ALASKA IWAYS ARCHITECTURE UPDATE

September 2022
Version 1.0

Revision History

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V 0.0	September 15, 2022	D. Nguyen	L. Jacobson	Draft for internal review
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List of Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADOT&PF	Alaska Department of Transportation & Public Facilities
AFD	Anchorage Fire Department
AIAS	Alaska International Airport System
AKIA	Alaska Iways Architecture
AMATS	Anchorage Metropolitan Area Transportation Solutions
AMHS	Alaska Marine Highway System
ANSI	American National Standards Institute
APD	Anchorage Police Department
APTA	American Public Transportation Association
ARIA	Anchorage Regional ITS Architecture
ARC-IT	Architecture Reference for Cooperative and Intelligent Transportation
ARRC	Alaska Railroad Corporation
ASC	Alaska Science Center
AST	Alaska State Troopers
ASTM	American Society for Testing and Materials
ATIS	Advanced Traveler Information Systems
AVL	Automated Vehicle Location
C2C	Center-to-Center
C2F	Center-to-Field
CAPRI	Compliance Analysis and Performance Review Information
CAV	Connected (or Cooperative) Automated Vehicle
CBERRRSA	Chugiak/Birchwood/Eagle River Rural Road Service Area
CCTV	Closed Circuit Television
CDL	Commercial Driver's License
CDLIS	Commercial Driver's License Information System
CIP	Capital Improvement Projects
CMP	Congestion Management Plan
CMU	Conflict Monitor Units
CPRM	Certified Public Road Miles
CV	Commercial Vehicle or Connected Vehicle
DHSEM	Division of Homeland Security and Emergency Management
DMS	Dynamic Message Signs
DMV	Division of Motor Vehicles
DOT&PF	Department of Transportation & Public Facilities
DPS	Department of Public Safety

DSRC	Dedicated Short-Range Communications
EAS	Emergency Alert System
EMS	Emergency Medical Services
EOC	Emergency Operations center
EOP	Education and Outreach Plan
ESS	Environmental Sensor Stations
ETMCC	External TMC Communications
F2F	Field to Field
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMS	Field Management Stations
FTA	Federal Transit Administration
GFI	General Farebox Inc.
GIS	Geographic Information System
GPS	Global Positioning System
GTFS	Google Transit Feed Specification
H&SS	Health & Social Services
HAR	Highway Advisory Radio
HSIP	Highway Safety Improvement Program
IEEE	Institute of Electrical and Electronics Engineers
IM	Incident Management
IMT	Incident Management Team
IPEMS	Injury Prevention and EMS
ISO	International Organization for Standardization
ISP	Information Service Provider
ISSD	Information Systems and Services Division
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
IVR	Interactive Voice Response
JBER	Joint Base Elmendorf-Richardson
M&O	Maintenance & Operations
MCM	Maintenance and Construction Management
MCV	Maintenance and Construction Vehicle
MDC	Mobile Data Computers
MMS	Maintenance Management System
MOA	Municipality of Anchorage
MPO	Metropolitan Planning Organization
MS	Message Sets
MSCVC	Measurement Standards and Commercial Vehicle Compliance

MTP	Metropolitan Transportation Plan
NEMA	National Electrical Manufacturers Association
NOAA	National Oceanic and Atmospheric Administration
NTCIP	National Transportation Communications for ITS Protocol
NWS	National Weather Service
OEM	Office of Emergency Management
PMB	Portable Dynamic Message Signs
PTD	Public Transportation Department
RAD-IT	Regional Architecture Development for Intelligent Transportation
RAWS	Remote Automated Weather Stations
RSE	Roadside Equipment
RWIS	Road Weather Information Systems
SAE	Society of Automotive Engineers
SAFER	Safety and Fitness Electronic Records
SCP	Signal Control and Prioritization
SDO	Standards Development Organization
SEOC	State Emergency Operations Center
SET-IT	Systems Engineering Tool for Intelligent Transportation
SPP	Stakeholder Participation Plan
STIP	Statewide Transportation Improvement Program
STIP	Statewide Transportation Improvement Program
TCIP	Transit Communications Interface Profiles
TDP	Transportation Data Programs
TMC	Traffic Management Center
TMCC	TMC Communications
TMDD	Traffic Management Data Dictionary
TOC	Transportation Operations Center
TSS	Transportation Sensor Systems
UPWP	Unified Planning Work Program
USDOT	United States Department of Transportation
USGS	U.S. Geological Survey
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to Vehicle, Infrastructure, or other Devices
WAA	Wide Area Alert
WAN	Wide Area Network
WAW	Wide Area Wireless
WIMS	Weigh-In-Motion Systems

1 Introduction

This report documents the update to the Alaska Iways Architecture (AKIA) for the Alaska Department of Transportation and Public Facilities (ADOT&PF). The AKIA is a statewide ITS (Intelligent Transportation System) Architecture that was initially developed in 2003. ADOT&PF developed the label of Iways to represent the state's ITS. Iways stands for, intelligence, integration, internet, and information (the "I") for air, sea, and roadways (the "ways"). The last update to the AKIA was initiated in 2016 and adopted in 2017. This update reflects changes since that time including:

- Updates to the National ITS Architecture.
- Technologies currently in place and planned to be deployed.
- The stakeholder's understanding and assessment of the needs that can be met using ITS.
- Agency and stakeholder changes.

A second document, the Use and Maintenance guide for the AKIA, is a companion to this report. While this report describes the Iways Architecture itself, the Use and Maintenance document provides guidance to support the use of the architecture and guides the maintainer(s) on how to keep the architecture up-to-date.

1.1 What is ITS?

Intelligent Transportation Systems (ITS) involves the application of advanced sensor, computer, electronic, and communication technologies integrated with the built transportation infrastructure. ITS technologies are deployed to improve the transportation system operations, which includes relieving congestion, enhancing safety, providing traveler information, and many others. Some examples of ITS already in place within the state of Alaska include:

- Public information websites such as the ADOT&PF's 511 website and interactive map depicting roadway driving conditions;
- Weather and pavement detectors that provide real-time information to support winter maintenance operations;
- Computerized traffic detectors, including those that can be managed from a central computer platform; and
- Marine vessel tracking and dispatch systems.

ITS technologies continue to support traffic operations in the state of Alaska today and plans are in place to deploy new technologies and expand applications in the future.

1.2 What is an ITS Architecture?

The term 'architecture' in reference to transportation related computerized systems and technologies, is a framework that describes these inherently complex systems. For ITS, architectures are focused on data flows between elements or systems that may be owned and operated by different agencies or departments and are integrated into an overarching system that aims to improve transportation operations. It takes into account the state's existing resources to effectively meet current transportation needs as well as potential future improvements to the system. ITS architectures include:

- The requirements for defining the connections;

- Documenting the connections; and
- Documenting any supporting resources, such as interagency agreements, that will enable the architecture to be implemented as planned

By creating an ITS architecture, existing resources can easily be identified and future needs and expectations can be planned for.

1.3 FHWA Rule 940 on ITS Architecture Compliance

When ITS was first broadly funded by the Federal Highway Administration (FHWA) in the 1990s, many of the systems that were implemented were not designed to enable access to the data that was used within them. When agencies wanted to use the source or processed data for other purposes, they were not able to do so without either replacing the system, or making a large investment to modify their existing system.

For example, many agencies wanted to extract traffic data from freeway management and traffic signal control computer systems so that the data could be used for other functions such as performance monitoring or planning. However, when the systems were specified, the project requirements only identified the organization's management/operations functions. The systems were thus designed to pull traffic data from detectors *into* the system. Data could not be easily exported from the system. In addition, not all the coordination and integration needs with other systems, such as sharing camera images or dynamic message sign control, were identified or known. Computerized systems and software were new ground for many agencies, and the project development processes in place were not designed to support planning for technologies that might be called upon in the future to provide functions not needed in the original core system.

FHWA responded to this issue by recommending that systems engineering processes, developed for computerized technologies, be applied to plan for potential future integration and data connections. Systems engineering processes include the development of systems architectures.

Because these processes provide such long-term added value, the USDOT further instituted the National ITS Architecture conformity rule (23 CRF Part 940) (and the FTA National ITS Architecture Policy on Transit Projects) requiring that ITS Architectures be completed for certain 'regionally significant' ITS projects if the projects are to be eligible for Federal transportation funding. Today, developing, documenting, and using an ITS Architecture is considered a best practice in the transportation/ITS industry.

1.4 Document Overview

This report is organized to address the key requirements of the FHWA Rule 940, relating to ITS Architectures, and includes:

- Chapter 2 Background
  - This chapter provides an overview of ADOT&PF's ITS program.
- Chapter 3 Processes and Outcomes
  - This chapter focuses on stakeholder activities conducted as a part of the ITS Architecture update project.
- Chapter 4 Operational Concept

- This chapter describes the ADOT&PF Iways Architecture with service area descriptions and data flow diagrams. It includes information on which agencies will fund, own, operate, and maintain the ITS systems as described in the service areas.
- Chapter 5 Interfaces and Information Exchanges
    - This chapter provides an overview of the data flows within the Architecture.
- Chapter 6 Standards
    - This chapter discusses the standards that may be applicable to the data flows identified in the ITS Architecture.

1.5 Scope of the ITS Architecture

The following defines the scope of the ITS Architecture in terms of geography, timeframe, and purpose & objectives.

1.5.1 Description of the Region

The ITS Architecture documented in this report is a statewide architecture for Alaska and is not focused on a specific region within the state. Figure 1 below displays a map of the state of Alaska as well as major transportation travel ways.

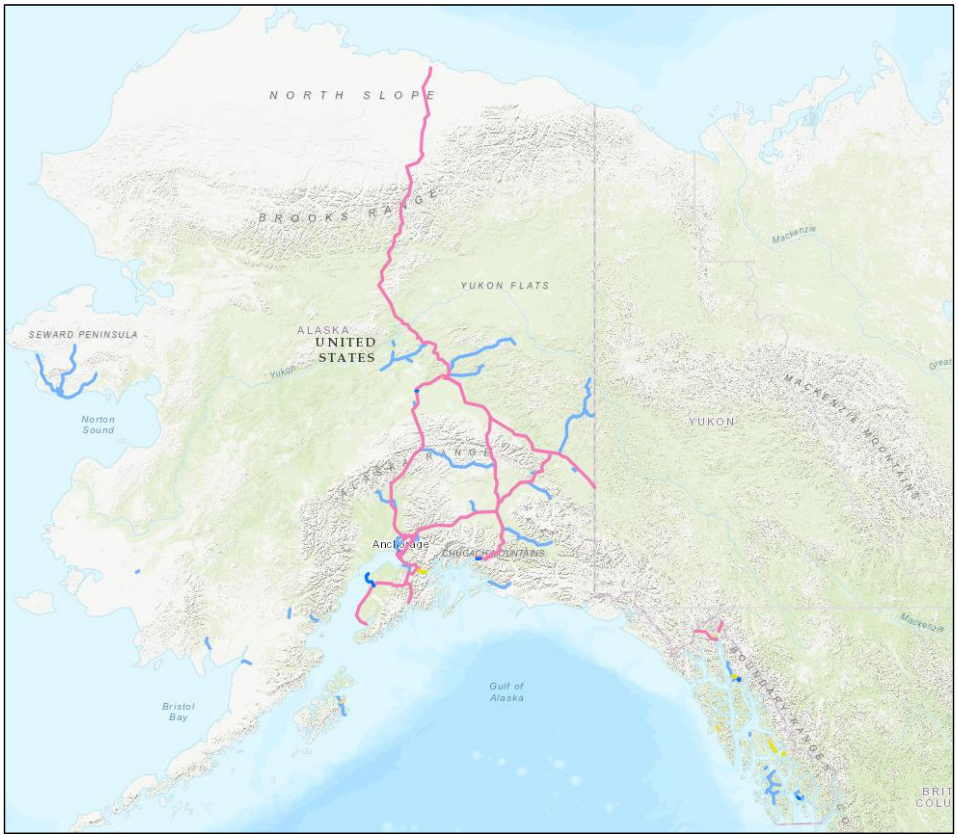

Figure 1. State of Alaska and Major Travel Ways Map

The state of Alaska boundaries encompasses approximately 586,000 square miles of land and is the largest state in the United States. As of 2020 estimates, Alaska has a population of 733,391 where nearly half of those residents live in the Anchorage region.

Alaska is the home to many transportation options including:

- Alaska Railroad Corporation, which services both passenger and freight
- Alaska Marine Highway System, which carries both passengers and automobiles to many of Alaska's coastal communities
- The Alaska International Airport System (AIAS) – comprised of Ted Stevens Anchorage and Fairbanks International Airports

Although Alaska has many unique transportation options for travelers, the state is also a hub to a robust surface transportation system. The surface transportation system includes:

- 16,130 miles of public roads in centerline miles according to ADOT&PF's 2015 Certified Public Road Miles (CPRM) report. ADOT&PF maintains approximately 5,600 miles of those roads.
- Major highways such as the Alaska, Dalton, Denali, Elliot, Glacier, Glenn, Haines, Klondike, Mitkof, Parks, Richardson, Seward, Steese, Sterling, Taylor, Tok Cutoff, Tongass, and Top of the World Highways.
- Signalized intersections on state-owned facilities.
- Remote highways with Portable Dynamic Message Signs (PDMS's) to warn drivers of hazardous driving conditions.

Winter maintenance is a problem unique to Alaska's surface transportation system. Many of Alaska's surface infrastructure are equipped with road weather sensors and anti-icing technology to respond to unsafe conditions. Snow and ice removal on Alaskan roadways is core to maintaining the transportation network.

1.5.2 Timeframe

The planning horizon for the Alaska Statewide Iways Architecture is 5 years from 2022 – 2027. This timeframe takes into account the state's needs and potential implementation funding availability. As a result of the rapid rate of technology advancements, the ability to plan for technology in the long term (10+ years) becomes limited.

Commented [GI(1]: How are we doing within the timeframe

1.5.3 Purpose and Objectives of the Update

The 2016 AKIA report was one large document that detailed ITS goals, ITS functions, and connections between systems that could support those functions. Stakeholder groups, their needs, and vision were also captured in the documents for a comprehensive report of the statewide ITS Architecture. Furthermore, tables of functional requirements, architecture flows, standards, and others made up the bulk of the report. Although the previous document was extensive and all-inclusive, it was also difficult to comprehend. This is largely due to its size because of the number of tables included in the document. In this update, the focus is to:

- Condense the architecture so that it is easy to access and understand.
- Revise the previous AKIA to reflect updates to existing systems, new systems already deployed since the update, planned systems, and stakeholder visions and goals for ITS in the timeframe of this update.
- Reduce unnecessary bulk in the report.
- Update the AKIA to reflect updates to the National ITS Architecture.

Although there are many changes being implemented in this update, the procedures still follow those from the Statewide Alaska Iways Architecture Maintenance Plan developed in 2008. The architecture also meets Federal Rule 940 requirements and is consistent with both the National ITS Architecture and the Anchorage Regional ITS Architecture (ARIA).

The primary purpose of the AKIA is to pinpoint and document potential connections between technological systems and elements of agencies/departments that will enhance transportation operations in terms of efficiency and safety. By identifying these connections, future systems can be implemented with these connections in mind and compatibility concerns can be limited.

Additional objectives for the AKIA update include integrating with and supporting statewide planning, programming, and design processes. Alaska's Statewide Transportation Improvement Program (STIP) provides a set of transportation projects to be implemented within the next several years. These sets of projects contain ITS elements to be deployed which should be consistent to a practical extent with what is shown in the AKIA. The AKIA is also a great source for supporting the programming process of ITS projects by providing information regarding the current status of ITS in the state and identifying planned interfaces with other ITS elements. In project design processes, the AKIA can be of use by identifying stakeholders with whom to coordinate, providing requirements that may be needed for the project, and identifying standards that may be needed for implementation.

Stakeholder involvement is another key objective for this project. Coordination of stakeholders during the update process insured that the architecture provides relevant information that is important to the users. Additionally, the exchange of ideas provided stakeholders a better understanding of the needs of each party and potential future interactions.

