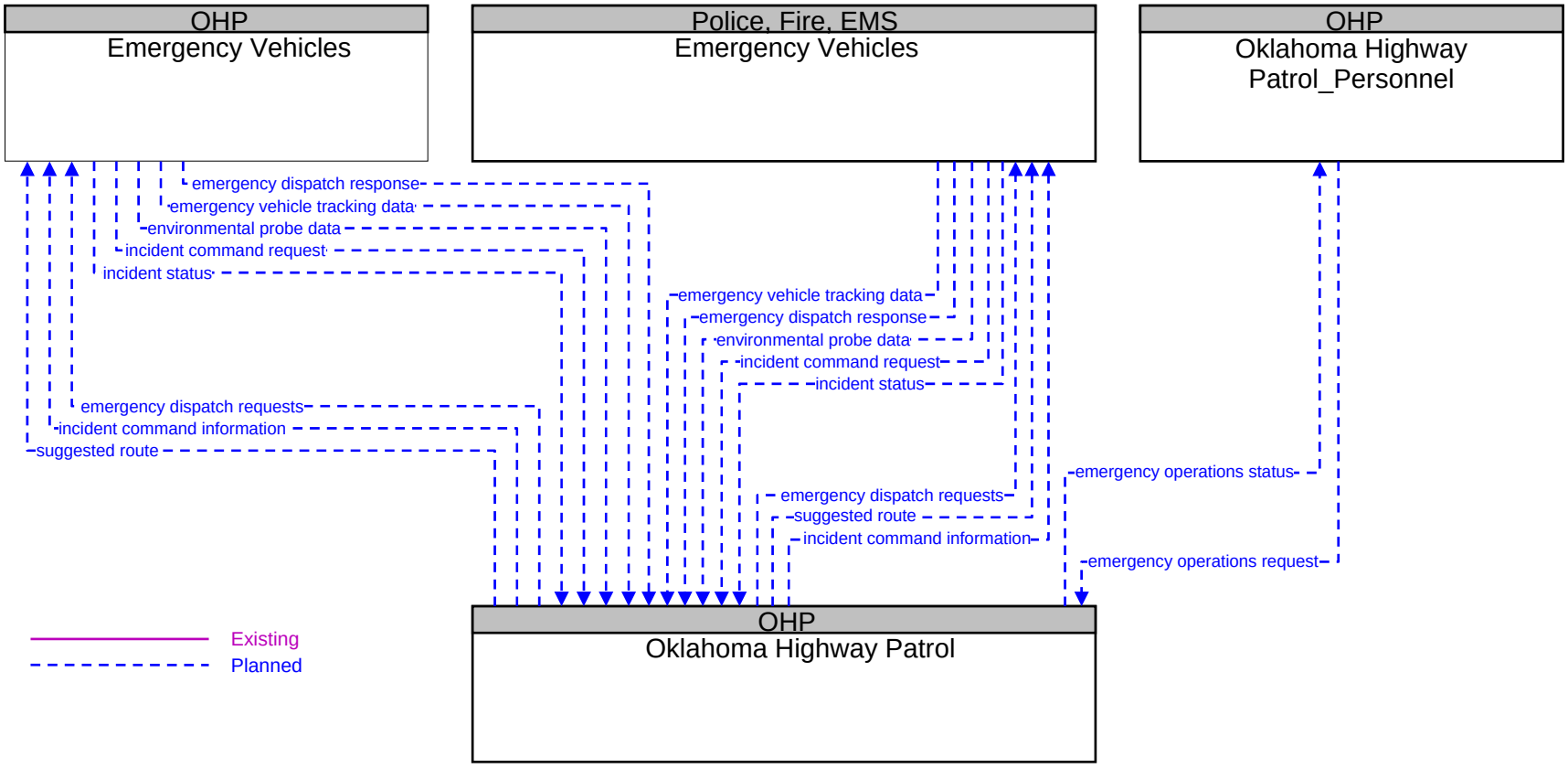
