Concept of Operations (ConOps) for:
Keys Connecting Overseas to Advance Safe Travel (Keys COAST) Project

FLORIDA DEPARTMENT OF TRANSPORTATION
DISTRICT 6

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List of Acronyms and Abbreviations

AASHTO ..... American Association of State Highway and Transportation Officials
ARC-IT ..... Architecture Reference for Cooperative and Intelligent Transportation
ATC ..... Advanced Traffic Controller
ATSPM ..... Automated Traffic Signal Performance Measures
BSM ..... Basic Safety Message
CCTV ..... Closed-Circuit Television
ConOps ..... Concept of Operations
CV ..... Connected Vehicle
CVRIA ..... Connected Vehicle Reference Implementation Architecture
DSRC ..... Dedicated Short Range Communication
EDC ..... Every Day Counts
EMC ..... Emergency Management Communications
FCC ..... Federal Communications Commission
FDOT ..... Florida Department of Transportation
GNSS ..... Global Navigational Satellite System
GPS ..... Global Positioning System
HMI ..... Human-Machine Interface
I2V ..... Infrastructure to Vehicle
IEEE ..... Institute of Electrical and Electronics Engineers
ITS ..... Intelligent Transportation Systems
MAP ..... Map Data
MCTT ..... Multi-Channel Test Tool
NEMA ..... National Electrical Manufacturers Association
OBU ..... On-board Unit
OEM ..... Original Equipment Manufacturer
ORR ..... Operational Readiness Review
OSADP ..... Open Source Application Development Portal
PDO ..... Property Damage Only
PID ..... Personal Information Device
POE ..... Power over Ethernet
RSU ..... Roadside Unit
RTMC ..... Regional Traffic Management Center
SAE ..... Society of Automotive Engineers
SCMS ..... Security Credential Management System
SDK ..... Software Development Kit
SOP ..... Standard Operating Procedures

SPaT ..... Signal Phase and Timing
SRB ..... Statewide Radio Bridging
SRM ..... Signal Request Message
SSM ..... Signal Status Message
TERL ..... Transportation Engineering Research Laboratory
THEA ..... Tampa Hillsborough Expressway Authority
TIM ..... Traveler Information Message
TMC ..... Transportation Management Center
TRR ..... Test Readiness Review
TSM&O ..... Transportation Systems Management and Operations
TSP/P ..... Traffic Signal Priority/Preemption
UMTRI ..... University of Michigan Transportation Research Institute
V2I ..... Vehicle to Infrastructure
V2V ..... Vehicle to Vehicle
WiBB ..... Wireless Broadband
VRU ..... Vulnerable Road User
WSA ..... WAVE Service Announcement

1. Overview

The first section of this Concept of Operations (ConOps) document provides four elements: system identification, an overview of the document, a high-level overview of the proposed system and a brief description of the scope.

1.1. Identification

Project Name: Keys Connecting Overseas to Advance Safe Travel (Keys COAST)

Financial Project Identification: [*Insert the financial project identification code, when it becomes available*].

Federal Aid Project Number: [*Insert the federal aid project number, when it becomes available*]. No federal aid is dedicated to the project, at this time.

The Florida Department of Transportation (FDOT) plans to create a connected vehicle (CV) corridor consisting of thirty-one (31) intersections, eighteen (18) other signals and one (1) weigh-in-motion screening station along 112.5 miles of US 1 from Key Largo to Key West, Florida. Additionally, the project will deploy Automated Traffic Signal Performance Measures (ATSPM) software.

This project falls within the District 6 SunGuide Transportation Management Center operations and within FDOT District 6 in Monroe County. This ConOps describes high-level conceptual planning as part of a systems engineering approach to develop a CV and ATSPM Deployment Project.

1.2. Document Overview

The ConOps describes the current state of operations, establishes user needs and the reasons for change, and defines desired operations in the future. This document will be used to present the vision, goals, and direction of the project, and will support the systems engineering development process.

The project serves as a deployment platform for basic CV functions on US 1 and continues FDOT's early deployment, field examination, investigation, and use of CV technology and ATSPM.

This document is written for the FDOT District 6 Traffic Operations Office's Transportation Systems Management and Operations (TSM&O) Unit. It is also written for the system designer, software developer, Intelligent Transportation Systems (ITS) contractor and integrator to ensure the ultimate products and facilities meet the intentions of the FDOT. It includes stakeholders, their associated roles, and functions of the CV and ATSPM deployment.

The purpose of this document is to:

- Identify stakeholder and user needs and the proposed system expectations.
- Communicate the system developer's understanding of the user needs and how the system will meet those needs.

1.3. System Overview

1.3.1. Background

USDOT's initial experiment with CVs was undertaken with the CV Proof-of-Concept Test Bed in Novi Michigan from 2007 through 2010 and continued with the Safety Pilot Model Deployment in Ann Arbor, Michigan, conducted by the University of Michigan Transportation Research Institute (UMTRI) from 2011 through 2013. USDOT is currently sponsoring CV deployments through the USDOT CV Pilot Program to test the use and effects of CVs in several environments, including downtown Tampa, Florida, I-80 in Wyoming, and New York City. USDOT is testing CV service packages, in these three environments and establishing interoperability between vendors prior to larger-scale deployment.