The prior update in 2016 was based on the National ITS Architecture version 7.1. The latest version of the National ITS Architecture has been updated to the Architecture Reference of Cooperative and Intelligent Transportation (ARC-IT version 9.1). This new update brings significant expansion of service packages, reorganization of the architecture, new concepts, new information flows, and others. One of the largest changes that came with ARC-IT 9.1 was the inclusion of connected and automated vehicles and sustainable travel concepts. ARC-IT is now organized into 4 views:

- Enterprise View - Describes the relationships between organizations and the roles those organizations play within the connected vehicle environment.
- Functional View - Describes abstract functional elements (processes) and their logical interactions (data flows) that satisfy the system requirements.
- Physical View - Describes physical objects (systems and devices) and their functional objects as well as the high-level interfaces between those physical objects.
- Communications View - Describes the layered sets of communications protocols that are required to support communications among the physical objects that participate in the connected vehicle environment.

ARC-IT is organized by service packages, much like the National ITS Architecture 7.1 was. A new architecture tool was also developed to support the development of new concepts and projects called Systems Engineering Tool for Intelligent Transportation (SET-IT). SET-IT is focused on individual project deployments. It will not be needed for the update to the AKIA.

2 Background

In 2000, Alaska DOT&PF initiated the development of a statewide ITS architecture. As the architecture development process progressed, the benefits attainable from ITS initiatives for the state were made clear. As a result, a regionally specific ITS architecture was created for Anchorage, AK. By developing an architecture that was regionally specific, the needs and requirements of travelers and stakeholders in Anchorage can be better represented compared to a statewide architecture. The two architectures serve as extensions to one another and can be used to compare differences and similarities between statewide and regional needs and requirements.

The initial AKIA was developed based on Version 3.1 of the National ITS Architecture. The update to the AKIA was then made based on Version 5.0. With changes to the National ITS Architecture over time, updates to the AKIA have to be made to keep the information presented relevant. In the 2016 update to the AKIA, user needs were identified based on stakeholder input from various agencies pertinent to statewide transportation operations. ITS solutions were identified that could satisfy the user needs. The ITS solutions were grouped into user services, which are documented in the National ITS Architecture. The user services describe what ITS solutions should achieve with the completion of the architecture to solve the user needs identified. The user services document from the previous AKIA provided the groundwork for the development of the ITS Long Range Vision and Operational Concept. Within the ITS Long Range Vision and Operational Concept documents from the previous AKIA, a total of seven service areas were established as applicable to the stakeholder goals and requirements. The program areas included Traffic Management, Winter Maintenance, Commercial Vehicle Operations and Freight, Public Transportation, Incident and Emergency Management, Traveler Information, and Data Archive. These service areas consist of ITS elements and user services that help satisfy the identified user needs. One of the principle steps in developing the AKIA was to connect the service areas, user needs, user services, and services packages from the National ITS Architecture into one cohesive package.

The development of the 2016 Statewide Alaska Iways Architecture accounted for the needs and requirements of the state. However, as time progressed and technology changed, the architecture had to be adjusted accordingly. This update to the AKIA aims to accommodate for the changes in needs and requirements since the previous update. Since the 20016 update, the National ITS Architecture has been updated with new services, elements, and flows to account for technological innovations over time. The previous update included one document, with unnecessary bulk because of the detailed tables included. The length of the document made it difficult to navigate and comprehend. This AKIA update keeps the single document, but cuts down on the length by leaving out unnecessary tables and pages and makes the remaining text easier to understand. By cutting down on excess pages, the updated AKIA becomes more coherent and will result in a more manageable maintenance process. The update follows the Use & Maintenance Guide adopted in 2017, but with the conversion to the new RAD-IT software, the Use & Maintenance Guide was also updated to reflect those changes.

3 Processes and Outcomes

The AKIA update relies heavily on stakeholder input and coordination to ensure that the architecture reflects their needs. To identify the needs of Alaska's key stakeholders workshop webinars were conducted as input to the update process. The workshop webinars were organized based on the service areas that make up the architecture. Key stakeholders relevant to each service area were invited to review the existing architecture diagrams from the 2016 update. Based on the feedback received from these workshops, changes to the service areas were identified. In addition, the workshops were used to further discuss operations, exchange ideas, and solidify the structure of the architecture. The webinars were implemented based on service areas to provide the relevant information to the correct stakeholder groups. For example, the webinar focused on public transportation may not be completely pertinent to the Measurement Standards and Commercial Vehicle Compliance (MSCVC) group. By organizing webinars in this manner, the use of the stakeholders' time was used more effectively. In addition to the webinars, periodic status updates and communication were completed throughout the process.

Figure 2 displays the AKIA update process with an emphasis on stakeholder involvement. The document review was first conducted to gather the information required to draft the groundwork for update to the architecture. After the initial document review process was completed, the webinars were conducted. Each of the three webinars were focused on a set of service areas and a targeted group of stakeholders. This way, the detailed components of the architectures were reviewed in more detail with the relevant stakeholders. After the webinars, the architecture structure and stakeholder needs were confirmed. The described stakeholder involvement process was part of the stakeholder Education and Outreach Plan (EOP) created for the previous update. More information on the EOP can be found in Section 3.2 Stakeholder Outreach.

Figure 2. AKIA Update Process

3.1 RAD-IT

The Regional Architecture Development for Intelligent Transportation (RAD-IT) is a software application that aids in the development of regional and project ITS architectures based on ARC-IT. This program replaces the Turbo Architecture software. RAD-IT and its predecessor software, Turbo Architecture™, are widely used throughout the U.S. in the development and maintenance of ITS architectures. RAD-IT supports better usability and accessibility to the ITS Architecture. RAD-IT includes all of the service packages and concepts that are in ARC-IT. The update to the Alaska Iways Architecture was implemented in RAD-IT (version 9.1). The software is free and available for download at

Commented [GI(2]: When Will I need to use RAD?

https://www.arc-it.net/html/resources/radit.html

RAD-IT supports the FHWA Rule 940 and the FTA National ITS Architecture Policy on Transit Projects; specifically, it provides:

- Support for defining and documenting Functional Requirements
- Support for documenting Operational Concepts (i.e. Roles and Responsibilities)
- Additional fields in Regional Description to fully define an architecture's scope
- Support for documenting any required or existing Agreements
- Support for identifying any ITS Standards available to support the implementation of the architecture

3.2 Stakeholder Outreach

The AKIA update supports planning, programming, and design processes of ITS projects within the state of Alaska. Stakeholder involvement is a critical constituent of the update process. The AKIA Update Stakeholder Education and Outreach Plan (EOP) was created to involve stakeholders more closely in the project and simultaneously educate them on the process. The EOP also created an opportunity for stakeholders to gather together, exchange ideas, and strengthen relationships where ITS operations are involved.

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The primary tool used in the EOP is the webinar. The webinars are central to the EOP and was used to educate stakeholders on the AKIA update process, solidify concepts, and discuss implementation strategies. These three webinars were held with targeted stakeholder groups relevant to the AKIA service areas discussed in each webinar as shown in Figure 2.

An additional tool used in the EOP is the Iways website. The website serves as an educational tool for stakeholders and the general public. Information relating to the AKIA is shown in plain English with easy-to-follow diagrams that support the understanding of the processes completed in the update.

Furthermore, project coordination was key to the process and to stakeholder outreach. The AKIA consultant team consists of personnel that overlap with those from the ARIA consultant team. By creating a team that is comprised of knowledgeable personnel, project coordination is made more seamless.

3.2.1 Alaska DOT&PF

The Alaska Department of Transportation and Public Facilities (ADOT&PF) has an overall mission to "Keep Alaska Moving through service and infrastructure." ADOT&PF is organized into Statewide and three regional offices in Juneau (Southcoast Region), Fairbanks (Northern Region), and Anchorage (Central Region). Each regional office has planning, engineering, traffic data, and maintenance & operations staff that work to achieve the goals and objectives of the region. Statewide also consists of similar staff.

ADOT&PF is made up of many divisions/sections that specialize in different aspects of Alaska's transportation system. As mentioned, there are regional offices and statewide offices. Statewide functions include commercial vehicle operations and enforcement (Measurement Standards and Commercial Vehicle Compliance) and Alaska Marine Highways staff to support the Regional Offices in meeting the overall mission statement. Each key division within ADOT&PF is treated as a separate stakeholder in this architecture to highlight the interactions and flow of data amongst these divisions along with external flows.

3.2.2 DOT&PF Alaska Marine Highway System

Commented [GI(3]: Are they tied into 511?

The Alaska Marine Highway System (AMHS) is a division of ADOT&PF responsible for transporting people and vehicles via vessels. AMHS is an integral part of Alaska's State highway system because many coastal communities cannot be accessed by a land-based road system. The Alaska Marine Highway System is divided into Southeast Alaska, South Central Alaska, and Southwest Alaska regions.

AMHS currently maintains and operates 11 vessels in their fleet, with additional ferries being planned. Additionally, all 11 vessels are a part of AMHS's Vessel Tracking system. Users can visit the AMHS's Vessel Tracking website to view the last updated location of each vessel, its destination, and other important information. The information is displayed on an interactive map and is updated frequently. The map also displays all of the communities that these vessels serve. The map can be accessed by visiting the following website:

http://www.dot.state.ak.us/amhs/map.shtml

3.2.3 DOT&PF Alaska Railroad Corporation

The Alaska Railroad Corporation (ARRC) is owned by Alaska DOT&PF since 1985, but functions like a private business. The ARRC does not operate on funds coming from the state and employees are not state employees. Rather, ARRC generates revenue through its freight, passenger, and real estate services.

The ARRC has been in operation since 1923 and operates freight and passenger railroad that ranges from Seward to Fairbanks-North Pole. The passenger railroad service operates year-round and serves more than 500,000 users every year. Although ARRC is primarily a public transportation service provider, freight is a large part of their operations as they link ports to major metropolitan areas such as Anchorage.

3.2.4 DOT&PF Aviation and Airports

ADOT&PF's Aviation division and airports are an important part of the state's transportation system. ADOT&PF owns 247 rural airports not including Ted Stevens Anchorage International Airport and Fairbanks International Airport. As part of the stakeholder outreach process, ADOT&PF Aviation, Ted Stevens Anchorage International Airport, Bethel Airport, and Juneau International Airport were included in stakeholder interview groups to gather valuable input. Ted Stevens Anchorage International Airport is the second largest airport in the United States in terms of landed weight of cargo aircraft.

3.2.5 DOT&PF Bridge Design Section

Statewide Design and Engineering Services is one of ADOT&PF's many divisions. The Bridge Design Section is a subdivision of the Statewide Design and Engineering Services division with responsibilities of providing design services and consultant management for bridge construction projects and providing a wide range of services with the existing public highway bridges in the state. The Bridge Design Section also works with the Maintenance & Operations (M&O) staff on bridge repairs.

3.2.6 DOT&PF Transportation Data Programs & Regional Highway Data sections

The Transportation Data Programs (TDP) section is responsible for maintaining transportation information systems. These systems have the purposes of aiding in highway design, operations, and maintenance. Additionally, the management systems support transportation planning by providing crash and traffic data to Department personnel and other government agencies.

In regards to data collection, the Regional Highway Data sections (Northern, Central and Southcoast) collect traffic data where it's uploaded to central information system called Traffic Server. They provide Regional traffic data reports and help generate reports for the annual Highway Performance Monitoring System annual submittal. The TDP manages Traffic Server and administers Federal and State reporting needs. TDP also upload weigh-in-motion (WIM) data into Traffic Server used to support class and volume counts.

Traffic data includes traffic volumes and counts, which is used for populating traffic maps and producing reports and data files. The TDP collects and manages the crash data collection and reporting statewide. Crash data is used in annual publications and is also provided to Traffic & Safety Engineers, the Alaska Highway Safety Office and other agencies as requested. All of the data collected from the section is stored in Oracle Tables and integrated with the Department's GIS linear reference system.

3.2.7 DOT&PF Information Technology Staff

Another division within ADOT&PF includes the Information Technology (IT) Staff. This group works to optimize existing technology and implement new technology to improve the productivity, manage costs, and meet the business needs of ADOT&PF. Specifically, they are responsible for delivering geographic information systems, ITS, software engineering, data center operations, and many others services that are crucial to ADOT&PF operations.

The IT Staff are responsible for managing two statewide ITS systems, Road Weather Information Systems (RWIS) and 511. Their 511 internal reporting system is called RIDE (roadway information description entry). This is essentially an internal 511 for ADOT&PF providing the coordinated exchange of traveler information.

The IT Staff Transportation Geographic Information Section (TGIS) maintains the enterprise geospatial database which houses the public roads network in a linear reference system (LRS). TGIS publish the road network for Department personnel and other agencies. The road network data consists of state and other agency routes along with various attributes such as number of lanes, intersections, mileposts, functional classifications and more. TGIS also maintains a library of route logs and photo logs (via Digital Roadway Viewer) on state routes accessible to Department personnel only.

3.2.8 DOT&PF Maintenance and Operations Division

The state Maintenance and Operations Division is in charge of the daily maintenance and operations of over 5,600 miles of state owned roadways and many other transportation infrastructures. ADOT&PF manages 80 maintenance facilities across the state which are involved in anti-icing, deicing, snowplowing, snow hauling, avalanche control, sign repair, drainage structures, and many other maintenance related responsibilities.

ADOT&PF utilizes ITS in their everyday operations. One example is the usage of Road Weather Information stations (RWIS) to improve efficiency of maintenance processes. RWIS are sensors installed within roadway pavement to collect weather information and conditions. This can be useful for deicing purposes when the pavement reaches certain temperatures. Knowing this, ADOT&PF can take the appropriate actions to combat icy conditions. In some cases, more advanced systems can be utilized. For example, an automatic deicing system on the Glenn Highway Bridge over the Knik River is used to address known icing problems. The department also implements a High Accuracy Differential Global Positioning System (GPS) on many snowplows and snow blowers. This helps with maintenance and operations by providing operators and dispatch real-time information on vehicle location and status so efficiency can be achieved and traveler information can be publicized.

3.2.9 DOT&PF Measurement Standards and Commercial Vehicle Compliance

ADOT&PF's Measurement Standards and Commercial Vehicle Compliance (MSCVC) Division's (formerly the Measurement Standards and Commercial Vehicle Enforcement Division) purpose is to ensure accurate trade measurements and to enforce commercial vehicle regulations. The division can be broken down into a Measurements Standards subdivision and a Commercial Vehicle Compliance subdivision.

The Measurements Standards subdivision is responsible for certifying the accuracy of weighing and measuring devices used in commercial trade. This ensures that there is a level playing field for businesses operating in the state. An example of this is the usage of high capacity vehicle scales, which have specific requirements for design, installation, and calibration for commercial use. Installation of these scales can fall into permanent, temporary, on-road, or off-road categories for different situations. An example of ADOT&PF scales used to measure weights of commercial vehicles is the Weigh-in-Motion System (WIMS). WIMSs allow for vehicle weights to be captured without vehicles having to stop, which allows for more efficient operations.

The Commercial Vehicle Compliance subdivision enforces federal and state commercial vehicle regulations. The ultimate goal is to improve safety by reducing the number of crashes in fatalities relating to commercial vehicles in the state. Enforcement of commercial vehicle regulations could involve inspection at weigh stations, terminal locations, or other applicable sites for size and weight compliancy.

3.2.10 DOT&PF Design & Engineering Services, Traffic & Safety Engineers

Traffic and Safety personnel focus on improving highway safety and operation. Staff is grouped into statewide and regional offices.

The Statewide Traffic and Safety Engineers manage the Highway Safety Improvement Program (HSIP) and develops and implements policy on traffic safety, operation, and traffic control devices.

They produce and maintain the Alaska Traffic Manual, Alaska Sign Design Specifications Manual, traffic-related standard drawings, and the Alaska Highway Safety Improvement Program Handbook. They provide traffic engineering support to regional staff and complete special projects for headquarters management.

The regional Traffic and Safety Engineers manage regional components of the HSIP and provide traffic engineering support to Planning, Preliminary Design, Design, Construction, and Maintenance staff. They see that regional plans and activities comply with applicable traffic control device standards, and provide expertise on safety countermeasures, traffic signals, street lighting, signs, striping, crashworthy hardware, work zone traffic control, capacity analysis, and railroad crossings.

3.2.11 Alaska Division of Public Health

The state of Alaska has a department called the Department of Health and Social Services (H&SS). This state agency is headquartered in Juneau and includes Emergency Medical Services (EMS) and Injury Prevention services. Within this department is the Division of Public Health. The Division of Public Health provides services such as chronic disease prevention, emergency programs, health planning, and many others.