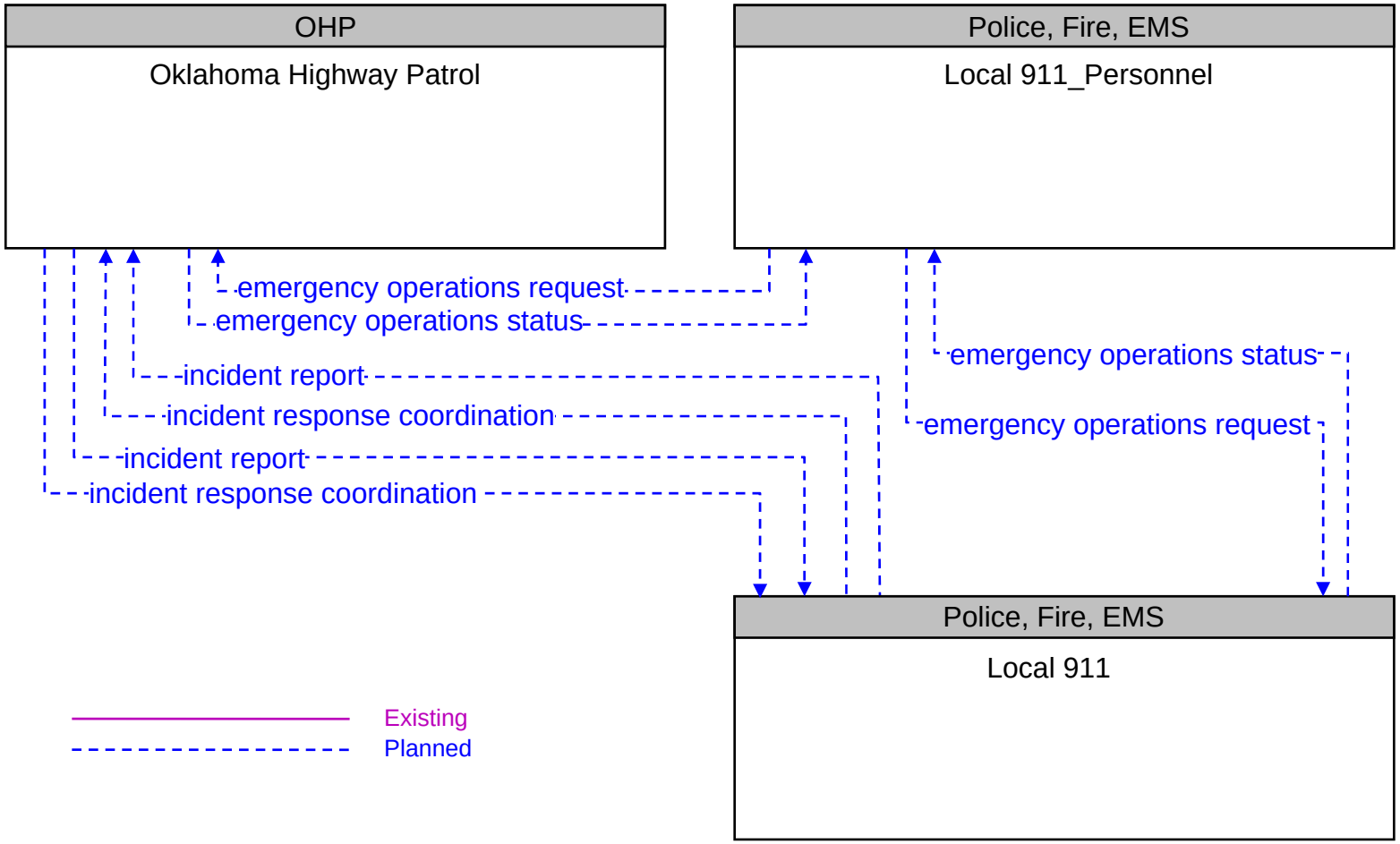