FDOT is a stakeholder in the Tampa CV Pilot and is pursuing the expansion of CV use in this and other projects in Florida that will use Roadside Units (RSUs) and On-board Units (OBUs). These efforts are supported by the National ITS Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT), which depicts ITS and CV service packages with underlying graphics and definitions of CV functionality. The original CV architecture, the Connected Vehicle Reference Implementation Architecture (CVRIA), and the National ITS Architecture (NITSA) were integrated into ARC-IT in July 2017.

The ATSPM concept was initiated and demonstrated by Indiana DOT and transportation engineering researchers at Purdue University. The initial software was extended by use at Utah DOT and is now a module being successfully used in several states, including Seminole County, Florida, to evaluate and improve signal and arterial performance. The ATSPM module is available through the FHWA Open Source Application Development Portal (OSADP)[1].

1.3.2. CV / ATSPM Project Overview

Primary users of the information derived from the CV and ATSPM deployment will initially include only FDOT District 6 TSM&O, FDOT Motor Carrier Size and Weight, TMC Arterial Operators, and FDOT fleet and asset maintenance contractor fleet vehicles. Users will be able to operate CVs with signal timing improvements and allow TMC Arterial Operators to assess signal performance. TMC Arterial Operators will be able to access the Roadside Unit (RSU) information remotely using SunGuide® and ATSPM software. In addition, users' vehicles equipped as CVs will carry an on-board unit (OBU) to send and receive Dedicated Short-Range Communication (DSRC) to the RSU and RTMC (vehicle to infrastructure (V2I)). Messages to and from vehicles (vehicle to vehicle (V2V)) will also be available as a part of this deployment.

The intended users also include any CV-equipped-vehicle drivers, freight operators, the transit operators and pedestrians. The users will in total include:

- FDOT District 6 TSM&O
- FDOT Motor Carrier Size and Weight
- FDOT District 6 SunGuide TMC
- FDOT District 6 Fleet Vehicle drivers

[1] https://www.itsforge.net/index.php/community/explore-applications#/30/133

- FDOT District 6 Work Zone Crews
- FDOT District 6 Drawbridge operator (Snake Creek)
- CV-equipped drivers from the general public
- Emergency vehicle drivers
- Transit operator(s) – Dade-Monroe Express Route 301, Lower Keys Shuttle, Greyhound, Florida Keys Shuttle
- Freight operators
- Vulnerable road users (VRUs), like pedestrians and cyclists

1.4. CV Project Scope

FDOT plans to create a connected vehicle (CV) corridor consisting of 50 locations on US 1 from Key Largo to Key West, Florida. Additionally, as part of this CV deployment, ATSPM software will be deployed at the SunGuide TMC, including integration with signal control information software in the SunGuide TMC.

The CV project includes systems engineering, procurement, installation, integration, configuration, operations, and maintenance of RSUs and OBUs. The RSUs, where possible, will be installed on existing poles or mast arms and will provide necessary DSRC messages (e.g., Signal Phase and Timing (SPaT) and other CV data) to users' in-vehicle devices (i.e., OBUs). The equipment includes RSUs, OBUs, and ancillary equipment to install and integrate the devices (e.g., antennas).

The ATMS analytics portion includes:

- Route Travel Times by Segment
- Speed
- Congestion Index
- Route Delay
- Progression Diagram
- Route Speed by Segment
- Timing Plan Analysis
- Day of Week Analysis
- Weekly Analysis
- Timing Run
- Delay by Phase
- Delay by Approach
- LARIC (Los Angeles Route Intersection Coordination) metric
- Idle Emissions
- Purdue Coordination Diagram

1.4.1. Functionality

1.4.1.1. CV

The project aims to improve safety and mobility with CV technology. The objectives of the CV deployment are to:

- Install RSU processing cards to extant McCain 2070E Advanced Traffic Controllers (ATCs)
- Install RSUs on extant emergency signals, drawbridge signals and a weigh-in-motion screening station
- Install OBUs in 250 FDOT, Emergency Response, Law Enforcement and other volunteer agency fleet vehicles
- Test and proper operations and DSRC message sending between the RSUs, and OBUs, as per Section 4.6.1 in Florida's SEMP for TRR and ORR
- Make use of a Security Credential Management System (SCMS) to issue digital certificates to participating vehicles and infrastructure for trustworthy communications among them; pseudonym certificates are issued from multiple organizations to preserve privacy among insiders and revoke misbehaving and malfunctioning CVs (See ARC-IT SU08 - SCMS service package)
- Operate National ITS Architecture (i.e., ARC-IT) service packages to include:
    - CVO06 – Freight Signal Priority
    - CVO08 – Smart Roadside and Virtual WIM
    - PS03 – Emergency Vehicle Preemption
    - PT09 – Transit Signal Priority
    - TM04 – CV Traffic Signal System
    - TM18 – Drawbridge Management
    - VS12 – Pedestrian and Cyclist Safety
    - VS02 – Vehicle to Vehicle (V2V) Basic Safety