The EMS and Emergency programs provided by this department includes ensuring the availability of EMS personnel, medical care, emergency planning, and emergency transport. The department responds to crashes via radio communications with hospitals and dispatch. This includes interactions with police and fire agencies. The crash data collected is linked to their population-based trauma registry. The data is used to provide information on crash outcomes and circumstances.

The Department of H&SS Injury Prevention and EMS (IPEMS) is also the entity that funded the smart call boxes maintained by the Regional Maintenance and Operation Departments. The smart call boxes allows for travelers to report emergencies to 911 dispatchers at locations where communication mediums are lacking.

3.2.12 Alaska State Emergency Operations Center, Alaska Division of Military & Veteran's Affairs

The Alaska State Emergency Operations Center (SEOC) belongs to Alaska's Division of Homeland Security and Emergency Management (DHSEM). The DHSEM is a division with the Alaska Department of Military and Veteran Affairs. The SEOC has a mission to gather, process, and report emergency information to aid in the support of local communicates in emergency response operations. The SEOC is responsible for responding to requests for support from local Incident Management Teams (IMT's) and also conducts situation assessment and provides reports to a wide variety of agencies and organizations. The center is located on the base at Fort Richardson.

One of the ways the DHSEM and SEOC works toward their mission is to inform the public of emergencies via the Alaska AMBER / Silver Alert system. The Alaska AMBER / Silver Alert system is a partnership between law enforcement agencies, the media, and the public and is an effective way to provide urgent information to the masses. The Emergency Alert System (EAS) is a television and radio broadcast system and is another method used to quickly disseminate alerts. The public can gain more information regarding the alert systems by visiting the state of Alaska website:

http://amberalert.alaska.gov/

3.2.13 Alaska State Troopers

The Alaska State Troopers (AST) is a department within the Alaska Department of Public Safety (DPS). AST's mission is to preserve the peace, enforce the law, prevent and detect crime, and protect life and property. Major components of the Division of AST include the Alaska Bureau of Investigation, Judicial Services, and the Alaska Bureau of Highway Patrol. The Alaska Bureau of investigation is responsible for major crimes and enforcing illegal drug distribution in the state. The Judicial Services component is responsible for prisoner transport. The Alaska Bureau of Highway Patrol keeps Alaska's highways safe by actively monitoring and traversing the highways.

Alaska State Troopers shares data with Emergency Medical Services, ADOT&PF, and other law enforcement agencies. By coordinating with EMS, AST plays a critical role in Alaska's incident and emergency management activities. Examples of data shared with ADOT&PF includes road conditions, crash reports, and traffic incident advisories. AST also inputs this data into ADOT&PF's RIDE system, which is then transmitted into the State's 511 system as a way to disseminate information to the public.

3.2.14 Military Bases

Military presence is primarily in Fairbanks and Anchorage. Near Fairbanks is the Eielson Air Force Base and the Fort Wainwright Army Post. In Anchorage is the Joint Base Elmendorf-Richardson (JBER). Military bases can play a role in Alaska's transportation in more ways than expected. For example, JBER is responsible for the collection of weather data that can be shared with transportation operations centers to improve decision making. They use their RWIS-obtained weather data to provide road condition statuses such as snowy and icy conditions.

3.2.15 Municipality of Anchorage

The Municipality of Anchorage (MOA) comprises 1,961 square miles and is home to nearly half of the State's population. The MOA region has 1,281 miles of Municipal roads with a robust transportation system that warrants its own regional ITS architecture referred to as the Anchorage Regional ITS Architecture (ARIA). The Anchorage region is home to many ITS including Dynamic Message Signs, signalized intersections, GIS, preemption and priority systems, and many others. MOA consists of many departments, divisions, and offices. The municipality departments include the Emergency Management office, Traffic Department, Fire Department, Police Department, the Port of Anchorage, and the Public Transportation Department. Many of Anchorage's departments play a vital role in the statewide transportation scheme. Within the Anchorage region is a federally organized Metropolitan Planning Organization (MPO) called Anchorage Metropolitan Area Transportation Solutions (AMATS), who are responsible for funding Anchorage's transportation system.

3.2.16 MOA Anchorage Police Department

The municipality's law enforcement division is called the Anchorage Police Department (APD). This is the largest law enforcement department in the state. Their mission is to protect and serve the region in a professional and compassionate manner. APD interacts with other agencies outside of the municipality including AST and ADOT&PF divisions to provide crash data and criminal reports. Anchorage produces over 60% of crashes within the state of Alaska. That's about 7,000-8,000 crashes annual. 911 callers within the Anchorage region will be directed to the 911 center operated by APD. APD also plays a role in databases including GIS and mapping capabilities. APD is also responsible for posting messages to Anchorages' two permanent message boards: one located on the Glenn Highway heading north out of Anchorage, and the other on the Seward Highway south of Anchorage. These message boards are displayed on the 511 website. APD Nixle alerts are also automatically sent to the 511 system for the Glenn and Seward highways.

3.2.17 Local Signal Operations Groups

One signal operations group is the Municipality of Anchorage Signal Section which is a part of the MOA Traffic Department. The Signal Section manages 277 signalized intersections, including many ADOT&PF owned signals. MOA's signal section is responsible for the implementation, operation, and maintenance of traffic signals within the Municipality's boundaries. The signal section also provides technical support to ADOT&PF regarding signals. MOA controls their signals centrally, enabling operators at the traffic department office to remotely adjust signal timings and perform other operations.

Another signal group is the Fairbanks Signal Section. The City of Fairbanks owns and maintains 95% of their signals. When a new signalized intersection is constructed, the city enters an agreement with the State to maintain the controllers.

3.2.18 City of Fairbanks

The City of Fairbanks is a municipal government and a home rule city. It is home to approximately 32,070 people per the 2013 US Census. The city is also home to the Fairbanks Emergency Communications Center, Fairbanks Police Department, and the Fairbanks Fire Department. The Emergency Communications Center is staffed 24 hours a day, seven days a week with dispatchers to answer calls relating to emergencies.

Located within the city of Fairbanks is the Fairbanks Metropolitan Area Transportation System (FMATS). FMATS is the Metropolitan Planning Organization (MPO) for the urbanized portion of the Fairbanks North Star Borough, which includes the City of Fairbanks and the City of North Pole. FMATS is responsible for defining a metropolitan planning area (MPA) based on the US Census urban area and that area which is likely to be urbanized within 20 years. The MPA population is approximately 71,824 in an area of about 113 square miles. FMATS is responsible for investing in local multi-modal transportation improvements that work for the betterment of the community. Although FMATS is housed within the City of Fairbanks, it is not considered a department of the city.

3.2.19 National Weather Service (NWS) Alaska Region

The National Weather Service (NWS) is an agency belonging to the National Oceanic and Atmospheric Administration (NOAA). The purpose of the NWS is to provide weather, water, and climate data. This includes forecasts and warnings to protect life and property while enhancing the economy. One way the Alaska Region NWS headquarters achieves this is by presenting the information on their website:

https://www.weather.gov/arh/
From there, users can examine a hazards map, satellite map, radar map, and surface analysis map. On top of that, users can explore forecasts, climate information, weather data, and etc. ADOT&PF's RWIS data is also automatically sent to and processed by the NOAA Meteorological Assimilation Data Ingest System (MADIS). This website can be found at https://madis.noaa.gov/.

4 Operational Concept

An operational concept describes the characteristics of a system. In regards to the AKIA, an operational concept specifically describes how the systems, personnel, and data interact to provide transportation services. FHWA Rule 940 and the FTA policy requires that stakeholder roles and responsibilities be identified in the ITS Architecture. These roles and responsibilities are found within the operational concepts.

The AKIA update uses a combination of the previous Alaska Iways Architecture, the Anchorage Regional ITS Architecture, and ARC-IT as a foundation to describe the current ITS architecture.

4.1 Service Areas of the AKIA Update

ARC-IT defines the term “service package” as a collection of one or more Functional Objects that must work together to deliver a given ITS service and the information flows that connect them and other important external systems. In other words, they identify the pieces of the physical view that are required to implement a particular ITS service. Service packages are implemented through projects (or groups of projects, aka programs) and in transportation planning, are directly related to ITS strategies used to meet regional goals and objectives. This AKIA update uses a combination of the previous AKIA, the ARIA, and ARC-IT as the framework to describe the current AKIA. The information was tailored and customized in a way that incorporates aspects from many different ARC-IT service packages so that it more closely fits the unique Alaskan context. These tailored and customized groupings of service packages are defined as “service areas” within the AKIA to reflect that they are distinct from the ARC-IT service pages. The AKIA is described using the following service areas:

4.1.1 Traffic Management

This service area is focused on the data exchanged between traffic management centers and their respective roadway field devices. The information transferred between these centers and roadway systems support Alaska’s surface street operations. Some of the systems involved in this service area include Closed Circuit Television (CCTV) Cameras, Dynamic Message Signs (DMS), traffic data recorders, and others.

4.1.2 Maintenance

The Maintenance service area is especially important to the state of Alaska. Due to the abundant amount of snowfall and microclimates in the state, environmental sensors, anti-icing, maintenance vehicle on-board systems, avalanche monitoring, and weather related centers make up the core of this service area. Data exchanged amongst the systems include environmental and pavement data, maintenance and construction work plans, and weather information.

4.1.3 CVO and Freight

This service area outlines some of the key data flows pertaining to Alaska’s commercial vehicle and freight operations. ADOT&PF’s MSCVC division plays a large role in this service area. Their centers and roadway systems exchange daily site activity data, violations, and credential information. MSCVC and

Program Development share maintenance of WIM,, and other roadway devices that inspect commercial vehicles in the field and communicate with the appropriate centers. The Federal Motor Carrier Administration and commercial vehicle operators are also included in this service area.

4.1.4 Public Transportation

The state of Alaska's public transportation operations include all of the regionally specific public transit systems such as MOA's People Mover, Juneau's Capital Transit, Fairbanks North Star Borough MACS Transit, Matsu MASCOT Transit, and others. Additionally, AMHS is also included this service area where the focus is to highlight the communication amongst public transit centers, public transit websites, and vehicle/vessel on-board systems.

4.1.5 Incident and Emergency Management

The core of this service area is focused on incident and emergency management centers such as the State Emergency Operations Center (SEOC), law enforcement, and EMS dispatch. During an emergency, these centers are actively communicating and exchanging data with other subsystems. Data relevant to the incident and emergency can be exchanged with emergency vehicle on-board systems, traffic management centers, and traveler information services.

4.1.6 Traveler Information

Traveler Information is a service area that largely depends on subsystems from other service areas. Core traveler information systems such as Alaska's 511 phone and web interface require information from a variety of sources to be able to distribute that information to the public. For example, public transit agencies can provide transit schedule information while AST or other law enforcement can send incident information to the 511 system.

4.1.7 Data Archive

The final service area in the AKIA is focused on coordination amongst the large range of different archives into a more centralized system that can be accessed by authorized agency users. This promotes easier access to information from multiple archives and improving the efficiency in data gathering. Archives that could be involved include the law enforcement crash databases, ADOT&PF's internal 511 system, road weather data, and public transit archives.

4.2 Data Flows and Service Areas

Data flows and service areas were customized to meet the specific needs and requirements of Alaska stakeholders. Each of the service areas outlined in this chapter is presented with the following:

- Narrative
  - A description of the operations concept for the service area;
- Data Flow Diagram
  - A graphical illustration of how data flows amongst computer systems, roadway devices, equipment, and people;

- Roles and Responsibilities Table
    - Summarizes and identifies the roles of each stakeholder involved in the service area in terms of design, implementation, operation, and maintenance;

The operational concepts are also described by Functional Requirements. Functional requirements are high-level descriptions of what each ITS element is supposed to do in a service area. Essentially, it outlines the required tasks of each element to support the ITS services that area is supposed to provide. They also contain the high-level status (e.g. existing or planned) of each element. They are not detailed design requirements.

Functional requirements in ARC-IT act more like a list of options or capabilities that a user may select from for their projects, but are not required to. For example, users can use these functional requirements as a starting point for projects that do not have a Concept of Operations developed yet.

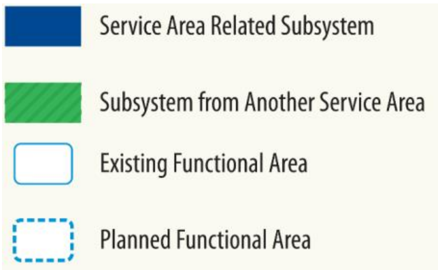
The functional requirement tables can be extracted from the RAD-IT file. For instructions on how to extract the Functional Requirement tables, please reference Section 4.5 in the Used & Maintenance Guide. Alternatively, the Functional Requirements can be viewed in the Functions tab of the RAD-IT file.

Together, these service areas will contribute to the improvement of traffic operations and safety for the state of Alaska in the present and the future.

4.3 Definitions

ARC-IT provides a common language and framework for all ITS. The following provides key definitions to aid in the comprehension of the diagrams presented in this document. Specifically, subsystems and functional areas, architecture (data) flows, and terminators are defined in the list that follows. A more complete list of definitions from ARC-IT can be found in Appendix A: Glossary of Terms.

- Subsystems and Functional Areas
    - Subsystems and Functional Areas are principal structural elements of an ITS Architecture. Subsystems can contain one or more Functional Areas. The Functional Areas represent equipment or data processing components. An example of how a subsystem and functional areas are related is shown:
        - Subsystem: Roadway Devices (field subsystem)
        - Functional Areas: Surveillance Cameras, DMS, Signal Controllers



- Terminator
    - Representations of the people, systems, or general environment that interacts with ITS.

- Architecture Flows
  - Representations of data and/or information that is exchanged between subsystems or between a subsystem and a terminator. They are represented by arrows in the diagrams presented in this document.

4.4 Traffic Management

The existing traffic management system in the state of Alaska consists of communications between centralized computers and roadway equipment such as traffic signal controllers, traffic detectors, and traffic surveillance cameras. The data exchanged amongst these existing systems include collecting traffic data, transmitting traffic images, and altering device configurations to support traffic management operations. To improve on the existing system, this service area proposed to incorporate the usage of connected vehicle roadside equipment and Statewide/Regional Virtual Transportation Operations Center functions.

A key element proposed in this service area is the connected vehicle roadside equipment. With the current state of technology, connected vehicles will soon be commonplace for travelers. The implementation of communication with future connected vehicles is a logical step to improve traffic operations and collect the vast amount of data that will become available with these vehicles.

Statewide/Regional Virtual Transportation Operations Center (VTOC) functions are included in the service area as well. The purpose of the VTOC functions are to streamline traffic management operations to a more centralized center. The VTOC functions can help facilitate data transfer by consolidating from multiple sources, processing, and transfering data such as traffic images and traffic data to multiple destinations such as the SEOC and the 511 system. The VTOC functions will provide a central hub to assist agencies in daily operations and coordinate responses to traffic incidents with the goal of optimizing network performance. The proposed VTOC concept includes both statewide VTOC functions and an envisioned collaboration with MOA for a possible future TOC (either virtual or physical) in the Anchorage region. The statewide VTOC functions could be incorporated in an Anchorage TOC covering both the statewide features and those needed in the Anchorage region.