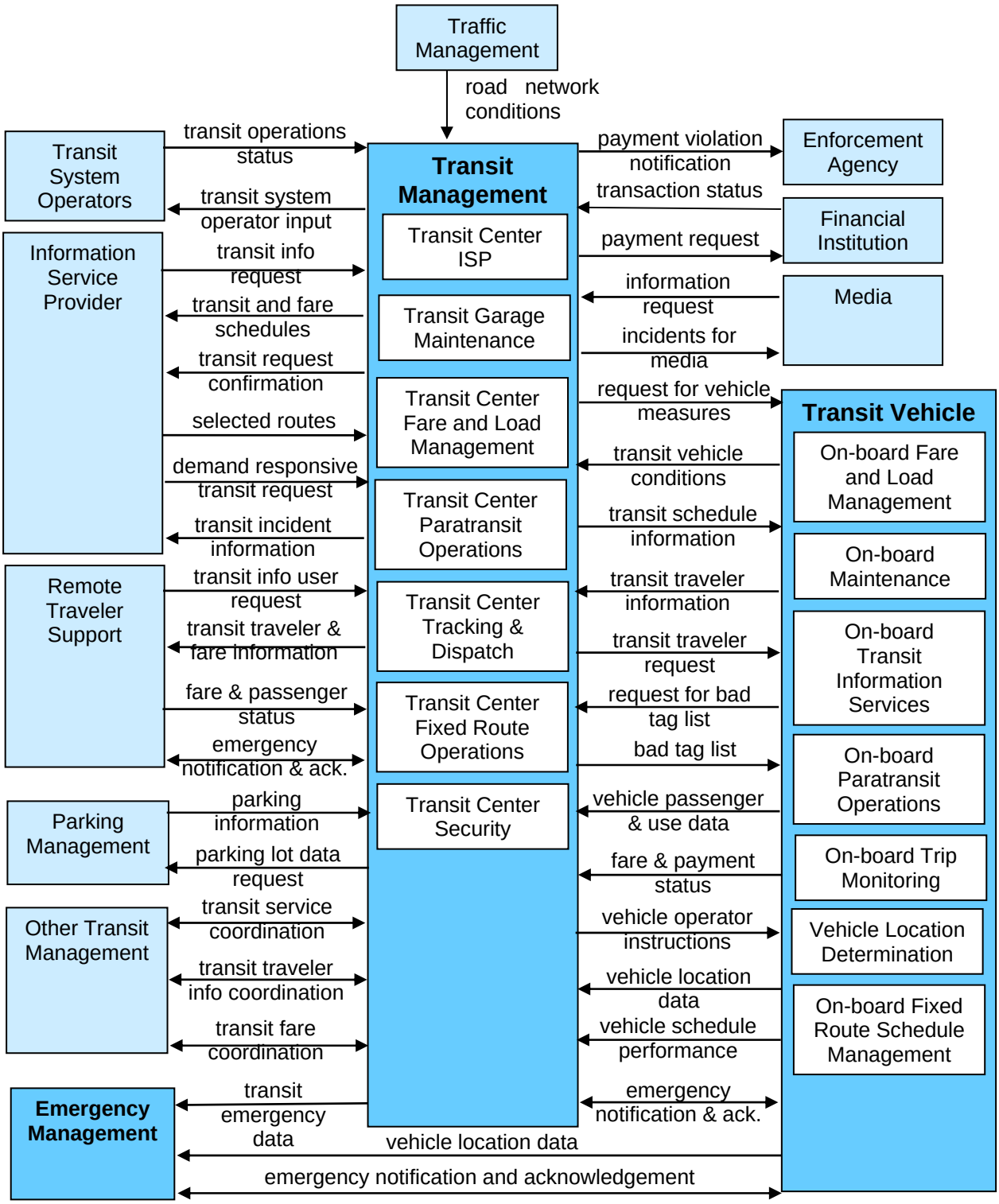
Figure 10: Local 911 Centers Data Flows Diagram