FDOT D6 will need to add these eight service packages to the Regional ITS Architecture (RITSA), and possibly SU08 for SCMS. Since the Turbo Architecture is no longer applicable, amending the RITSA will need to be done with the Regional Architecture Development for Intelligent Transportation (RAD-IT) software that supports development of regional and project ITS architectures using ARC-IT as a starting point.

1.4.1.2. ATSPM

The project will install ATSPM software at the SunGuide TMC. ATSPM technology is the outcome of a collaboration among FHWA, the American Association of State Highway and Transportation Officials (AASHTO), state departments of transportation (DOTs), and academic research efforts. The Federal Highway Administration (FHWA) is promoting automated traffic signal performance measures (ATSPM) in the fourth round of Every Day Counts (EDC-4) as a means to improve on these traditional retiming processes by providing continuous performance monitoring capability. FDOT is participating with the EDC-4 with three deployments in the stae by 2020. This Monroe County ATSPM will be the first FDOT-led deployment in District 6.

With ATSPM, TMC operator signal retiming efforts can be based directly on actual performance without dependence on software modeling or expensive, manually collected data. ATSPMs consist of a high-resolution data-logging capability added to existing traffic signal infrastructure and data analysis techniques.[2]

[2] https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/factsheet/automated_traffic_signal.pdf

ATSPM offers data for number of arrivals on green/red along with other performance measures for signal retiming and coordination. CVs act as vehicle probes moving along the corridor, which is useful as ATSPM data. The Purdue coordination diagram is particularly useful in evaluating signal timing. Table 1 summarizes ATSPM capabilities.

Table 1: ATSM Performance Measures and Detection Needs

Detection Replaceability	Detection Type Required	Common Performance Measures	Transparity* Capable
No	High Resolution Controller only (no additional detection need)	Purdue Phase Termination	
		Split Monitor	Yes
		Pedestrian Actuation/Delay	
		Preempt Duration	Yes
Replaceable with High CV Penetration	Advanced Count Detection (400 feet behind stop bar)	Purdue Coordination Diagram	
		Approach Volume	Yes
		Volume to Capacity Ratio	Yes
		Purdue Link Pivot	
		Platoon Ratio	
		Arrivals on Red	
		Approach Delay	Yes
		Executive Summary Reports	
	Advanced Detection with Speed	Approach Speed	Yes
	Lane-by-Lane Count Detection	Turning Movement Counts	Yes
		Red/Yellow Actuation	Yes
	Lane-by-Lane Presence Detection	Split Failure (future)	
	Probe Travel Time Data	Purdue Travel Time Diagram	

*Note: Transparity is a trade name for the McCain Computing Cloud.

2. Referenced Documentation

The following documents were used as guidance in the development of this Concept of Operations document and are listed below for reference only.

Brecht, B., Therriault, D., Weimerskirch, A., Whyte, W., Kumar, V., Hehn, T., & Goudy, R. (2018). *A Security Credential Management System for V2X Communications.* https://arxiv.org/abs/1802.05323

FDOT. (March 7, 2005, Version 2). *Florida's Statewide Systems Engineering Mangaement Plan: Deliverable 1-10: Technical Memorandum.* http://www.fdot.gov/traffic/its/projects_deploy/SEMP/PDF/050315_D1-10_V2.pdf

Iteris. (Accessed July 2017). *Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) 8.0.* https://local.iteris.com/arc-it/

University of Michigan Transportation Research Institute. (2016 accessed). *Safety Pilot Technology web page.* http://safetypilot.umtri.umich.edu/index.php?content=technology_overview