Table 1. Traffic Management Roles & Responsibilities

Stakeholder	RR Description	RR Status
ADOTPF	Send traffic and road network conditions information to other centers.	Existing
ADOTPF	Send traffic and road network conditions information to other centers.	Existing
ADOTPF	Collect traffic and road network conditions information from roadway sensors and detectors.	Existing

Stakeholder	RR Description	RR Status
ADOTPF/ Information Technology Staff	Collect traffic and road network conditions information from other centers and field devices.	Existing
ADOTPF/ Information Technology Staff	Send traffic and road network conditions information to other centers and to the public.	Existing
ADOTPF/ Transportation Data Programs and Regional Highway Data Sections	Collect traffic sensor information from field devices.	Existing
ADOTPF/ Transportation Data Programs and Regional Highway Data Sections	Send traffic sensor information to traffic centers.	Planned
Combined/ DMS Owners and Operators	Send traffic information to the public via DMS.	Existing
Combined/ DMS Owners and Operators	Initialize, configure, operate, and maintain DMS.	Existing
Combined/ Law Enforcement Agencies	Collect traffic and road network conditions information from other centers.	Existing
Combined/ Law Enforcement Agencies	Send traffic information to DMS.	Existing
Combined/ Public Sector Agencies	Collection traffic and road network conditions information from field devices.	Planned
Combined/ Public Sector Agencies	Send traffic and road network conditions to other centers.	Planned
Combined/ Traffic Signal Owners and Operators	Initialize, configure, operate, and maintain field devices such as traffic detectors, cameras, sensors, and preemption/priority systems.	Existing
Combined/ Traffic Signal Owners and Operators	Collect traffic information from field devices.	Existing
Combined/ Traffic Signal Owners and Operators	Receive and process signal preemption/priority requests.	Existing
Public or Private Sector Agency/	Collect user-supplied traffic data.	Planned
State of Alaska/ Division of Homeland Security and Emergency Management	Collect traffic and road network conditions information from traffic centers.	Existing

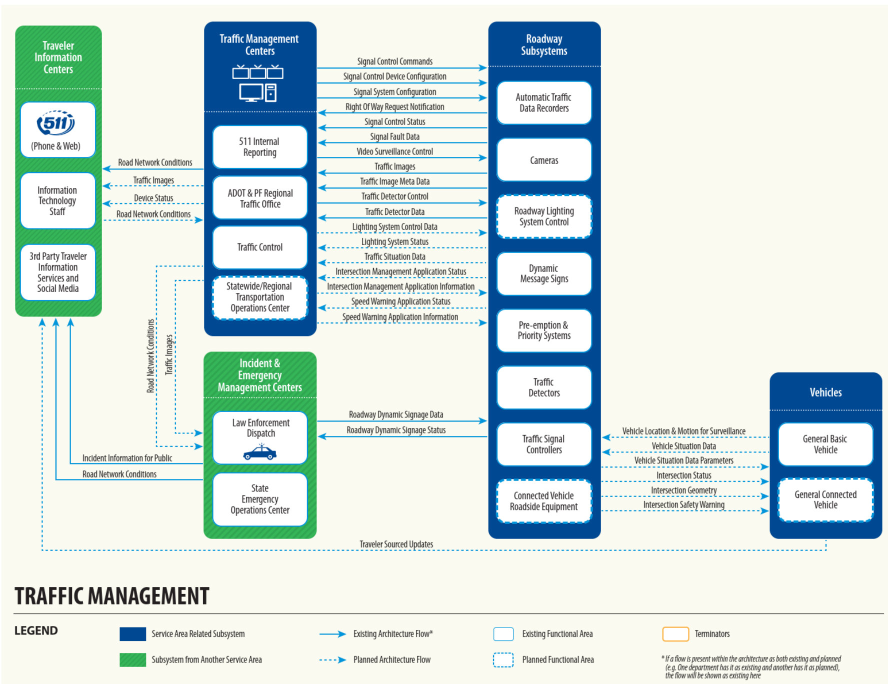


Figure 3. Traffic Management Flow Diagram

A larger version of this flow diagram can be found in Appendix C: Architecture Flow Diagrams.

4.5 Maintenance

The Maintenance service area aims to effectively coordinate maintenance and construction activities in the state, especially when it relates to dealing with winter weather. There are many maintenance vehicles such as snowplows with on-board systems and automatic vehicle location (AVL) technologies that help to improve winter maintenance operations and communications. It is proposed that a road weather data repository be used in conjunction with weather services such as the National Weather Service offices to collect and store weather data. ADOT&PF is currently using a Maintenance Decision Support System (MDSS) in several regions which serves as a weather data repository for the Maintenance and Operations staff. Additionally, more communication and data exchange with a traffic management center can minimize traffic impacts.

The current system involves maintenance centers communicating with roadway devices to collect environmental and road weather data. For example, the network of bridge scour sensors are maintained by the U.S. Geological Survey Alaska Science Center, but data is collected from these sensors by ADOT&PF's Bridge Design Section Offices. The data collected from these sensors can be used to determine when maintenance on bridges are needed when bridge scour becomes a concern. Other maintenance activities include the Road Weather Information System (RWIS) Server collecting data from environmental sensor stations (ESS) across the state.

Snowplows (and other maintenance vehicles) are outfitted with on-board systems and AVL. On-board systems include sensory devices, data processing capabilities, data storage, communication functions that support maintenance activities such as data hubs/cell phones and other devices to transmit data back to a National Center for Atmospheric Research databases in Boulder, CO and in turn to the MDSS. The capability of snowplows or maintenance vehicles with installed/built in sensors to collect weather, environmental and vehicle telemetry data provide maintenance centers with the most up-to-date information on current conditions. Additionally, the vehicle telemetry data provides maintenance centers real-time information on the location, speed and status of vehicles so more timely and informed decisions are made. The Alaska specific MDSS integrates real time weather data collection from fixed RWIS sites as well as mobile weather sensors located on mobile maintenance vehicles to provide weather forecasting for specific locations within a geographic area. In addition to weather forecasting, the MDSS system provides pavement temperature forecasting to maintenance forces. Pavement temperature forecasts are a critical component of the decision making process in responding to winter weather events. The MDSS system also provides treatment recommendations as an additional tool to proof decisions made by maintenance personnel. The maintenance foremen are the final link in the decision process for the pavement treatments radioed to the truck operators.

An element labeled as Road Weather Data is also proposed in this service area. This element is meant to act as an archive data repository to store road weather conditions such as surface temperature, icing, treatment status, and others. This supports maintenance and construction operations by creating a consolidated and robust weather database that is more easily accessible to a wider range of departments if needed.

Communication and coordination with departments outside of the maintenance realm is a goal that is highlighted with the planned flows in the architecture. Communication with traffic management centers such as the proposed Statewide/Regional TOC can help to minimize traffic impacts at locations where maintenance work is being completed. Maintenance and construction work plans can be reviewed by TOCs to determine any traffic impacts and feedback can be provided. Other departments and agencies to coordinate maintenance work plans include the ARRC and AMHS.

Connected vehicle concepts have also been added to this service area. Notably, the connected vehicle roadside equipment has been proposed which allows for the future capability to exchange data with all different types of connected vehicles, including maintenance connected vehicles. The roadside equipment would allow for reduced speed notifications and lane closure information be sent out to connected vehicles approaching a maintenance or construction work zone. Furthermore, connected vehicles (including transit vehicles) with on-board sensors can be leveraged to collect road weather data. Maintenance connected vehicles are also anticipated to communicate with the roadside equipment to maximize efficiency in operations.

Table 2. Winter Maintenance Roles & Responsibilities

Stakeholder	RR Description	RR Status
ADOTPF	Collect and distribute maintenance and construction information.	Existing
ADOTPF	Collect and send maintenance and construction asset/equipment information.	Existing

Stakeholder	RR Description	RR Status
ADOTPF/ Alaska Marine Highway System	Communicate with maintenance centers regarding maintenance and construction activities that may affect AMHS operations.	Planned
ADOTPF/ Alaska Railroad Corporation	Communicate with maintenance centers regarding maintenance and construction activities that may affect ARRC operations.	Planned
ADOTPF/ Bridge Design Section	Collect, process, and distribute information received from bridge scour sensors.	Existing
ADOTPF/ Information Technology Staff	Collect maintenance and construction information from maintenance centers.	Existing
ADOTPF/ Information Technology Staff	Collect and distribute roadway weather information.	Existing
ADOTPF/ Regional Highway Construction Section	Gather and send maintenance and construction information such as work plans, maintenance activities, and asset information.	Existing
ADOTPF/ Regional Maintenance and Operations Districts	Gather and send maintenance and construction information such as work plans, maintenance activities, and asset information.	Existing
ADOTPF/ Regional Maintenance and Operations Districts	Collect road weather information via the RWIS system including the central server, environmental sensor stations, and weather and pavement sensors.	Existing
ADOTPF/ Regional Maintenance and Operations Districts	Collect and send maintenance, construction, vehicle location, and weather information via maintenance vehicle on-board systems.	Existing
ADOTPF/ Regional Maintenance and Operations Districts	Initialize, configure, operate, and maintain field devices such as weather and pavement sensors and automated bridge anti-icing systems.	Existing
Combined/ Law Enforcement Agencies	Communicate with maintenance and construction centers to coordinate with maintenance and construction activities.	Existing
Combined/ Public Sector Agencies	Communicate and coordinate with maintenance centers regarding work plan and maintenance activities.	Planned
Combined/ Traffic Signal Owners and Operators	Collect traffic information from field devices.	Planned
Combined/ Traffic Signal Owners and Operators	Initialize, configure, operate, and maintain field devices.	Planned
Combined/ Traffic Signal Owners and Operators	Receive and process signal preemption/priority requests.	Planned
Combined/ Weather and Pavement Sensor Owners	Maintain and operate weather and pavement sensors.	Existing
DMVA/ Department of Homeland Security and Emergency Management	Collect current asset restrictions information from maintenance centers.	Existing
National Center for Atmospheric Research/	Collect and send weather information.	Existing
NOAA/ National Weather Service (NWS) Alaska Region	Collect and send weather information.	Existing
U.S. Geological Survey/ Alaska Science Center	Initialize, configure, maintain, and operate the bridge scour system and sensors.	Existing

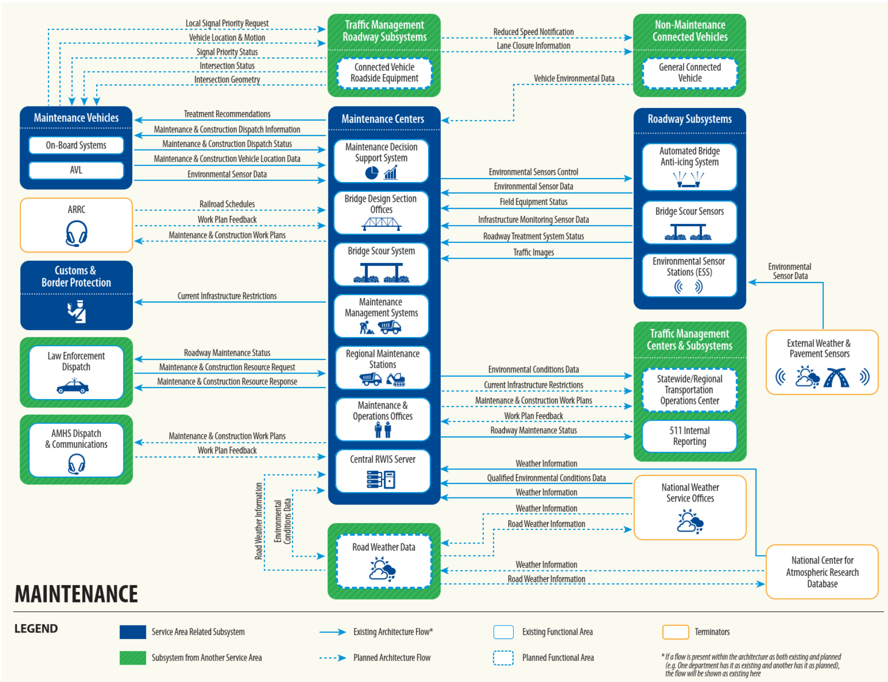


Figure 4. Winter Maintenance Flow Diagram

A larger version of this flow diagram can be found in Appendix C: Architecture Flow Diagrams.

4.6 CVO and Freight

This service area summarizes the commercial vehicle and freight operations in the state and proposes new elements and flows that could improve efficiency and effectiveness. The proposed data flows include the flows between ADOT&PF's 511 Internal Reporting and commercial vehicle operation offices and motor carriers to integrate traffic and commercial vehicle operations.

A planned element to be implemented by ADOT&PF's MSCVC division is the extended online permit system. The Permitting Program was formally referred to as the Single and Extended Permit Process (SEPP). The Permitting Program is an electronic oversize and overweight permitting system and expands on the capabilities of the SEPP. Within the Permitting Program is the Temporary Registration for Trucks (TRT) system.

The 511 Internal Reporting system can be used to send alerts and advisories of traffic related incidents to motor carriers and commercial vehicle operation offices. This can help these respective entities adjust their operations accordingly and adapting to real time incidents. Additionally, these motor carriers and commercial vehicle operation offices can send information regarding their fleet, freight, and equipment information so that the traffic management entities can grab that information from the internal 511 reporting system and adjust their operations accordingly.

The Alaska Court System has been added to this service area to show the future potential to electronically transfer citations. The Weight Restrictions Map has also been added. The Weight Restrictions Map is a collaboration between the state's GIS section and Maintenance and Operations districts to feed information such as weight restrictions into MSCVC subsystems.

Table 3. CVO and Freight Roles & Responsibilities

Stakeholder	RR Description	RR Status
ADOTPF/ Bridge Design Section	Send bridge tolerances information.	Existing
ADOTPF/ Information Technology Staff	Collect fleet and freight information including daily site activities.	Planned
ADOTPF/ Measurement Standards and Commercial Vehicle Compliance	Collect fleet and freight information via roadway systems such as weigh stations, inspection, WIM, and other computerized systems.	Existing
ADOTPF/ Measurement Standards and Commercial Vehicle Compliance	Process, archive, and distribute fleet and freight information including daily site activities.	Existing
ADOTPF/ Measurement Standards and Commercial Vehicle Compliance	Collect and process safety information.	Existing
ADOTPF/ Measurement Standards and Commercial Vehicle Compliance	Collect, process, and distribute commercial vehicle credential and safety information.	Existing
ADOTPF/ Measurement Standards and Commercial Vehicle Compliance	Send commercial vehicle citation and violation information.	Existing
ADOTPF/Transportation Geographic Information Section	Initialize, configure, maintain, and operate the weight restrictions map.	Existing
Combined/ Weight Restriction Map Collaborators	Initialize, configure, maintain, and operate the weight restrictions map.	Existing
Combined/ Weight Restriction Map Collaborators	Send weight restrictions information.	Existing
Commercial Vehicle Operators/ Motor Carriers (Any)	Provide fleet and freight information including identification and equipment information.	Existing
Commercial Vehicle Operators/ Motor Carriers (Any)	Send on-board vehicle information and trip log data.	Existing
Federal Motor Carrier Safety Administration/	Collect and distribute safety and credential information.	Existing
State of Alaska/ Alaska Court System	Receive citation information	Planned
State of Alaska/ Department of Public Safety	Receive citation information.	Existing

Stakeholder	RR Description	RR Status
State of Alaska/ DOA/ Division of Motor Vehicles	Collect credential information including commercial driver's license data.	Existing

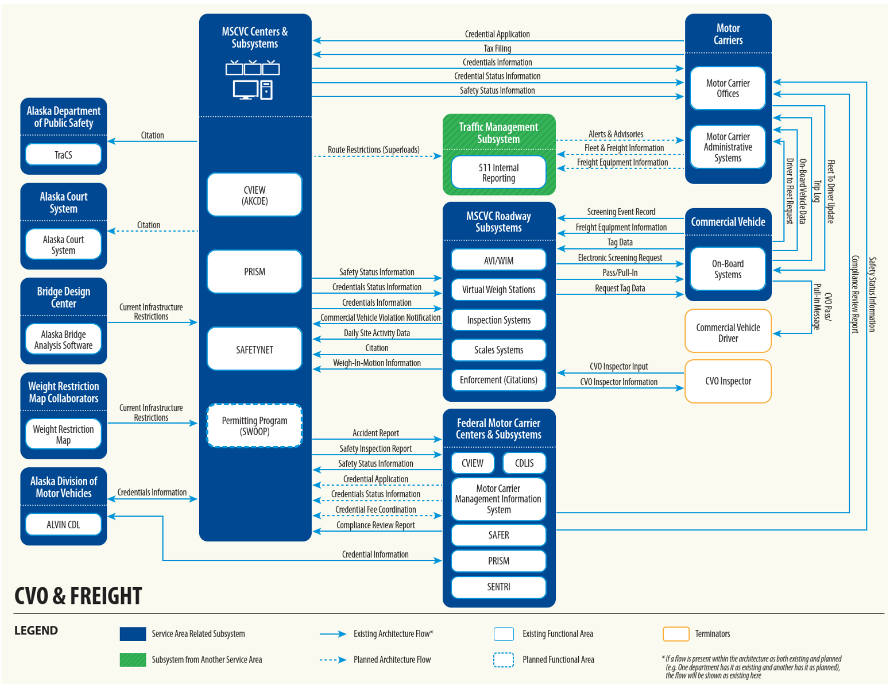


Figure 5. CVO & Freight Flow Diagram

A larger version of this flow diagram can be found in Appendix C: Architecture Flow Diagrams.