Transit Management

The Transit Management System consists of over 20 agencies operating across the state of Oklahoma. Interface with the Traffic Management subsystem (STIC) allows coordination between agencies. This interface with other transit, transportation and emergency management subsystems will allow the capability of passenger trips across multiple jurisdictions with the use of vehicle tracking technology. Real-time traffic information received from the other center subsystems is used to further the efficiency of transit operations. Connection to emergency dispatcher and the use of vehicle monitoring systems provide the timeliest information for response. On-board maintenance will provide accurate data for vehicle performance and maintenance scheduling. Figure 11 shows the interconnect diagram for participating agencies which includes:

Figure 11: Transit Management Flows Diagram



Commercial Vehicle Operations (CVO)

Commercial Vehicle Operations plays a large role in the state of Oklahoma. A separate business plan has been developed to define the functions of Oklahoma's CVO program. The Oklahoma CVISN Top Level Design Document defines the state's CVO architecture in detail. Oklahoma's CVO program is composed of three subsystems: Commercial Vehicle Administration, Commercial Vehicle Check, and the Commercial Vehicle subsystem. These subsystems will be able to meet Oklahoma's CVO's goal by providing the following capabilities:

- Provide for electronic filing of credentials applications and fuel tax payments; electronic verification of applications and supporting information; electronic payment; and electronic processing / issuance capabilities;
- Electronically exchange information among agencies and other states;
- Electronically access credential and safety status information (snapshots) from the roadside;
- Electronically screen carriers and vehicles for safety and credential compliance at mainline speeds.