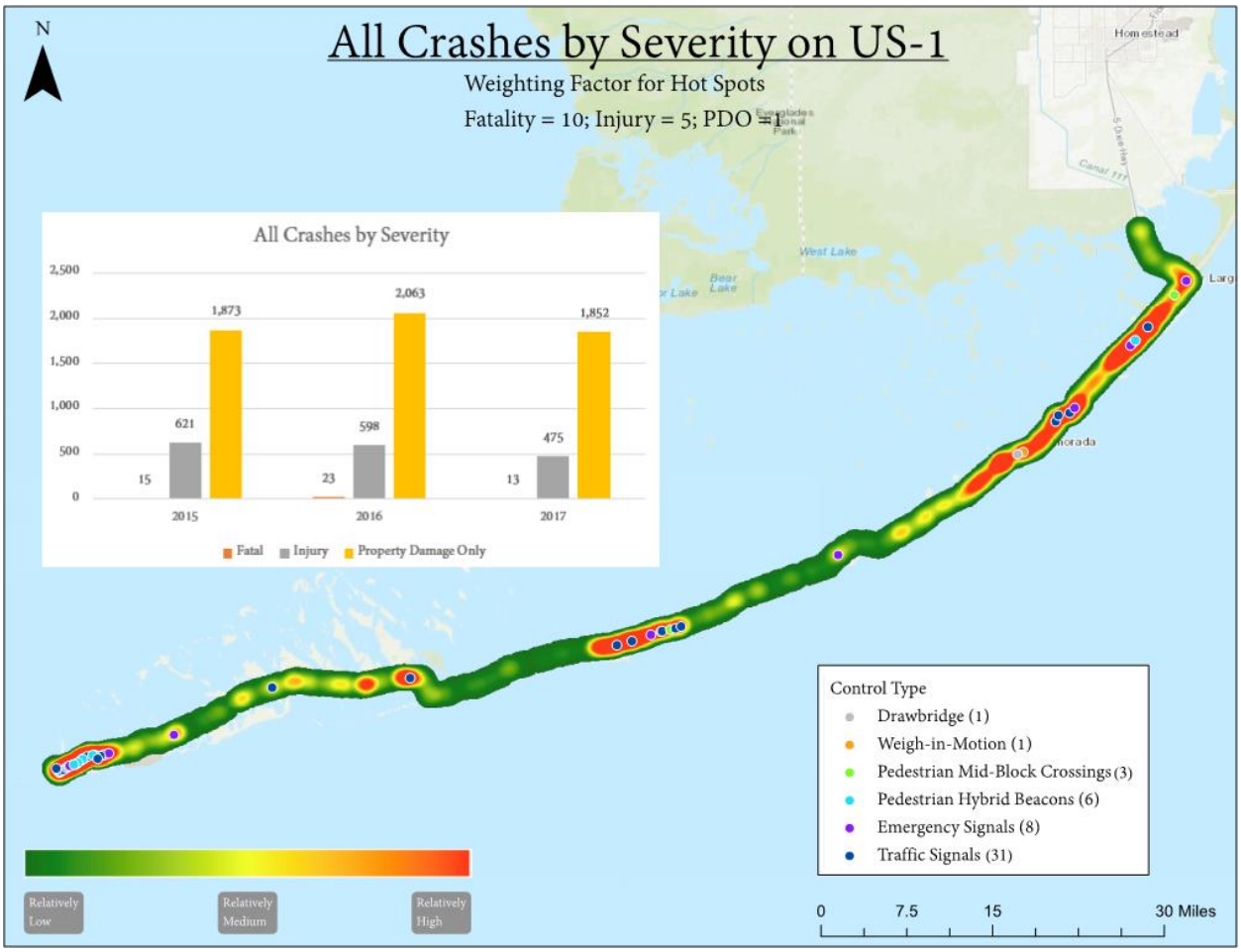
3. Current System Situation

This section of the ConOps describes the user experience of the existing system and sets the framework for the motivations for developing the system described in Section 4.

3.1. Background, Objectives, and Scope

The FDOT owns and operates traffic signals in the Florida Keys on US 1, which varies in lane width, from Key Largo in the north to Key West in the south. Traffic is an issue as there is an AADT of 11,000 to 32,000 vehicles per day, depending on location and time of year. Average truck traffic is seven to twelve percent. Traffic safety is an issue as there are significant numbers of crashes, as shown in Figure 1.

Figure 1: Florida Keys Crash Severity



Note: PDO is Property Damage Only.

3.2. Operational Constraints

This section covers limitations on the operational constraints of the existing system.

Presently, there is ITS in the deployment area (e.g., CCTV, DMS) that operates over wireless microwave communications, since the fiber optic network does not extend to the deployment area. All traffic signal connectivity to the SunGuide TMC is through cellular communications (Verizon). Regarding CV use, latency over cellular may affect CV alerts to the SunGuide TMC and coordination between signals. Broadband cellular latency should be less than 200 msec (0.2 seconds). Any SunGuide TMC to signal controller latency is probably introduced at the servers processing the data in the control center. The DSRC communications used in RSU to OBU communications is unaffected by the cellular latency, though the signal latency may be the controlling issue. Eventually the system may be moved to Wireless Broadband (WiBB).

The extant McCain signal controllers will need to make DSRC J2735 message-set data available. Upgrades are identified in Section 3.3.1. Typical one-second polling from controllers to the central system will not be sufficient for real-time SPaT data processing.

The Snake Creek Drawbridge is a hardwired system operated manually by a Tender who observes boat and vehicular traffic and has no communications with the SunGuide TMC.

3.3. Description of the Current System or Situation

The corridor traffic signals, not including drawbridge signals, emergency signals, and mid-block crossing signals, are connected by the cellular network. All the ATCs can make SPaT data available, but they need RSUs to disseminate that info to travelers. The signals alone, connected to one another or interfaced with the TMC signal software, can determine SPaT. The ATCs provide signal coordination in the field and to the TMC.