4.7 Public Transportation

The public transportation aspect of this service area is comprised of many regional/local public transit agencies and the AMHS. The existing service area is mainly made up of the center to roadway and center to vehicle data connections. Public transit agencies and Alaska Marine Highways are shown to operate in a very similar fashion. The main difference is that there is a dedicated Vessel Tracking System for AMHS shown in the service area as well as surveillance cameras at AMHS terminals operated by staff, security, and local law enforcement. It is proposed in this service area that a statewide/regional TOC play a larger role in transit operations.

Some of the proposed/planned data flows shown between the statewide/regional TOC and the public transportation centers include traffic images, incident information, and transit schedules. Public transit agencies can benefit from receiving traffic images and incident information from the traffic management side because they can use that real-time information to adapt to changing conditions and more effectively utilize their fleets. Even if no action can be made to a disruptive traffic condition, public transit agencies can use that information to better inform their riders of an incident. On the other side, traffic operation centers can use public transportation schedules to coordinate how to best mitigate traffic impacts. Both sides can benefit from this exchange of information.

Public transit vehicle on-board systems and AVL is another key aspect to this service area. Many of the public transit agencies already have robust on-board systems and vehicle tracking technology implemented in their operations. Other agencies are at varying stages of deploying that component into their system. The flow diagram shows that these flows exist between the vehicles and the centers even though some agencies may not have that technology at this point.

Connected vehicle concepts have also been added to this service area. Notably, the connected vehicle roadside equipment has been proposed which allows for the future capability to exchange data with transit connected vehicles. The roadside equipment would allow transit connected vehicles to communicate with the roadside equipment to maximize efficiency in operations.

Table 4. Public Transportation Roles & Responsibilities

Stakeholder	RR Description	RR Status
ADOTPF/ Alaska Marine Highway System	Maintain and operate a vessel tracking system.	Existing
ADOTPF/ Alaska Marine Highway System	Collect and send ferry location, schedule, incident, and service information.	Existing
ADOTPF/ Alaska Marine Highway System	Maintain cameras at AMHS terminals.	Existing
ADOTPF/ Information Technology Staff	Receive transit incident and service information.	Existing
ADOTPF/ Information Technology Staff	Receive transit vehicle location and schedule information.	Planned
Combined/ Law Enforcement Agencies	Operate cameras at AMHS terminals.	Existing
Combined/ Law Enforcement Agencies	Collect and send incident and emergency information.	Existing
Combined/ Public Sector Agencies	Send traffic and incident information to transit centers.	Planned
Combined/ Traffic Signal Owners and Operators	Receive transit vehicle location, schedule, incident, and service information.	Planned
Combined/ Traffic Signal Owners and Operators	Receive and process signal preemption/priority requests.	Existing
Combined/ Traffic Signal Owners and Operators	Send intersection information.	Planned
Combined/ Transit Agencies	Collect and send transit vehicle location, schedule, incident, and service information.	Existing

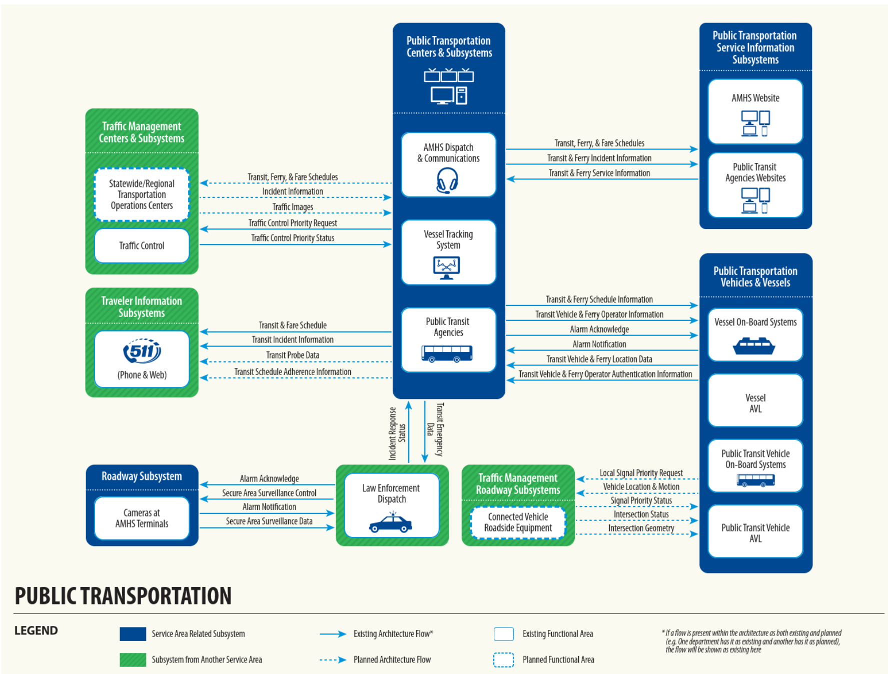


Figure 6. Public Transportation Flow Diagram

A larger version of this flow diagram can be found in Appendix C: Architecture Flow Diagrams.

4.8 Incident and Emergency Management

Incident and emergency management is a critical component of any transportation system. For the state of Alaska, the existing elements and systems consist of the regional 911 system, law enforcement dispatch, EMS dispatch, the State Emergency Operations Center (SEOC), and the communication and data exchanged with other systems and centers. These incident and emergency centers communicate and coordinate with the appropriate agencies during an emergency to gather information and respond to an incident. For ADOT&PF, adverse weather and snowfall is a concern throughout the year. As such, an Avalanche Detection System is shown as planned in this service area to support in early detection and incident mitigation. As with many of the service areas, a connection with a statewide/regional TOC can be beneficial and therefore proposed in this area as well.

The Avalanche Detection System is a GIS-based avalanche prediction system. The system will consist of remote automated weather stations (RAWS) installed in areas that may be prone to avalanches. This system can potentially integrate with the RWIS program to collect data and provide a forecast of potential avalanche occurrences. The data collected from this system would then be sent to the appropriate emergency management and winter maintenance centers. In the architecture, the Regional Maintenance Stations and the SEOC are shown to be the proposed recipients of this data.

The proposed statewide/regional TOC is a large part of the architecture in general. The same can be said about its role in this service area. During an emergency or incident, the exchange of emergency and traffic data can be crucial. The emergency management centers can provide information on the incident and the response status. In return, the TOC can provide emergency routes, emergency traffic control information, and traffic images so emergency centers can get the latest traffic conditions. The information sent from the emergency management centers can also be sent to the internal 511 system so other departments and agencies can be kept up to date on the incident. Additionally, the statewide/regional TOC can forward the emergency information received to other centers and the 511 phone and web system so the public can be informed.

The concept of using drones to assist in incident and emergency response has been included as a part of the EMS, law enforcement, and other emergency vehicle elements. The use of drones allows for the emergency responders to quickly gather information at an incident site in ways that a traditional emergency vehicle may not be able to.

Table 5. Incident & Emergency Management Roles & Responsibilities

Stakeholder	RR Description	RR Status
ADOTPF	Collect incident and emergency information.	Existing
ADOTPF	Send incident and emergency information.	Existing
ADOTPF	Coordinate incident and emergency response.	Existing
ADOTPF/ Alaska Marine Highway System	Send incident and emergency information to emergency management centers.	Existing
ADOTPF/ Alaska Railroad Corporation	Send incident and emergency information to emergency management centers.	Existing
ADOTPF/ Information Technology Staff	Collect and distribute incident and emergency information.	Existing
ADOTPF/ Information Technology Staff	Collect and send avalanche data including monitoring sensor data and incident information.	Planned
ADOTPF/ Information Technology Staff	Collection and send emergency traffic control information in the Anton Anderson Tunnel.	Existing
ADOTPF/ Regional Highway Construction Section	Send construction and work zone information to emergency management centers.	Existing
ADOTPF/ Regional Highway Construction Section	Communicate with emergency management centers.	Existing
ADOTPF/ Regional Maintenance and Operations Districts	Send real time road weather data.	Planned
ADOTPF/ Regional Maintenance and Operations Districts	Collect and send avalanche related data including monitoring sensor and incident data.	Planned
ADOTPF/ Regional Maintenance and Operations Districts	Communicate with emergency management centers.	Existing
Combined/ Law Enforcement Agencies	Collect and distribute incident and emergency information.	Existing
Combined/ Law Enforcement Agencies	Communicate and coordinate with other centers for emergency response.	Existing
Combined/ Law Enforcement Agencies	Collect law enforcement vehicle location data via on-board systems.	Existing
Combined/ Public Sector Agencies	Communicate and coordinate with incident and emergency centers and response teams.	Planned

Stakeholder	RR Description	RR Status
Combined/ Public Sector Agencies	Send traffic and road network conditions information.	Planned
Combined/ Public Sector Agencies	Send incident and emergency information.	Planned
Combined/ Public Sector Agencies	Distribute emergency traveler information.	Planned
Combined/ Traffic Signal Owners and Operators	Receive and process emergency preemption requests.	Existing
Combined/ Transit Agencies	Communicate and coordinate with incident and emergency centers and response teams.	Existing
Combined/ Transit Agencies	Distribute transit emergency data.	Existing
EMS Providers/	Communicate and coordinate with other centers for emergency response.	Existing
EMS Providers/	Collect emergency vehicle location data via on-board systems.	Existing
EMS Providers/	Collect and distribute incident and emergency information.	Existing
NOAA/ National Weather Service (NWS) Alaska Region	Send weather information.	Existing
State of Alaska/ Division of Homeland Security and Emergency Management	Broadcast incident and emergency information.	Existing
State of Alaska/ Division of Public Health	Communicate and coordinate with other centers for emergency response.	Existing
State of Alaska/ Division of Public Health	Collect and distribute incident and emergency information.	Existing

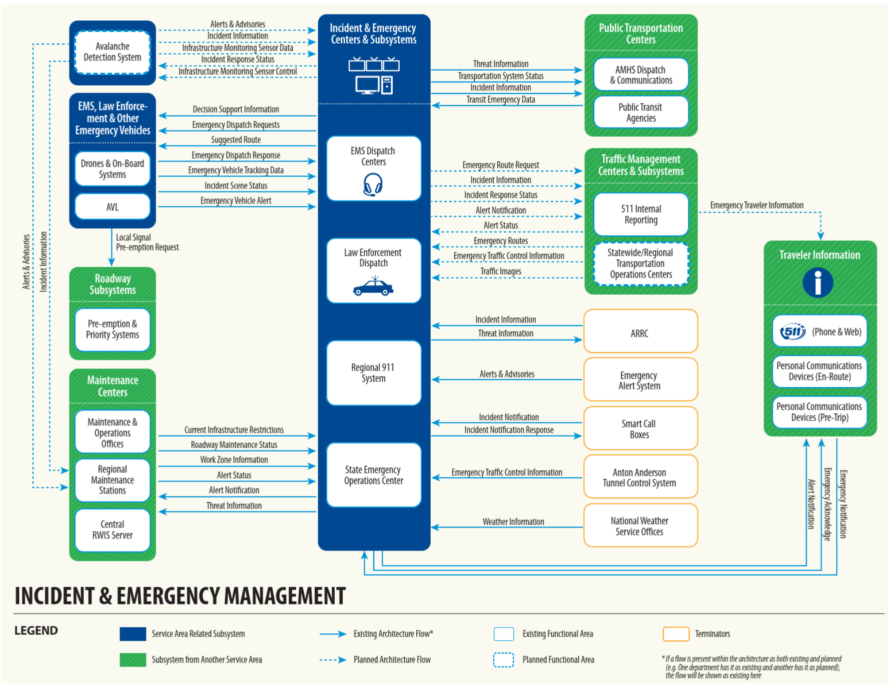


Figure 7. Incident & Emergency Management Flow Diagram

A larger version of this flow diagram can be found in Appendix C: Architecture Flow Diagrams.

4.9 Traveler Information

One of the main ways for the public to obtain traveler information is through the state's 511 phone, smartphone app and web interface. Users can go on the website to view an interactive map that shows current driving conditions, traffic images, weather information, planned events, etc. Users can also use the 511 phone system with either voice or touch-tone commands to find the information they need. Currently, there are links that direct users to the various public transit websites including AMHS. The service area proposes that there is more integration between the 511 system and public transit information from the various agencies. A 3rd party traveler information services element is also shown within this service area. This element is meant to serve as a way to collect information from travelers on the roadway and have that information accessible to the TOCs.

One of the ways public transit agencies can more closely integrate with the 511 system is to share transit related incident information and other transit operations and service information with the system. 511 can use this information to provide travelers with more information when they use the phone system to call in instead of forwarding the call. The web interface and interactive map can also include more transit information so users don't have to search for the link to the different transit agencies.

Having a 3rd party traveler information service that collects data from traveler inputted applications can also be beneficial to this service area. An example of this service could be Waze or social media applications. Waze is a smart phone application that allows travelers to input information on traffic conditions and incidents in real-time. Social media such as Twitter can also provide such information as travelers can Tweet about incidents as they are stuck in the roadway. This information can be valuable and timely in ways that other methods of data collection cannot achieve. Data would be collected in real time and the location can be determine based on the type of application and if users have location services turned on in their mobile devices. Traffic management centers such as the proposed statewide/regional TOC can collect, process, and redistribute this data in a way that is beneficial to all travelers and other agencies.

Maintenance vehicle on-board systems are included in this service area to show the potential future integration of its environmental sensor and vehicle location data to the 511 system to be accessible to the public.

Table 6. Traveler Information Roles & Responsibilities

Stakeholder	RR Description	RR Status
ADOTPF/ Information Technology Staff	Collect and distribute traveler information including traffic, transit, ferry, and incident information.	Existing
ADOTPF/ Information Technology Staff	Collect and distribute maintenance and construction information from maintenance centers.	Planned
ADOTPF/ Regional Highway Construction Section	Send construction and work zone information.	Existing
ADOTPF/ Regional Maintenance and Operations Districts	Send maintenance and work zone information.	Existing
ADOTPF/ Regional Maintenance and Operations Districts	Send road weather information.	Existing
ADOTPF/ Regional Maintenance and Operations Districts	Collect and send maintenance, construction, vehicle location, and weather information via maintenance vehicle on-board systems.	Planned
Combined/ Law Enforcement Agencies	Send incident information.	Existing
Combined/ Public Sector Agencies	Send incident and traffic information.	Planned
Combined/ Traffic Signal Owners and Operators	Collect and send road network condition information.	Existing
Combined/ Transit Agencies	Send transit information including fares, schedule, incident, and service information.	Existing
Media/	Collect and send to the public traveler information.	Existing
NOAA/ National Weather Service (NWS) Alaska Region	Send weather information.	Existing
Public or Private Sector Agency/	Collect traveler information.	Planned

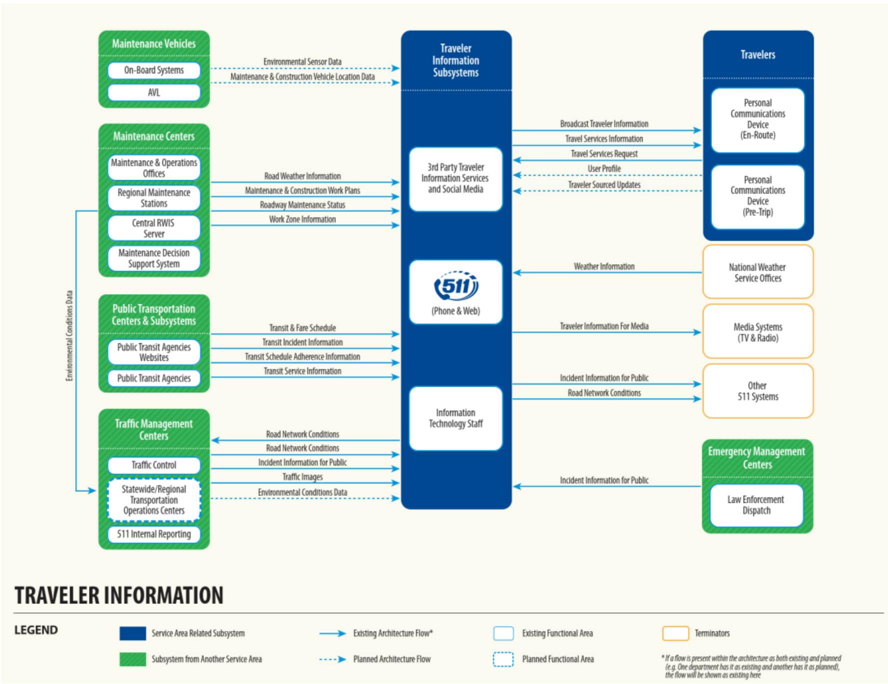


Figure 8. Traveler Information Flow Diagram

A larger version of this flow diagram can be found in Appendix C: Architecture Flow Diagrams.