The figures which follow provide an overview of the Oklahoma CVISN Design. The key elements included in here are the:

- Oklahoma CVISN System Design Template, showing all of the functional systems involved in CVO data exchange (systems highlighted in yellow are new systems).
- Design For Host Computers And Networks, showing the host computers and networks involved in Oklahoma's CVISN Level 1 deployment; and identifying the "owner" of the systems and the communication links used to connect systems.
- Oklahoma High Level Connectivity Overview, showing the same interfaces as the Host Computers and Networks Diagram, but from a network management perspective.

For more information, refer to the Oklahoma CVISN Top Level Design Description, available from ODOT's Planning and research Division, which contains more detailed information on system interfaces, operational data flows and hardware/software configurations.

Figure 12. Oklahoma CVISN Level 1 Architecture

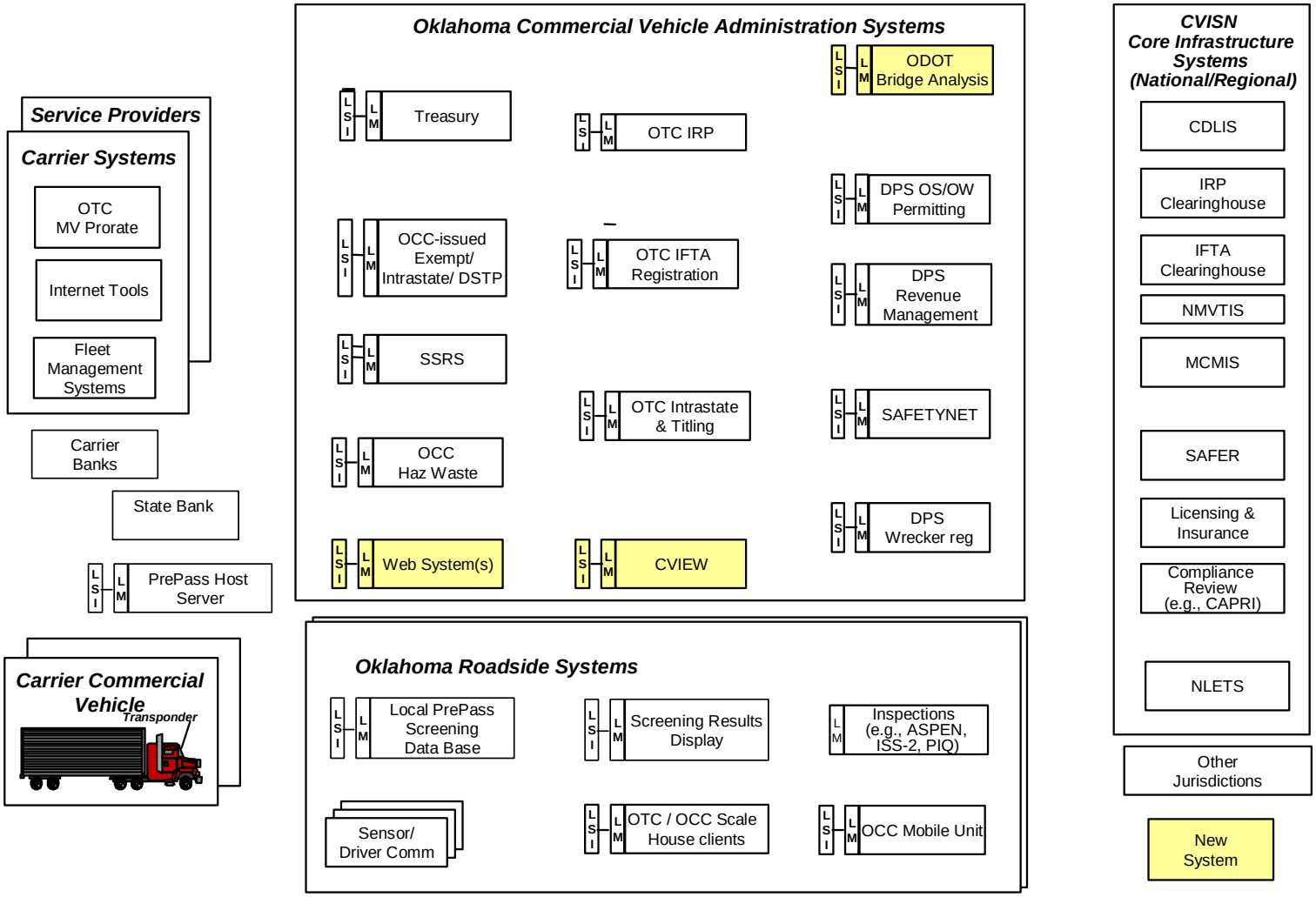


Figure 13. Oklahoma Host Computers and Network Template

(——— Changes Required for CVISN projects)