The Snake Creek Drawbridge, located on US 1 near mile marker (MM) 86 in Islamorada, Village of Islands is a hardwired system of two signals operated manually by a Tender who observes boat and vehicular traffic. It is not connected to any other system.

The Plantation Key Weigh Station, located on US 1 at mile marker (MM) 86 in Islamorada, Village of Islands, utilizes a manual toggle switch to change the OPEN or CLOSE message on the blank out signs. It is not connected to any other system.

3.3.1. Signals, Beacons, Drawbridge and Weigh-in-Motion Screening Station

US 1 in the deployment area has traffic signals, beacons, drawbridge, and pedestrian signals and a weigh-in-motion screening station:

- Thirty-One (31) traffic signals with McCain controllers (15 connected by cellular network to the SunGuide TMC, 16 not connected by cellular)
- Eight (8) emergency signals (not connected by cellular)
- One (1) drawbridge signal (not connected by cellular, operated locally by FDOT D6 Maintenance Contractor)
- Six (6) flashing beacons for pedestrians (not connected by cellular). Five of the six pedestrian hybrid beacons (PHB) are under construction, planned completion in 2019.

- Three (3) pedestrian mid-block crossings (2 connected by cellular network to the SunGuide TMC, 1 not connected by cellular)
- One (1) weigh-in-motion screening station

Figure 2 and Table 2 show the geographic layout of the signals.

Figure 2: Location of Traffic Signals and Devices.

Table 2: US 1 Signals (SW to NE)

Number	Intersection	Device	City/County
1	Fleming Street*	Traffic Signal	Key West
2	Southard Street*	Traffic Signal	Key West
3	Truman Avenue*	Traffic Signal	Key West
4	Duval Street*	Traffic Signal	Key West
5	Simonton Street*	Traffic Signal	Key West
6	Windsor Lane*	Traffic Signal	Key West
7	White Street*	Traffic Signal	Key West
8	Florida Street*	Mid-Block	Key West
9	Eisenhower Drive*	Traffic Signal	Key West
10	Fire Station*	Emergency Signal	Key West
11	First Street*	Traffic Signal	Key West
12	US Customs Services*	Mid-Block PHB	Key West
13	Fifth Street*	Traffic Signal	Key West
14	Fairfield Inn & Suites	Mid-Block PHB	Key West
15	Overseas Market*	Traffic Signal	Key West
16	Near Key Plaza*	Mid-Block PHB	Key West
17	Kennedy Drive*	Traffic Signal	Key West
18	Searstown*	Traffic Signal	Key West
19	Capital City Bank*	Mid-Block PHB	Key West
20	North Hotel*	Mid-Block PHB	Key West
21	S Roosevelt Boulevard*	Traffic Signal	Key West
22	Flagler Ave*	Traffic Signal	Key West
23	College Road*	Traffic Signal	Key West
24	Cross Street	Traffic Signal	Monroe
25	MacDonald Avenue	Traffic Signal	Monroe
26	3rd Street	Emergency Signal	Monroe
27	Emerald Drive	Emergency Signal	Monroe
28	Crane Blvd.	Traffic Signal	Monroe
29	Key Deer Blvd	Traffic Signal	Monroe
30	33rd Street	Traffic Signal	Marathon
31	Sombrero Beach Road	Traffic Signal	Marathon
32	89th Street	Emergency Signal	Marathon
33	107th Street	Traffic Signal	Marathon
34	109th Street	Traffic Signal	Marathon
35	121st Street	Mid-Block	Marathon
36	Sadowski Causeway	Traffic Signal	Marathon
37	Coco Plum Drive	Traffic Signal	Marathon
38	Layton City Hall	Emergency Signal	Monroe

Number	Intersection	Device	City/County
39	Plantation Key Weigh Station	Weigh-In-Motion Station	Islamorada
40	Snake Creek Drawbridge	Drawbridge Signal	Islamorada
41	Woods Avenue	Traffic Signal	Islamorada
42	Bessie Road	Traffic Signal	Islamorada
43	Ocean Blvd.	Traffic Signal	Monroe
44	Jo-Jean Way	Emergency Signal	Monroe
45	Woodward Way/Fisherman's Terrace/ East Drive	Emergency Signal	Monroe
46	Ocean Bay Drive/Atlantic Blvd	Traffic Signal	Monroe
47	South of Bay Drive	Mid-Block PHB	Monroe
48	Tarpon Basin	Traffic Signal	Monroe
49	North of Taylor Drive/Bowen Drive	Mid-Block	Monroe
50	CR905, Key Largo	Emergency Signal	Monroe

*The city of Key West signals are operated and maintained by City of Key West. The Department will assume the operations and maintenance starting July 1, 2020.