4.10 Data Archive

Agencies within the state currently maintain their own data archives. This makes it convenient for internal operations within each agency to access historic data. However, accessing information from other archives and agencies is not as easy. This service area aims to support multi-agency archive data sharing. It is proposed that a "Transportation Data Archive System" act as a central data repository in which other archives can contribute to and retrieve data from. Some of the data exchanged and archived should be protected and access controlled. This is to protect privacy and sensitive data that is being exchanged. Sharing is also subject to permissions from the data source.

Potential stakeholders that can contribute to this from the ADOT&PF side include the Bridge Design Section, the Transportation Data Programs, the IT staff, Regional Maintenance and Operations Districts, and Statewide Materials. Other agencies that are shown to be potential contributors include law enforcement agencies (AST and APD) and the various transit agencies.

The Bridge Design Section maintains the Bridge Management System which keeps information and on the State's public bridges. They can provide maintenance information on the bridges to the central archive.

The Transportation Data Programs Section, the IT staff, and Regional Highway Data Section are proposed to be the potential maintainers of the central Transportation Data Archive System. However, this role might be outsourced.

The Transportation Data Programs Section is responsible for incorporating the information from the legacy Transportation Asset Management System into the central repository such as physical transportation infrastructure data. The legacy Transportation Asset Management System, which has been integrated into the new Agile Assets System along with other legacy management systems. Additionally, the Transportation Data Programs Section is responsible for collecting road network data, traffic data, and crash data; which can be useful information to contribute to the central archive. They are also the one of the proposed stakeholders for the Traffic Data System.

The Regional Maintenance and Operations Districts are responsible for managing the highway maintenance activities information in the Agile Assets System. This information was originally from the legacy Maintenance Management System (MMS), which has been integrated into the Agile Assets System. Having this information readily accessible in the central Transportation Data Archive System would support the service area.

Statewide Materials is responsible for monitoring pavement conditions and reporting pavement condition information through the Agile Assets System. This information was originally from the legacy Pavement Management System, which has been integrated into the Agile Assets System. Again, this would be another valuable source of data to be exchanged.

IT staff is the stakeholder for the Road Weather Data and 511 Internal Reporting elements. It is proposed that the IT staff performs archive coordination with the central archive as well.

Law enforcement agencies (such as AST and APD) and public transit agencies (such as People Mover or MACS Transit) can contribute to the archival sharing. Crash data from law enforcement and transit data from public transit agencies would be valuable additions to the central repository. 3rd party traveler information service providers such as Waze can also play a role by contributing in 3rd party data to the central archive. A project data repository is also shown where multiple agencies can provide current project data information such as project location information which can be useful information to share.

Table 7. Data Archive

Stakeholder	RR Description	RR Status
ADOTPF	Coordinate archive data with other archive management systems.	Planned
ADOTPF	Send pavement related archive data.	Planned
ADOTPF	Send traffic related archive data.	Planned
ADOTPF	Send maintenance related archive data.	Planned
ADOTPF/ Bridge Design Section	Coordinate archive data with other archive management systems.	Planned

Stakeholder	RR Description	RR Status
ADOTPF/ Bridge Design Section	Send bridge related archive data.	Planned
ADOTPF/ Information Technology Staff	Coordinate archive data with other archive management systems.	Planned
ADOTPF/ Information Technology Staff	Send traffic and road weather related archive data.	Planned
ADOTPF/ Information Technology Staff	Maintain and operate a central archive database to allow for coordination with other archive management systems.	Planned
ADOTPF/ Regional Maintenance and Operations Districts	Coordinate archive data with other archive management systems.	Planned
ADOTPF/ Regional Maintenance and Operations Districts	Send maintenance related archive data.	Planned
ADOTPF/ Statewide Materials	Coordinate archive data with other archive management systems.	Planned
ADOTPF/ Statewide Materials	Send pavement related archive data.	Planned
ADOTPF/ Transportation Data Programs and Regional Highway Data Sections	Coordinate archive data with other archive management systems.	Planned
ADOTPF/ Transportation Data Programs and Regional Highway Data Sections	Send traffic related archive data.	Planned
ADOTPF/ Transportation Data Programs and Regional Highway Data Sections	Maintain and operate a central archive database to allow for coordination with other archive management systems.	Planned
Combined/ Archive Maintainers	Maintain and operate a central archive database to allow for coordination with other archive management systems.	Planned
Combined/ Archive Maintainers	Coordinate archive data with other archive management systems.	Planned
Combined/ Archive Maintainers	Send traffic related archive data.	Planned
Combined/ Law Enforcement Agencies	Coordinate archive data with other archive management systems.	Planned
Combined/ Law Enforcement Agencies	Send crash and incident related archive data.	Planned
Combined/ Public Sector Agencies	Coordinate archive data with other archive management systems.	Planned
Combined/ Public Sector Agencies	Send traffic related archive data.	Planned
Combined/ Transit Agencies	Coordinate archive data with other archive management systems.	Planned
Combined/ Transit Agencies	Send transit related archive data.	Planned
Private Sector Agency/	Send 3rd party traffic related archive data.	Planned

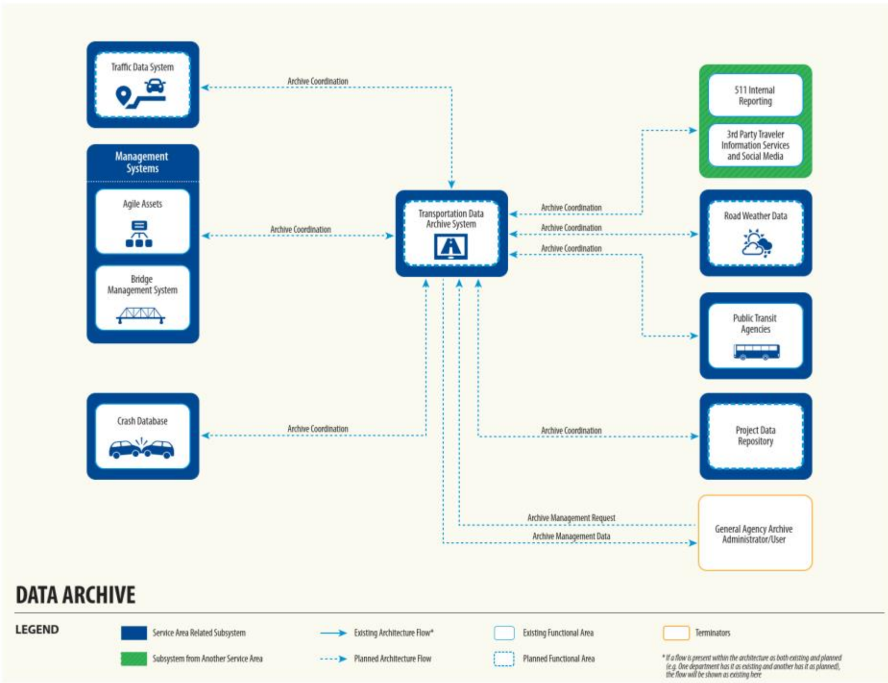


Figure 9. Data Archive Flow Diagram

A larger version of this flow diagram can be found in Appendix C: Architecture Flow Diagrams.

5 Interfaces and Information Exchanges

This chapter provides the interface requirements and information exchanges with planned and existing elements.

5.1 Interconnects

Architecture interconnects are communications paths that carry information between Physical Objects (subsystems and terminators) in the physical view of ARC-IT. Several different types of interconnects are defined in ARC-IT to reflect the range of interface requirements in ITS. The majority of the interconnects are various types of communications links. The following types of communications links are defined: Center to Center (C2C), Center to Field (C2F), Field to Field (F2F – communications from one field device to another), Wide Area Wireless (WAW – including Wide Area Broadcast), Short Range Wireless (includes Dedicated Short Range Communications or DSRC), Human Interface (e.g., what the system user sees and hears), and Vehicle On-Board.

- Center to Center (C2C) Communications:
  - A communication link serving stationary entities, including center Physical Objects. It may be implemented using a variety of public or private communication networks and technologies. It can include, but is not limited to, twisted pair, coaxial cable, fiber optic, microwave relay networks, spread spectrum, etc. In center to center communication the important issue is that it serves stationary objects. Both dedicated and shared communication resources may be used.
- Center to Field (C2F) Communications:
  - A communication link serving stationary entities, including center physical and field based objects. It may be implemented using a variety of public or private communication networks and technologies. It can include, but is not limited to, twisted pair, coaxial cable, fiber optic, microwave relay networks, cellular, spread spectrum, etc. In center to field communication the important issue is that it serves stationary objects. Both dedicated and shared communication resources may be used.
- Field to Field (F2F) Communications:
  - A communication link serving stationary entities, including field based objects. It may be implemented using a variety of public or private communication networks and technologies. It can include, but is not limited to, twisted pair, coaxial cable, fiber optic, microwave relay networks, cellular, spread spectrum, etc. In field to field communication the important issue is that it serves stationary objects. Both dedicated and shared communication resources may be used.
- Wide Area Wireless (WAW) Communications:
  - A communications link that provides communications via a wireless device between a user and an infrastructure-based system. Both broadcast (one-way) and interactive (two-way) communications services are grouped into wide-area wireless communications in ARC-IT. These links support a range of services in ARC-IT including real-time traveler information and various forms of fleet communications.
- Short Range Wireless
  - A wireless communications channel used for close-proximity communications between vehicles, mobile/personal devices, and the immediate infrastructure. It supports location-specific communications for ITS capabilities such as vehicle safety, transit vehicle

    - management, driver information, roadway payments, and automated commercial vehicle operations.
- Vehicle On-Board
    - A communications link serving devices installed in vehicles and other objects. These include On-Board Equipment (OBE) and On-Board Units (OBUs). OBEs are computer modules, display and a DSRC radio, that is installed and embedded into vehicles which provide an interface to vehicular sensors, as well as a wireless communication interface to the roadside and back office environment. OBUs are vehicle mounted devices used to transmit and receive a variety of messages to and from other connected devices (other OBUs and roadside units). Among the message types and applications supported by this device are vehicle safety messages used to exchange information on each vehicle's dynamic movements for coordination and safety.

5.2 Information Flows

ARC-IT defines information flows as the provision of information from one Physical Object to another in the physical view of ARC-IT. An information flow may include one or more other information flows (i.e., one flow is a sub-flow of another). An information flow may include message exchanges used to control the flow of information. An information flow may be unidirectional or bidirectional. Regardless, the informative description defines the information provided by the source. Information flow and architecture flow are terms that are used interchangeably. Information flows are also the primary tool used to define the ITS architecture interfaces. These information flows and their communication requirements define the interfaces which form the basis for much of the ongoing standards work in the national ITS program. Each information flow is defined by the source element (where the information originates), a destination element (where the information is sent), and a descriptive name for the flow itself. The status of the information flow (e.g. existing vs. planned) is also documented. For example the flow “signal control status” may have a source element of “Field/ Traffic Signal Controllers” and a destination element of “Center/ Signal Control.” The status would be “existing” because this flow currently exists within the State.

The AKIA update defines all existing and planned flows between ITS elements. A table that presents all of the architecture flows (including flow definitions) can be extracted from the RAD-IT software. Please refer to Section 4.5 in the Use & Maintenance Guide for instructions on how to output tables from RAD-IT. The flows have been shown graphically in the service area diagrams presented earlier in this report as well as in Appendix C: Architecture Flow Diagrams.

6 Standards

Standards are technical specifications that define how system components interconnect and interact. Because ITS standards are based on open, non-proprietary technology, their use can facilitate the deployment of interoperable ITS systems, and make it easier for state and local ITS deployers to develop and deploy integrated transportation systems.

Standards are established by the consensus of manufacturers, regulators, and users to provide guidelines for data interfaces of transportation system components. Essentially, standards allow for different systems to communicate using a common language, data elements, structures, and protocols.

There are currently nine Standards Development Organizations (SDOs) participating in ITS standards development processes:

- AASHTO (American Association of State Highway and Transportation Officials)
- ANSI (American National Standards Institute)
- APTA (American Public Transportation Association)
- ASTM (American Society for Testing and Materials)
- IEEE (Institute of Electrical and Electronics Engineers)
- ISO (International Organization for Standardization)
- ITE (Institute of Transportation Engineers)
- NEMA (National Electrical Manufacturers Association)
- SAE (Society of Automotive Engineers)

The life cycle of a standard begins with its publication. The standard is then reviewed and revised until it is ready for approval by the SDO. The standard is then tested over time and refined based on real-world implementation. The standard would then, over time, become broadly adopted by the industry. When a standard becomes widespread, stable, and available from a variety of manufacturers, they are considered mature. Once this occurs, the USDOT will consider the official adoption of the standard. According to Rule 940, if an ITS project receives Federal funds, the project must use applicable standards that have been adopted by USDOT. However, there are no standards that have been officially adopted by the USDOT at the time of this writing.

Currently, there are 99 standards that have been published by SDOs. Standards are continuously being developed and revised as technology continues to evolve and change. This list of standards may change dramatically within the foreseeable future. To see the most up to date list of published standards, please refer to the following link:

http://www.standards.its.dot.gov/DevelopmentActivities/PublishedStandards

To see the standards that are applicable to each service area, a table of standards can be extracted from the RAD-IT software. Please refer to Section 4.5 in the Use & Maintenance Guide for instructions on how to extract tables from RAD-IT. It is anticipated that many of the standards will eventually be adopted by USDOT and that their use will be made mandatory at some point in the future. Therefore, in the interim, it makes sense to consider using relevant published ITS standards in system design and implementation regardless of the status of USDOT adoption. This approach will facilitate future integration opportunities.

7 Appendix A: Glossary of Terms

This glossary of terms is compiled from the ARC-IT website: https://www.arc-it.net/html/glossary/glossary-a.html.

Architecture: Fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution. An architecture is functionally oriented and not technology-specific which allows the architecture to remain effective over time. It defines "what must be done," not "how it will be done."

Architecture Flow: See Information Flow.

Architecture Interconnect: Communications paths that carry information between Physical Objects (subsystems and terminators) in the physical view of ARC-IT. Several different types of interconnects are defined in ARC-IT to reflect the range of interface requirements in ITS. The majority of the interconnects are various types of communications links that are defined in the communications view. The following types of communications links are defined: Center to Center (C2C), Center to Field (C2F), Field to Field (F2F), Wide Area Wireless (WAW), Short Range Wireless (includes Dedicated Short Range Communications or DSRC), Human Interface (e.g., what the system user sees and hears), Vehicle On-Board, Contact or Proximity, Wide Area Broadcast, Position Location Interface, Network Time Protocol, and Personal Area Network.

Center Physical Objects: An entity that provides application, management, administrative, and support functions from a fixed location not in proximity to the road network. The terms "back office" and "center" are used interchangeably. Center is a traditionally a transportation-focused term, evoking management centers to support transportation needs, while back office generally refers to commercial applications. From the perspective of ARC-IT these are considered the same.

Data Flow: Representations of data flowing between processes or between a process and a terminator in the ARC-IT Functional View. Graphically, a data flow is shown as an arrow on a data flow diagram and is defined in a data dictionary entry in the functional view. Data flows are aggregated to form information flows in the ARC-IT Physical View.

Element: An ITS system or piece of a system named as the name used by stakeholders. Elements are the basic building blocks of regional ITS architectures and project ITS architectures.

Equipment Package: Legacy term from the National ITS Architecture v7.1. See Functional Object

Federal Highway Administration (FHWA): An agency of the United States Department of Transportation. FHWA administers the Federal-aid Highway Program, which provides financial assistance to States to construct and improve highways, urban and rural roads, and bridges. FHWA also administers the Federal Lands Highway Program, which provides access to and within national forests, national parks, Indian Tribal lands, and other public lands. FHWA is headquartered in Washington, DC, with field offices across the country, including one in or near each State capital.