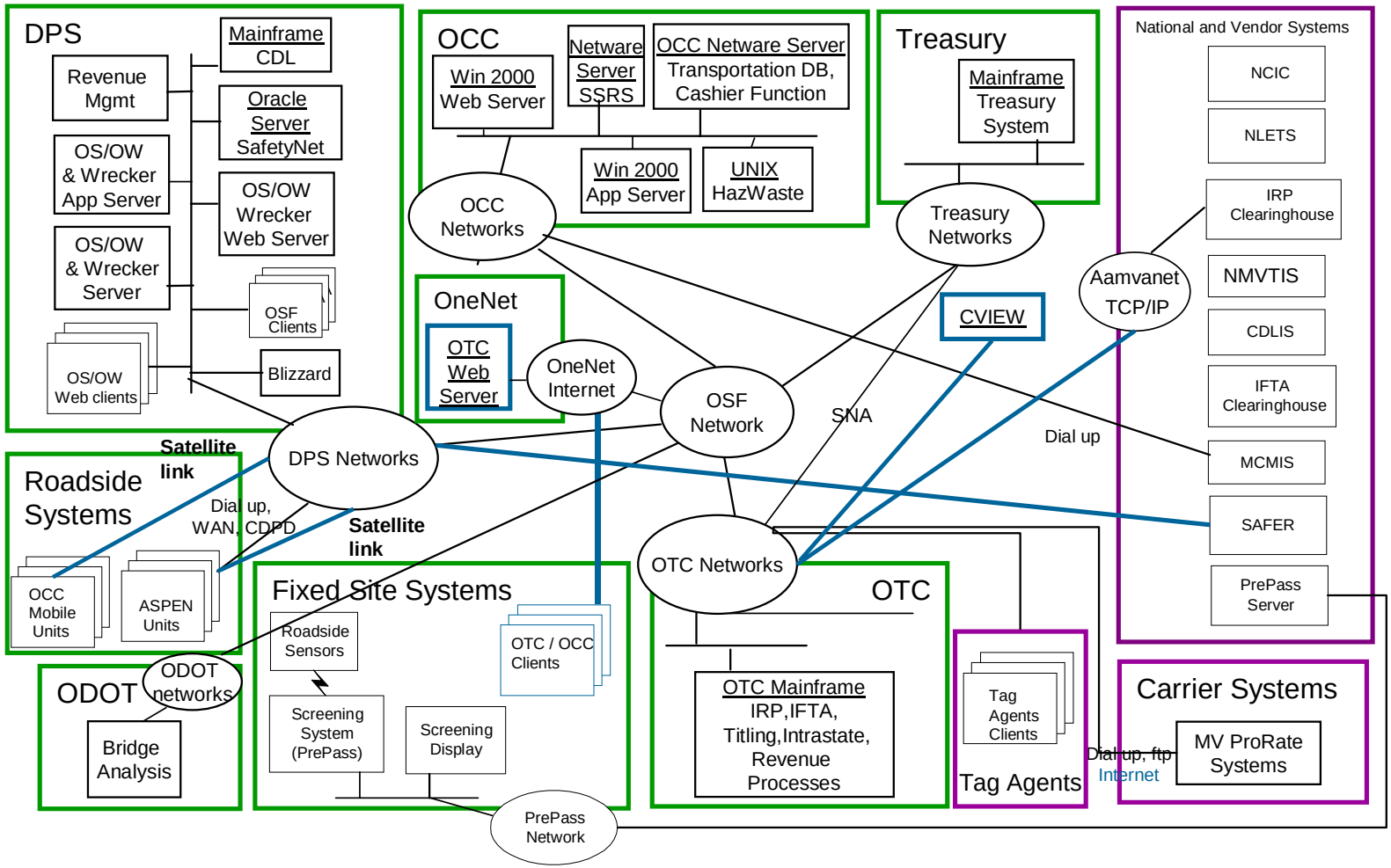
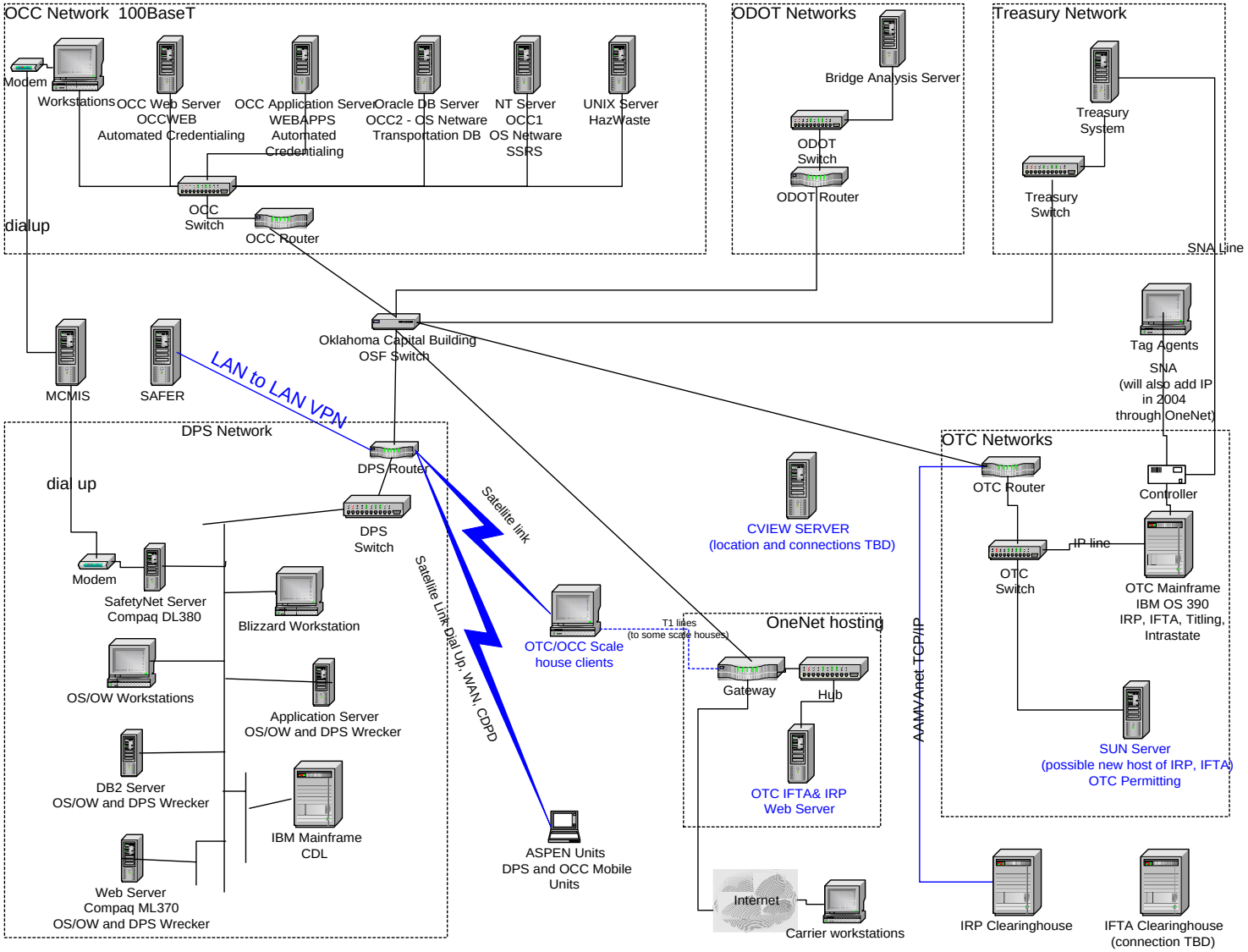