The SunGuide TMC uses Transparity® Traffic Management System (TMS) by McCain to manage and monitor the traffic signals in Table 2. Appendix C shows further details of field devices with additional information on emergency signals. Presently, McCain parts are in use. This discussion compares McCain products using their product numbers. To meet DSRC J2735 message set requirements, equivalent products would need to be retained:

- The McCain LMD-8000 and 1880EL are both NEMA TS 1 controllers. They would need to be replaced with McCain ATC eX2070 controllers or another TS 1 compatible controller.
- All traffic signals with Model 2070 controllers with E modules have been upgraded with 1c modules, except for traffic signals and emergency signal in the City of Key West.
- The NEMA locations would get controller cabinets equivalent to the extant McCain 332 controller cabinets.
- Use of Model 2070 controllers, as an option, would increase overall cost.

Note none of the emergency signals are connected to the RTMC central system. All RSU broadcasting for emergency services will be local.

3.3.2. RTMC

The FDOT District 6 Office SunGuide TMC is located at 1000 NW 111 Avenue, Miami, Florida. The SunGuide TMC is a 32,000-square foot facility featuring a multi-screen video wall and eighteen first floor workstations. FDOT uses fifteen of these workstations and the Miami-Dade Expressway Authority uses three for their respective staff to monitor and control closed-circuit television (CCTV) cameras, dynamic message signs, and vehicle detectors, to dispatch Road Rangers to clear accidents, remove debris, and assist stranded motorists.
The SunGuide TMC is a 24/7, secured facility with CCTV cameras set up to view the building's exterior as well as inside hallways and restricted areas (card entry access to sensitive rooms). An

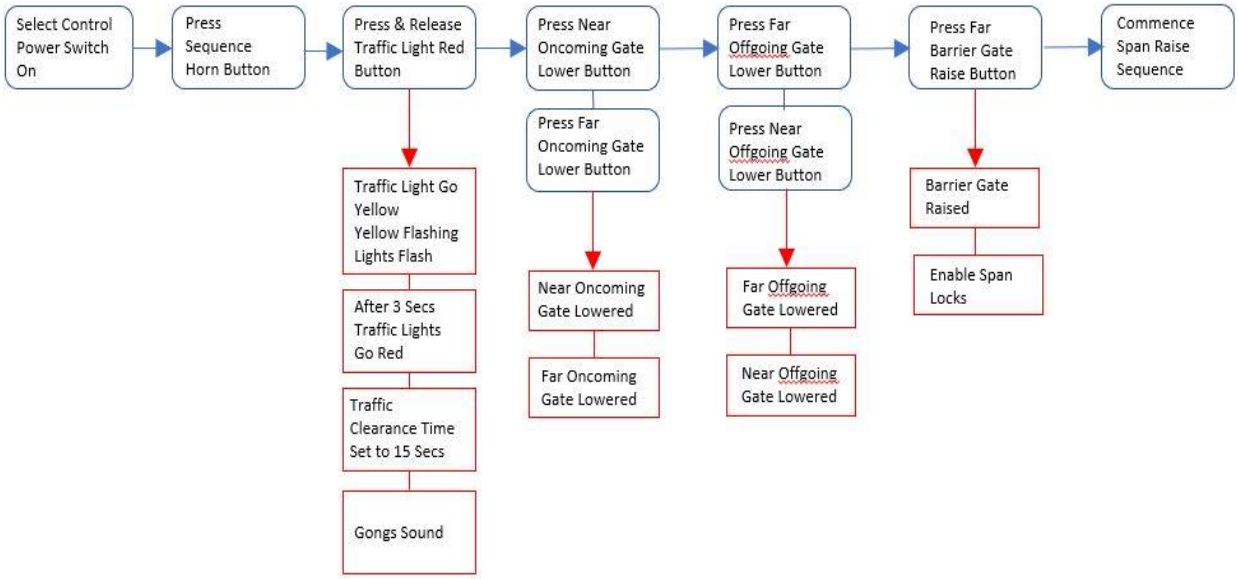
identification badge system provides separate control for the FDOT and FHP personnel. The building is designed to sustain the impact of a categories 1 and 2 hurricanes and has a diesel emergency generator and an uninterruptible power system supported with batteries for continuous operation during power outages.[3]

3.3.3. Snake Creek Bridge

Snake Creek Bridge is a single-leaf bascule bridge carrying the Overseas Highway (US 1) over Snake Creek, connecting Plantation Key and Windley Key. It is located near mile marker 86. The bridge is owned by the Florida Department of Transportation but managed by the Coast Guard, which has a sector station on Snake Creek. The bridge tender is contracted by FDOT. The bridge is opened once per hour, if needed.

Figures 3 and 4 describe the bridge open and close sequence block diagrams. The blue rectangles show the actions performed by the bridge tender. The red rectangles show the actions performed by the system in response to the bridge tender actions.