Federal Transit Administration (FTA): An agency of the United States Department of Transportation. FTA is the principal source of Federal financial assistance to America's communities for the planning, development, and improvement of public or mass transportation systems. FTA provides leadership, technical assistance, and financial resources for safe, technologically advanced public transportation that enhances mobility and accessibility, improves the nation's communities and natural environment, and strengthens the national economy. FTA is headquartered in Washington, DC, with regional offices in Atlanta, Boston, Chicago, Dallas, Denver, Kansas City, New York, Philadelphia, San Francisco, and Seattle.

Field Physical Objects: Infrastructure distributed near or along the transportation network, including 'intelligent' or 'smart' infrastructure which performs surveillance (e.g. traffic detectors, cameras), traffic control (e.g. signal controllers), information provision (e.g. Dynamic Message Signs (DMS)) and local transaction (e.g., tolling, parking) functions. Typically, their operation is governed by transportation management functions running in back offices. Field systems/devices also directly interface to vehicle or mobile Physical Objects. The Field class is one of the six general classes of Physical Objects defined in the Architecture, typically shown in orange on service package drawings.

Fixed Point – Fixed Point Communications: A communication link serving stationary entities. It may be implemented using a variety of public or private communication networks and technologies. It can include, but is not limited to, twisted pair, coaxial cable, fiber optic, microwave relay networks, spread spectrum, etc. In Fixed Point - Fixed Point (FP2FP) communication the important issue is that it serves stationary entities. Both dedicated and shared communication resources may be used. One of the types of architecture interconnects defined in ARC-IT.

Field – Vehicle Communications: A wireless communications channel used for close-proximity communications between vehicles and the immediate infrastructure. It supports location-specific communications for ITS capabilities such as toll collection, transit vehicle management, intersection safety, driver information, and automated commercial vehicle operations. One of the types of architecture interconnects defined in ARC-IT.

Functional Object: The building blocks of the Physical Objects of the physical view. Functional Objects group similar processes of a particular Physical Object together into an "implementable" package. The grouping also takes into account the need to accommodate various levels of functionality. Since Functional Objects are both the most detailed components of the physical view and tied to specific service packages, they provide the common link between the interface-oriented architecture definition and the deployment-oriented service packages.

Functional Requirement: A statement that specifies WHAT a system must do. The statement should use formal “shall” language and specify a function in terms that the stakeholders, particularly the system implementers, will understand. In the ARC-IT, functional requirements have been defined for each Equipment Package that focus on the high-level requirements that support regional integration.

Information Flow: The provision of information from one Physical Object to another in the physical view of ARC-IT. An information flow may include one or more other information flows (i.e., one flow is a sub-flow of another). An information flow may include message exchanges used to control the flow of information. An information flow may be unidirectional or bidirectional. Regardless, the informative description defines the information provided by the source. Information flows appear on service package diagrams as solid lines with an arrow at one or both ends that indicate the direction information is flowing. Information flows are the primary tool that is used to define the ITS architecture interfaces. These information flows and their communication requirements define the interfaces which form the basis for much of the ongoing standards work in the national ITS program. Note: The terms "information flow" and "architecture flow" are used interchangeably.

Intelligent Transportation Systems: The system defined as the electronics, communications or information processing in transportation infrastructure and in vehicles used singly or integrated to improve transportation safety and mobility and enhance productivity. Intelligent transportation systems (ITS) encompass a broad range of wireless and wire line communications-based information and electronics technologies.

ITS Physical Objects: Physical Objects that provide core capabilities and interfaces that may be included in any ITS system or device. The ITS class is one of six general Physical Object classes defined in ARC-IT. The ITS class objects are typically shown as grey boxes on service package drawings.

National ITS Architecture: A common, established framework for developing integrated transportation systems, now known as the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT). ARC-IT is comprised of the communications, enterprise, functional, and physical views which satisfy a defined set of needs. The National ITS Architecture is maintained by the United States Department of Transportation (USDOT).

Operational Concept: 1) A component of a regional architecture that identifies the roles and responsibilities of participating agencies and stakeholders. It defines the institutional and technical vision for the region and describes how ITS will work at a very high-level, frequently using operational scenarios as a basis. 2) Verbal and graphical statement of an organization's assumptions or intent in regard to an operation or series of operations of a system or a related set of systems.

Personal Physical Objects: Equipment used by travelers and others using personal devices to access transportation services pre-trip and en-route. This includes equipment that are owned and operated by the traveler/person as well as equipment that are owned by agencies and used/worn by staff/personnel. The Personal class is one of six general object classes defined in the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT).

Physical Objects: Systems or device that provide ITS functionality that makes up the intelligent transportation system (ITS) and the surrounding environment. Physical Objects are defined in terms of the services they support, the processing they include, and their interfaces with other Physical Objects. They are grouped into six classes: Centers, Field, ITS Support, Personal, and Vehicles. Due to the close correspondence between the physical world and Physical Objects, the interfaces between them are prime candidates for standardization. In all cases, a human physical object may be associated with the class of the physical object with which it interacts; e.g., 'Driver' is classed as a 'Vehicle' type.

Physical View: The physical view describes the transportation systems and the information exchanges that support ITS. In this view, the Architecture is depicted as a set of integrated Physical Objects (Subsystems and Terminators) that interact and exchange information to support the Architecture service packages. Physical Objects are defined to represent the major physical components of the ITS Architecture. Physical Objects include subsystems, and terminators that together provide a set of capabilities that are more than would be implemented at any one place or time. Subsystems are Physical Objects that are part of the overall Intelligent Transportation System and provide the functionality that is 'inside-the-boundary' of ITS. Terminators are Physical Objects that lie at the boundary of ITS and supply information needed by ITS' functions or receive information from ITS.

Project Architecture: A framework that identifies the institutional agreement and technical integration necessary to interface a major ITS project with other ITS projects and systems.

Region: 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. In metropolitan areas, a region should be no less than the boundaries of the metropolitan planning area.

Regional ITS Architecture: A specific, tailored framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects in a particular region. It functionally defines what pieces of the system are linked to others and what information is exchanged between them.

Service Package: The service packages, formerly known as market packages, provide an accessible, service-oriented perspective to ARC-IT. They were also known as "applications" in CVRIA. They are tailored to fit, separately or in combination, real world transportation problems and needs. Service packages collect together one or more Functional Objects that must work together to deliver a given ITS service and the information flows that connect them and other important external systems. In other words, they identify the pieces of the physical view that are required to implement a particular ITS service. Service packages are implemented through projects (or groups of projects, aka programs) and in transportation planning, are directly related to ITS strategies used to meet regional goals and objectives.

Stakeholders: A widely used term that notates a public agency, private organization or the traveling public with a vested interest, or a "stake" in one or more transportation elements within a regional ITS architecture or project ITS architecture.

Standards: Documented technical specifications sponsored by a Standards Development Organization (SDO) to be used consistently as rules, guidelines, or definitions of characteristics for the interchange of data. A broad array of ITS standards is currently under development that will specifically define the interfaces identified in ARC-IT.

Subsystem:
The principle structural element of the physical view of ARC-IT. Subsystems are individual pieces of the Intelligent Transportation System defined by ARC-IT. Subsystems are grouped into 5 classes: Centers, Field, Vehicles, Support, and Travelers. Example subsystems are the Traffic

Management Center, the Vehicle Onboard Equipment, and the ITS Roadway Equipment. These correspond to the physical world: respectively traffic operations centers, automobiles, and roadside signal controllers. Due to this close correspondence between the physical world and the subsystems, the subsystem interfaces are prime candidates for standardization.

Support Physical Objects: Centers that provide information and/or functionality that support ITS services but do not directly provide an ITS service' e.g. 'Cooperative ITS Credentials Management System.'

System: A collection of hardware, software, data, processes, and people that work together to achieve a common goal. Note the scope of a "system" depends on one's viewpoint. To a sign manufacturer, a dynamic message sign is a "system". To a state DOT, the same sign is only a component of a larger Freeway Management "System". In a regional ITS architecture or project ITS architecture, a Freeway Management System is a part of the overall surface transportation "system" for the region.

System Inventory: The list of all ITS-related elements in a regional ITS architecture or project ITS architecture.

Terminator: Terminators define the boundary of an architecture. ARC-IT terminators represent the people, systems, and general environment that interface to ITS. The interfaces between terminators and the subsystems and processes within ARC-IT are defined, but no functional requirements are allocated to terminators. The functional and physical view of ARC-IT both contain the same set of terminators.

Turbo Architecture: Now called RAD-IT. An automated software tool used to input and manage system inventory, service packages, architecture flows and interconnects of a regional ITS architecture and/or multiple project ITS architectures.

Vehicle – Vehicle Communications: Dedicated wireless system handling high data rate, low probability of error, line of sight communications between vehicles. Advanced vehicle services may use this link in the future to support advanced collision avoidance implementations, road condition information sharing, and active coordination to advanced control systems. One of the types of architecture interconnects defined in ARC-IT.

Vehicle Physical Objects: Covers the vehicle related elements onboard vehicles. Vehicle Physical Objects include general driver information and safety systems applicable to all vehicle types. Five fleet vehicle objects (Transit, Emergency, Commercial, Freight Equipment, and Maintenance and Construction Vehicles) add connected capabilities unique to these special vehicle types. The Vehicle Physical Object class is one of six general classes defined in the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT).

Wide Area Wireless (mobile) Communications: A communications link that provides communications via a wireless device between a user and an infrastructure-based system. Both broadcast (one-way) and interactive (two-way) communications services are grouped into wide-area wireless communications in ARC-IT. These links support a range of services in ARC-IT including real-time traveler information and various forms of fleet communications. One of the types of architecture interconnects defined in ARC-IT.

8 Appendix B: User-Defined Flow Definitions

Flow definitions can be found on the ARC-IT website:
https://www.arc-it.net/index.html. Alternatively, flow definitions can be found in the "Interfaces" tab within the RAD-IT file. "User-defined" flows, or flows that were tailored for the AKIA update, are identified as such.

8.1 User-Defined Flows

User-defined flows created in the AKIA update are identified with a period at the beginning and end of each flow name. This makes it easier to find user-defined flows in the RAD-IT database because flow names beginning with the period appear at the top when sorted in alphabetical order.

Table 8. User Defined Flows

Flow Name	Flow Description	Service Area
.environmental sensor data.	Current road conditions and surface weather conditions as measured by environmental sensors.	Winter Maintenance
.fleet and freight information.	Information about commercial fleet and freight daily activities.	CVO & Freight
.freight equipment information.	Information regarding container, trailer, or chassis of a commercial vehicle. Information could include identity, type, location, mileage, and others.	CVO & Freight
.treatment recommendations.	Options for treating pavement based on pavement temperature forecasting.	Winter Maintenance

9 Appendix C: Architecture Flow Diagrams

This appendix shows the flow diagrams of each service area. The diagrams are shown here in landscape to improve readability. A table of the architecture flows used in each service area can be outputted from the RAD-IT software. Please refer to Section 4.5 in the Use & Maintenance Guide for instructions on how to output architecture flow tables. Alternatively, architecture flow information can also be found in the “Interfaces” tab in the RAD-IT software.