Figure 14. Oklahoma CVISN Physical Design



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2.3 Institutional Layer

The institution layer of the physical architecture defines the relationships among agencies participating in ITS and the operational responsibilities of those agencies. A description of the basic role of agencies participating is in the following paragraphs.

2.3.1 *Oklahoma DOT*

The Oklahoma Department of Transportation is the lead organization responsible for operating and maintaining highway facilities and managing traffic and incidents on the Interstate Highway System. By managing, operating and maintaining a Statewide Transportation Information Center, ODOT will be able to do this more efficiently.

ODOT, through the STIC, will provide transportation information to travelers on the condition of the region's roadways. The type of information that may be provided includes incidents, traffic speeds, and roadway construction. Information could be provided to travelers through private information service providers or via roadside subsystems such as Dynamic Message Signs (DMS) and Highway Advisory Radio (HAR), and traveler information subsystems such as kiosks and an Internet web site.

Via ITS, ODOT can share transportation information electronically with other jurisdictions and agencies. The automatic exchange of information helps coordinate activities and services better, and thus improves rescue operations, increases safety, and provides travelers an improved, seamless transportation system.

2.3.2 *City/County Public Works Departments*

ODOT will not be responsible for managing the local streets; it will be up to the respective cities or counties to operate and manage the TOC's. The local Public Works Departments, which may include a Traffic Engineering Department, are responsible for managing traffic and incidents on the surface street network including the principal arterials that are part of the State Highway System. The cities and counties will collect traffic data from their roadway network, process it, and use the information to manage their transportation system. ITS functions such as Traffic Signal Control and Network Surveillance will help local governments control and manage the flow of traffic on the surface street system. The local TOCs will coordinate and communicate with the RTMC in order to assist regional traffic management.

Local governments will provide transportation information to travelers on the condition of surface streets. The type of information that may be provided includes incidents, traffic speeds, and roadway construction. Information could be provided to travelers via roadside subsystems such as DMS and HAR, and traveler subsystems such as kiosks and an Internet web site.

It is recommended that each city and county Public Works Department share transportation information electronically with other agencies – other local agencies and neighboring jurisdictions. The automatic exchange of information will help agencies coordinate their activities and services better and thus improve rescue operations and increase safety, and provide travelers an improved, seamless transportation system.

2.3.3 *Emergency Service Responders*

In the state of Oklahoma, there are many emergency service providers. With ITS implementation, each emergency service would communicate and coordinate electronically with their local RTMC in detecting, verifying and responding to incidents. The STIC would also communicate and coordinate electronically with freight carriers and the Department of Civil Emergency Management about such incidents.

2.3.4 *Transportation Planning Agencies*

One of the functions performed by the Metropolitan Planning Organization (MPO) is the continued planning of the transportation system. The MPO in the Tulsa Region is the Indian National Council of Governments (INCOG) and in the Oklahoma City Region is the Association of Central Oklahoma Governments (ACOG). The MPOs can be supported by ITS functions that electronically exchange transportation data with the STIC. Access to both real-time and archived electronic data, and the increased amount of data with which to work, will greatly improve the ability of ODOT and MPOs to plan for the current and future demand of transportation services.

Other participating agencies including ODOT, the cities and counties have transportation planning functions that will benefit from the data generated by ITS. The implementation of a virtual data warehouse will provide access to useful data for all participating agencies.

2.4 Communications Layer

2.4.1 *NIA Communications Guidelines*

As defined in the National ITS Architecture, the communications layer is the information transmission infrastructure that connects elements of the transportation layer and allows coordination and sharing of information among systems and people. The National ITS Architecture has identified four communications types for coordination and sharing information among systems. These include wireline communications, wide-area wireless communications, dedicated short-range communications (DSRC), and vehicle to vehicle communications.

Wireline communications addresses information transfer between two fixed entities. Physically, this communications type includes wireline (e.g. fiber optic or twisted pair copper) as well as point-to-point wireless (e.g. microwave) infrastructure.

Wide area wireless communications addresses information transfer between fixed and mobile entities and includes cellular and radio frequency technologies. It supports wide-area communications between mobile users or between mobile and fixed network-connected users. This communications type also includes one-way broadcast wireless voice and data communications systems used to provide basic traveler information across a wide-area.

Dedicated short-range communications (DSRC) is used to communicate short distances (<100 feet) between a vehicle and a roadside device. Examples of DSRC applications are toll tags for electronic toll collection and transponders for commercial vehicles such as used in the PrePass program by the Georgia Department of Safety.

2.4.2 *Interagency Agreements*

It will be necessary for each operating agency to sign agreements that will define the types of information to be shared, system control hierarchy, capital, operating and maintenance costs of facilities shared. Protocol for information exchange within each jurisdiction is to be defined and formalized in an inter-agency memorandum of understanding (MOU) or joint project agreement (JPA). The following information should be defined in MOUs:

1. Information and operating requirements pertaining to various ITS elements such as freeway or arterial (signal) control, dispatch information for emergency management, and transit management,
2. Uses of broadcast and interactive traveler/tourism information,
3. Sharing of responsibilities and costs,
4. Sharing of hardware, communications media, and data, and
5. Standardization.