Figure 3: Bridge Open Sequence Block Diagram



[3] http://www.fdot.gov/traffic/its/projects_deploy/rtmc.shtm#D6

Figure 4: Bridge Close Sequence Block Diagram

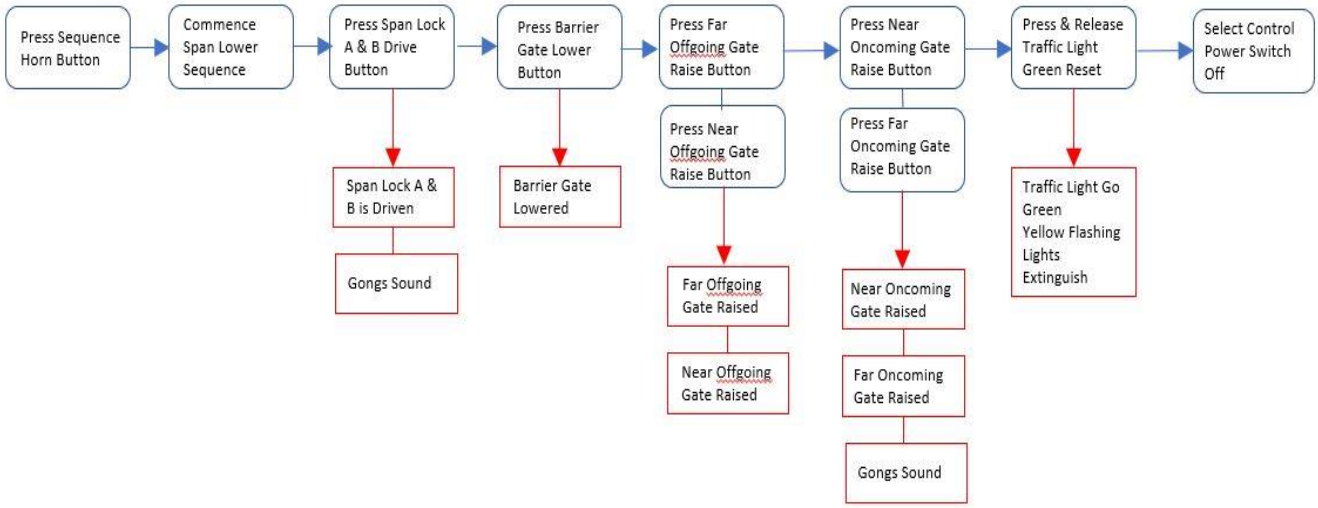
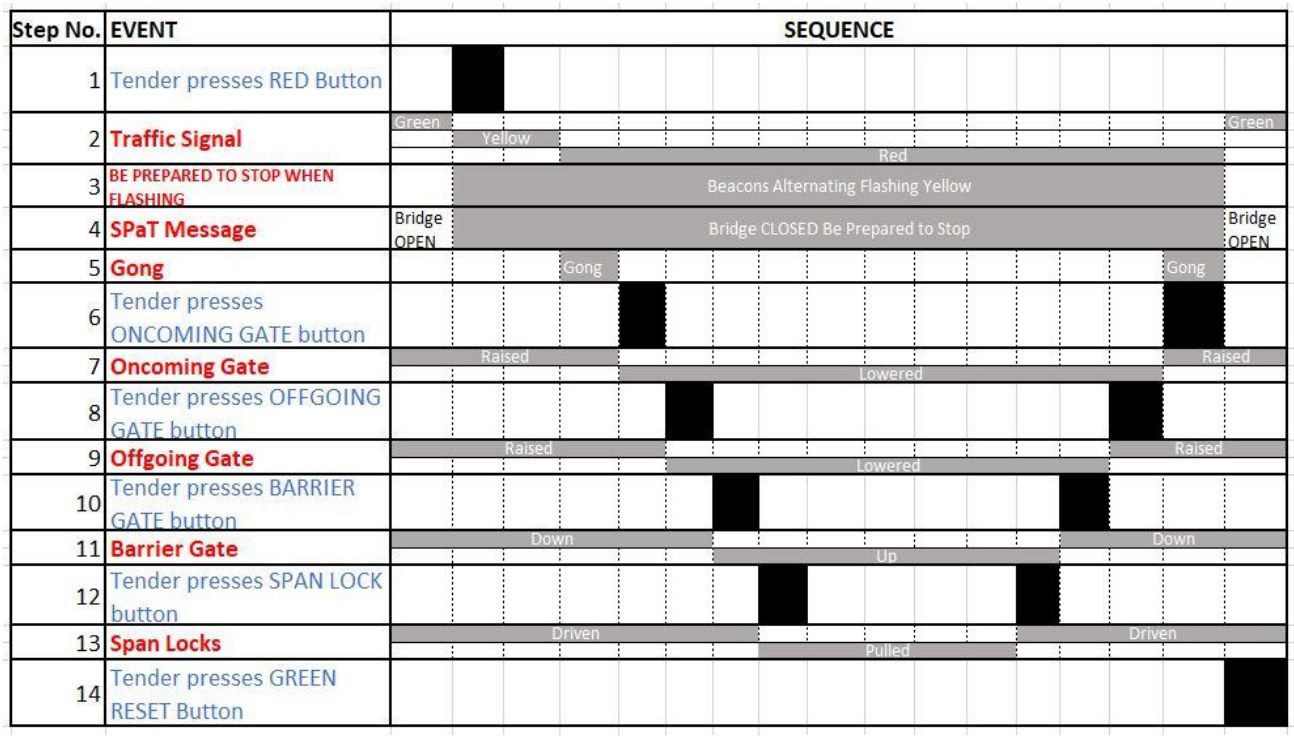