9.1 Traffic Management Flow Diagram

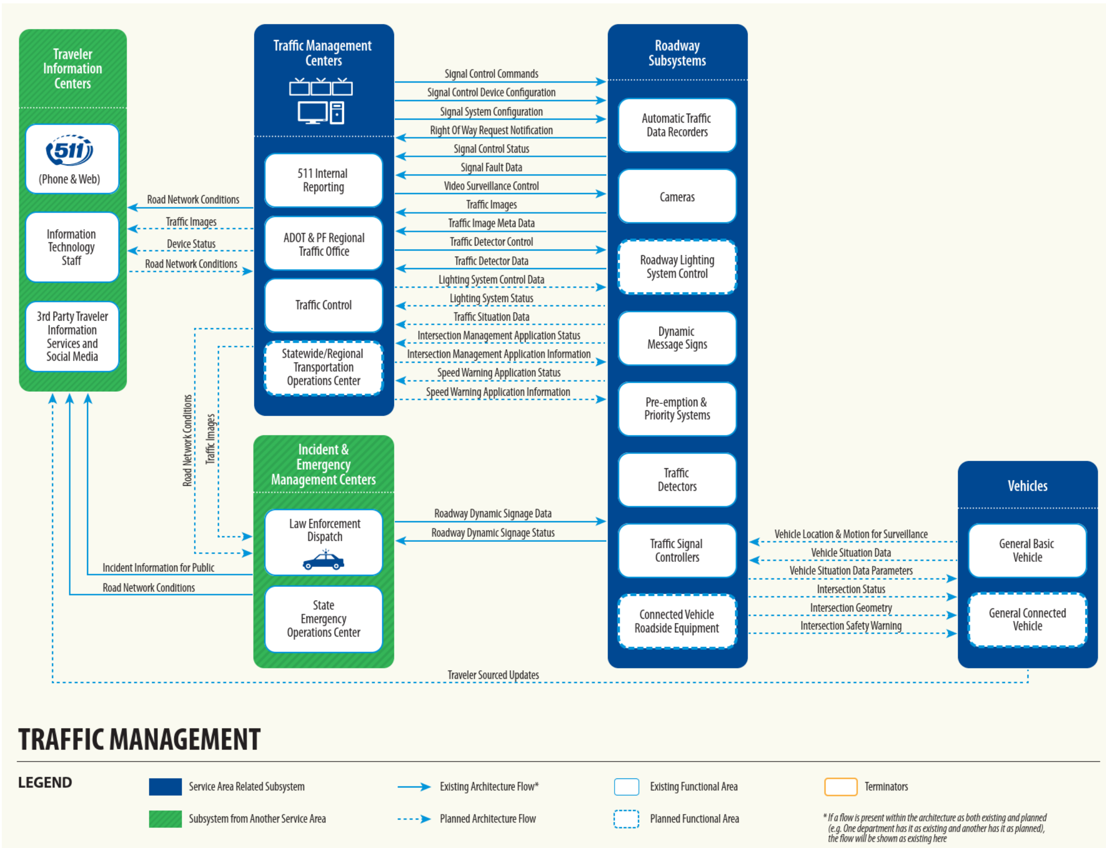


Figure 10. Large Traffic Management Flow Diagram

9.2 Maintenance Flow Diagram

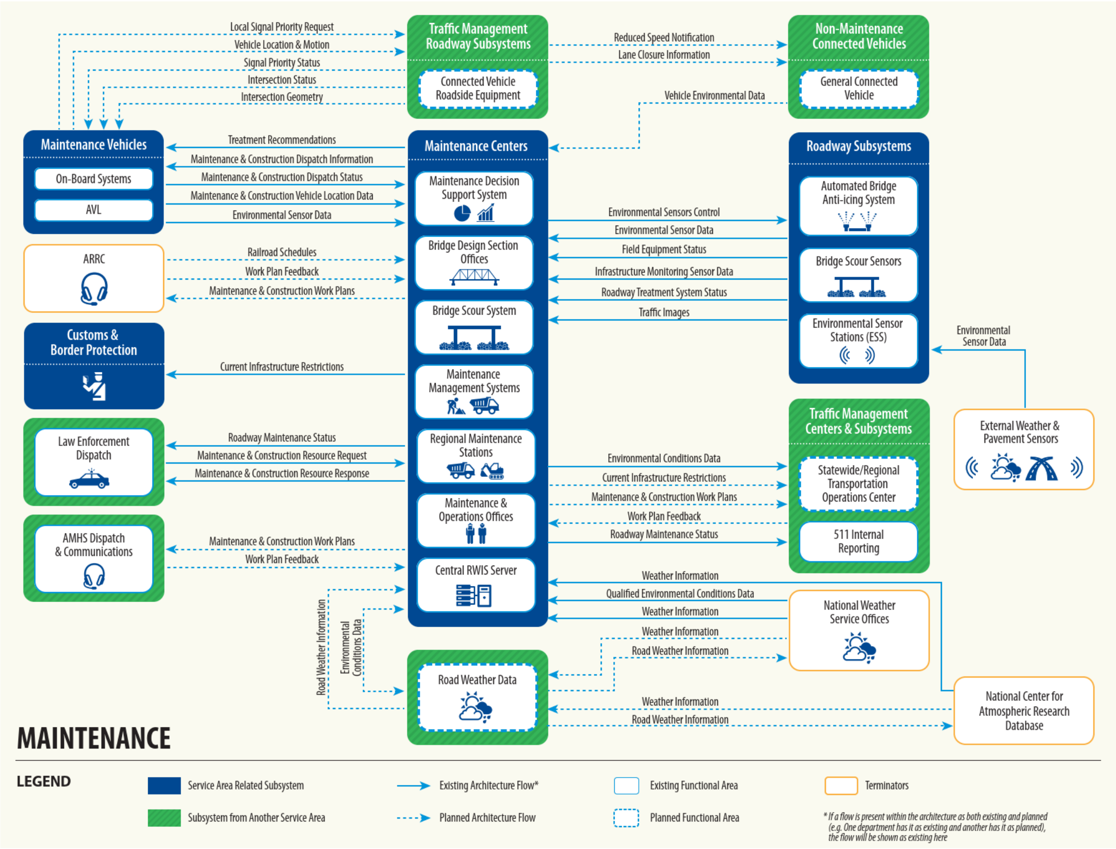


Figure 11. Large Winter Maintenance Flow Diagram

9.3 CVO and Freight Flow Diagram

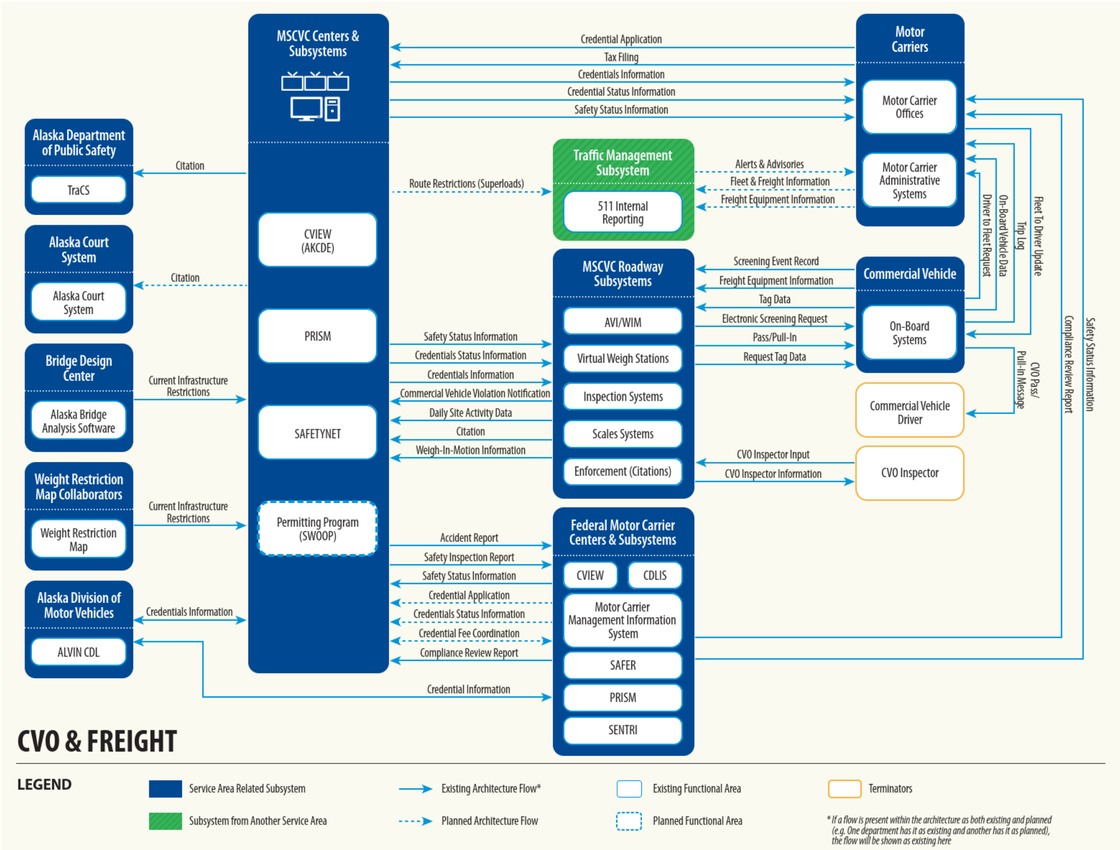


Figure 12. Large CVO and Freight Flow Diagram

9.4 Public Transportation Flow Diagram

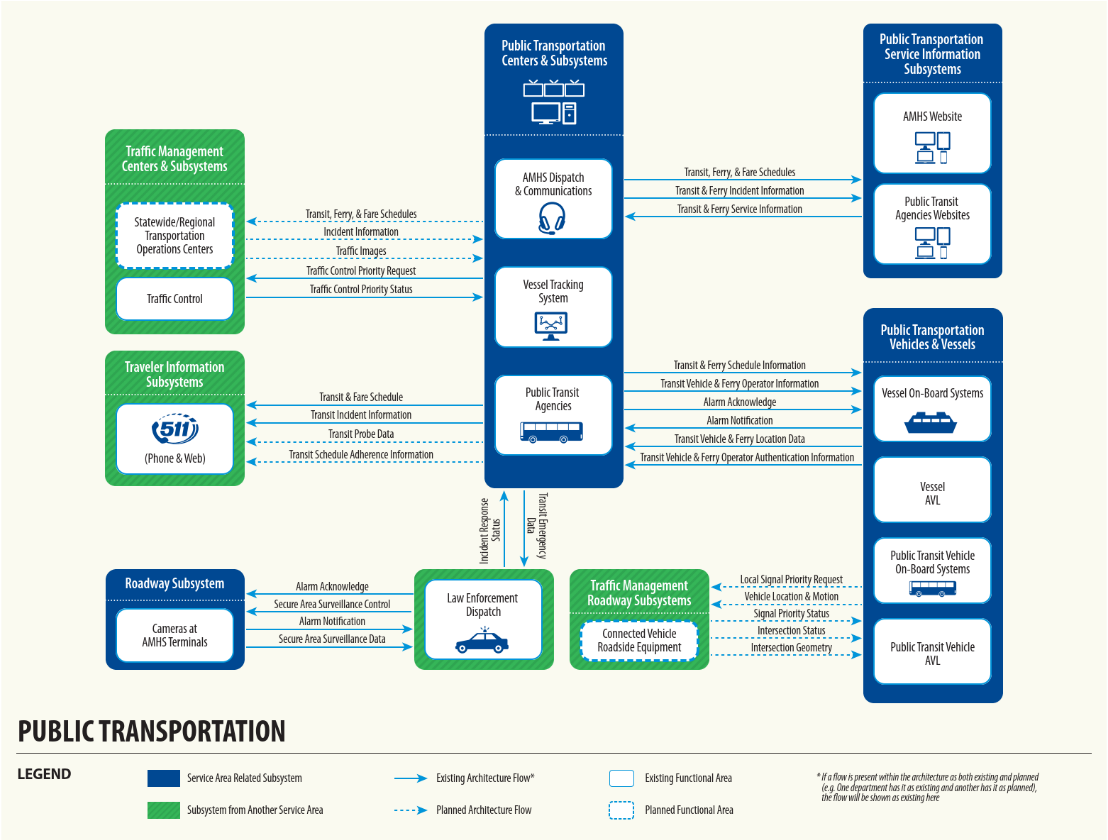


Figure 13. Large Public Transportation Flow Diagram

9.5 Incident and Emergency Management Flows & Flow Diagram

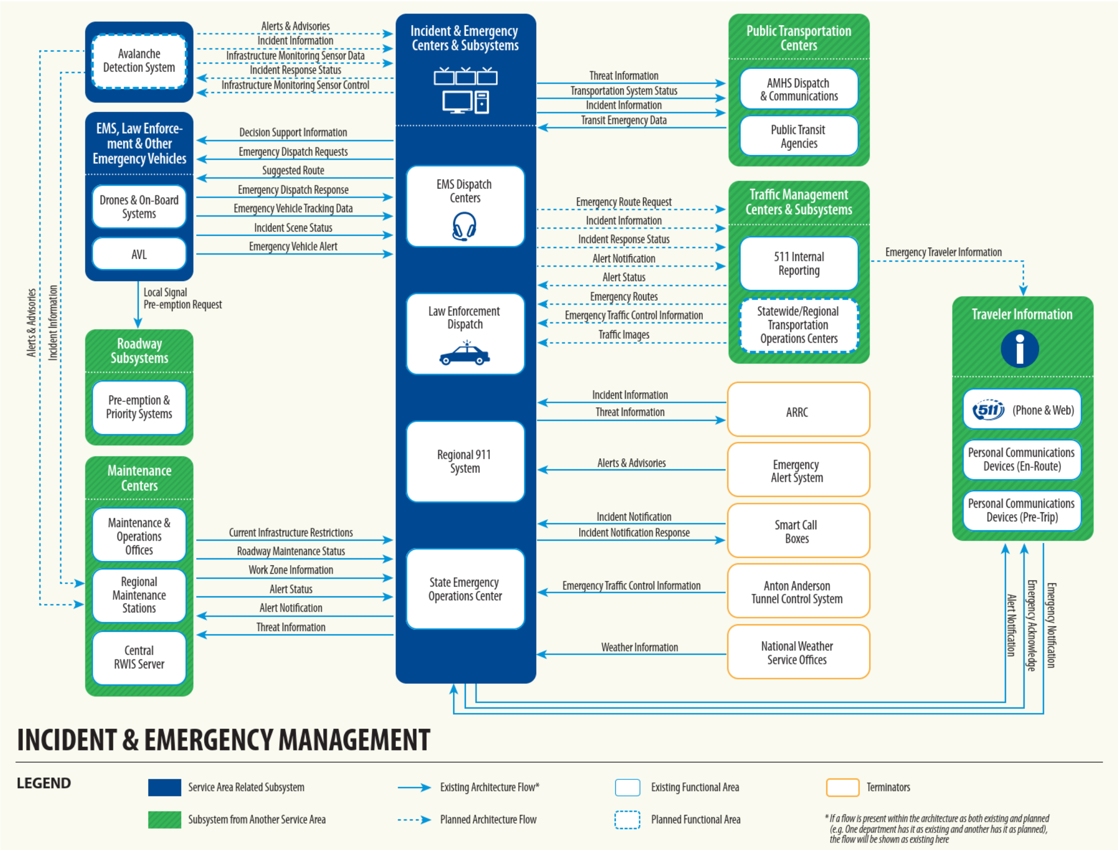


Figure 14. Large Incident and Emergency Management Flow Diagram

9.6 Traveler Information Flow Diagram

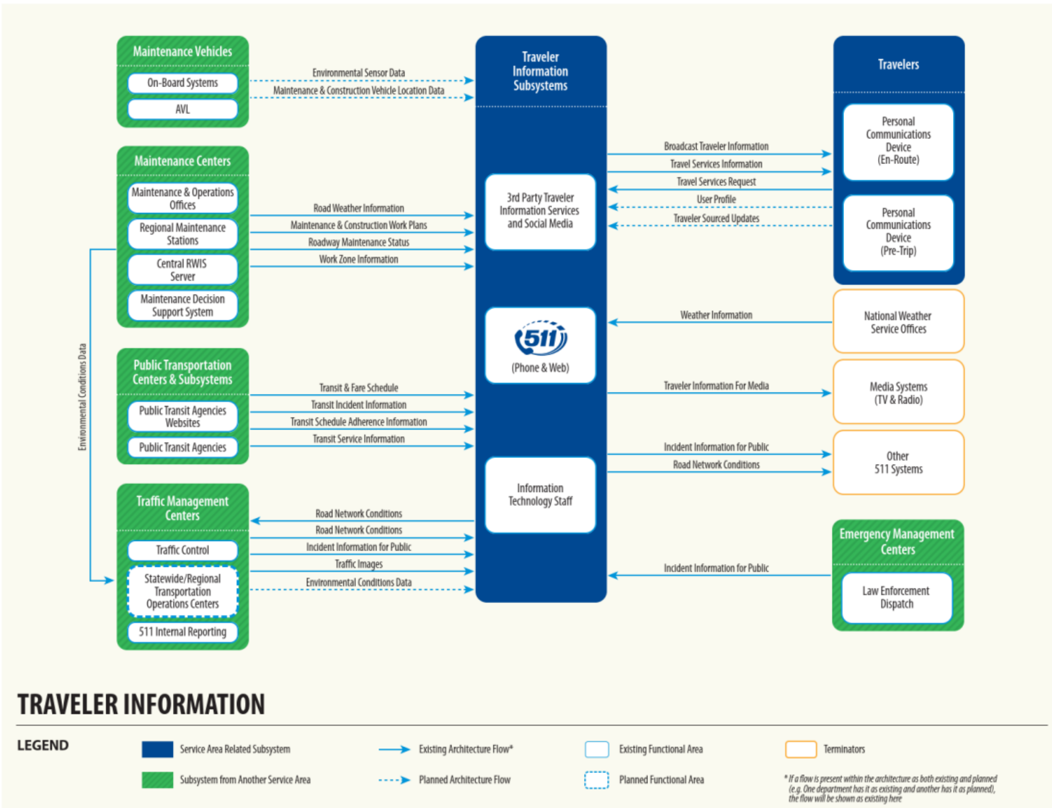


Figure 15. Large Traveler Information Flow Diagram

9.7 Data Archive Flow Diagram

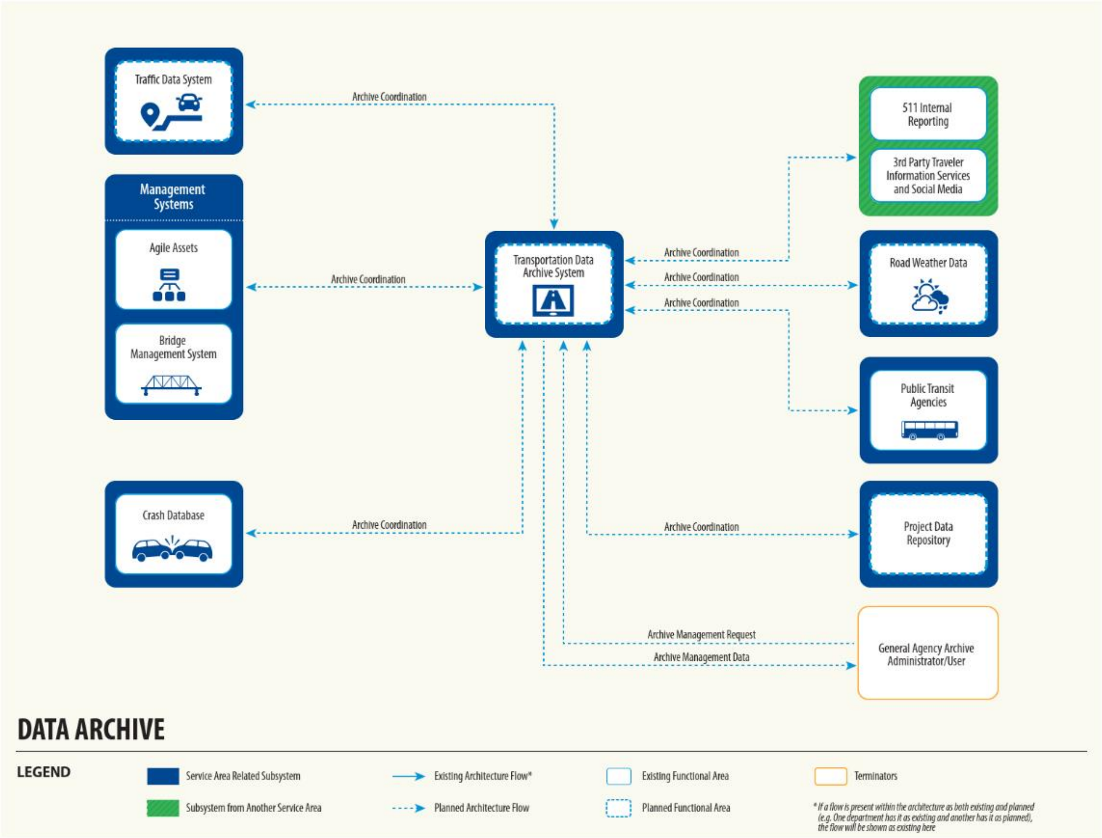


Figure 16. Large Data Archive Flow Diagram