2.4.3 ***Standards***

The protocol requirements are based on the message type and frequency. Any system command or control will occur in real time and a stable protocol will be required. US DOT is recommending any appropriate standards federally funded for ITS deployment such as the National Transportation Communications for ITS Protocol (NTCIP). Therefore, all systems in the region will be designed for NTCIP (or an equivalent federally adopted standard) compliance of individual elements, based on the maturity of specifications.

There are numerous additional messages that communicate information among the terminators within a subsystem in real time. NTCIP is recommended, although not required, for these communications. There are other messages that are sent with subsystems that will not occur in real time. NTCIP is optional for these non-real time messages. There are other messages to be sent via basic communications media such as telephone, pager, fax, Internet, radio broadcast or television broadcast. These communications do not need any transportation-related protocols.

In general, when a standard is required, this generally means that real-time control is involved, such as surveillance. Life safety may be at stake therefore the standard is categorized as being required.

A recommended standard indicates that data is passed between agencies and those receiving the data should have a common base for understanding its meaning. This is not a control standard, nor is it an issue of life safety.

Standards listed as optional relinquish the decision to those establishing the architecture flow. Communication may be easier with the local standard but it is not necessarily in real-time. Lastly, if no protocol category is listed, no standard currently available is applicable or needed.

In all cases, the protocol suggested is currently in development and adoption phases of the ITS Standards process. Therefore it is possible that a local standard may need to be adopted in the early stages of ITS development and a migration plan be implemented to use the National or International Standard when it is in place. In a migration plan, standards suggested in this section may change as they become standards adopted by the USDOT. The suggested standards will need to be updated to correspond with those regulations. The Intelligent Transportation Systems (ITS) program has placed emphasis on developing national standards for communications. Several standards organizations have been tasked to develop the communications standards necessary to provide system interoperability and seamless communications between systems and subsystems.

- *National Transportation Communications for ITS Protocol (NTCIP)*
  NTCIP development began with the traffic control industry recognizing the need to extend existing standards to include systems interoperability and communications issues. The NTCIP effort is focused on developing communications protocols necessary to “command and control” various ITS devices (DMS, CCTV, traffic signal controllers, etc.).

- *Advanced Traffic Management Systems Data Dictionary (TMDD)*
  TMDD provides unique definition and description of the data elements used in “sharing” data between systems.

- *Advanced Traveler Information System (ATIS)*
  ATIS protocol development focuses on developing standardized message sets used in disseminating traveler information.

- *Transit Communications Interface Profiles (TCIP)*
  TCIP focuses on developing standards for transit communications to various systems.

- *Commercial Vehicle Information Systems and Networks (CVISN)*
  CVISN refers to a collection of information systems and communications networks to support commercial vehicle operations (CVO). The FHWA CVISN program focuses on creating new ways for existing and newly designed systems to exchange information. A component of the CVO part of the National ITS Architecture, CVISN includes standards for communications technologies. These standards efforts are in the infancy stage.

The following lists all the standard documents that are included in the Statewide Architecture:

- ASTM 5 GHz Phys
- ASTM PS 105-99
- ASTM PS 111-98
- ATIS General Use
- ATIS Low Bandwidth
- CEA/EIA-794
- CEA/EIA-795
- DSRC 5 GHz
- DSRC 915MHz
- IEEE IM
- IEEE P1512.1
- IEEE P1512.a
- IEEE P1512-2000
- IEEE P1556
- IEEE Std 1455-1999
- ITE TM 1.03
- ITE TM 2.01
- ITE TS 3.TM
- NTCIP C2C
- NTCIP C2F
- NTCIP 1102
- NTCIP 1103
- NTCIP 1104
- NTCIP 1105
- NTCIP 1106
- NTCIP 1201
- NTCIP 1202
- NTCIP 1203
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- NTCIP 2301
- NTCIP 2302
- NTCIP 2303
- NTCIP 2304
- NTCIP 2305
- NTCIP 2501
- NTCIP 2502
- SAE J1746
- SAE J2313
- SAE J2353
- SAE J2354
- SAE J2369
- SAE J2529
- SAE J254