Figure 5 shows a phasing diagram and the pushbutton sequence steps performed by the bridge tender. The SPaT message indicating that the bridge is closed is initiated when the tender presses the RED button. In addition to the SPaT message, the traffic signal cycles to yellow and red and the flashing beacons are activated. When the GREEN RESET button is pressed, the traffic signal turns green, flashing beacons deactivate and the SPaT message indicates that the bridge is open.

Figure 5: Bridge Operating Sequence Steps

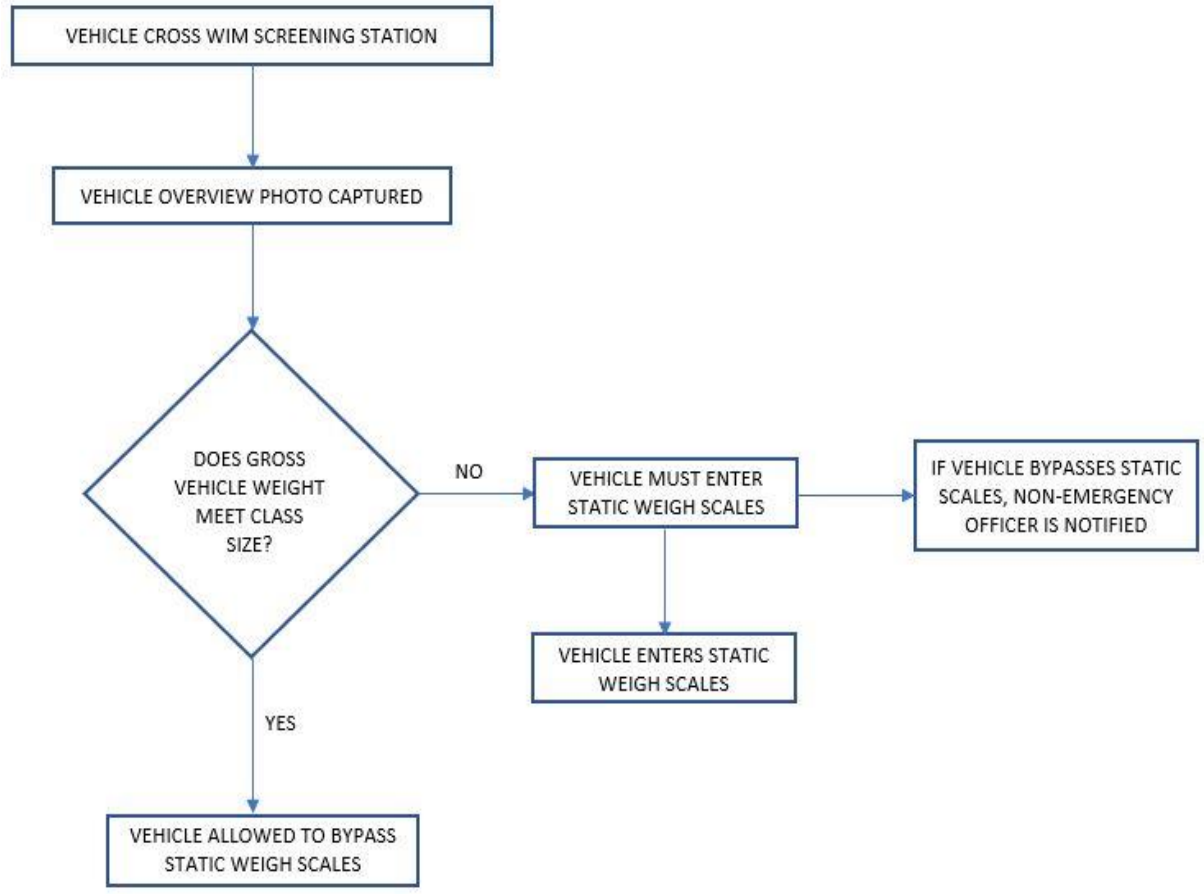


3.3.4. Plantation Key Weigh Station

The Plantation Key Weigh Station is located at Mile Marker (MM) 86 on US 1 in Islamorada, Village of Islands, Monroe County. The static scale house is located on the northbound side of US 1. There is a weigh-in-motion (WIM) screening station in the southbound direction; however, there is no WIM in the northbound direction. The northbound and southbound OPEN and CLOSE signs are manually operated with toggle switches from the static scale house.

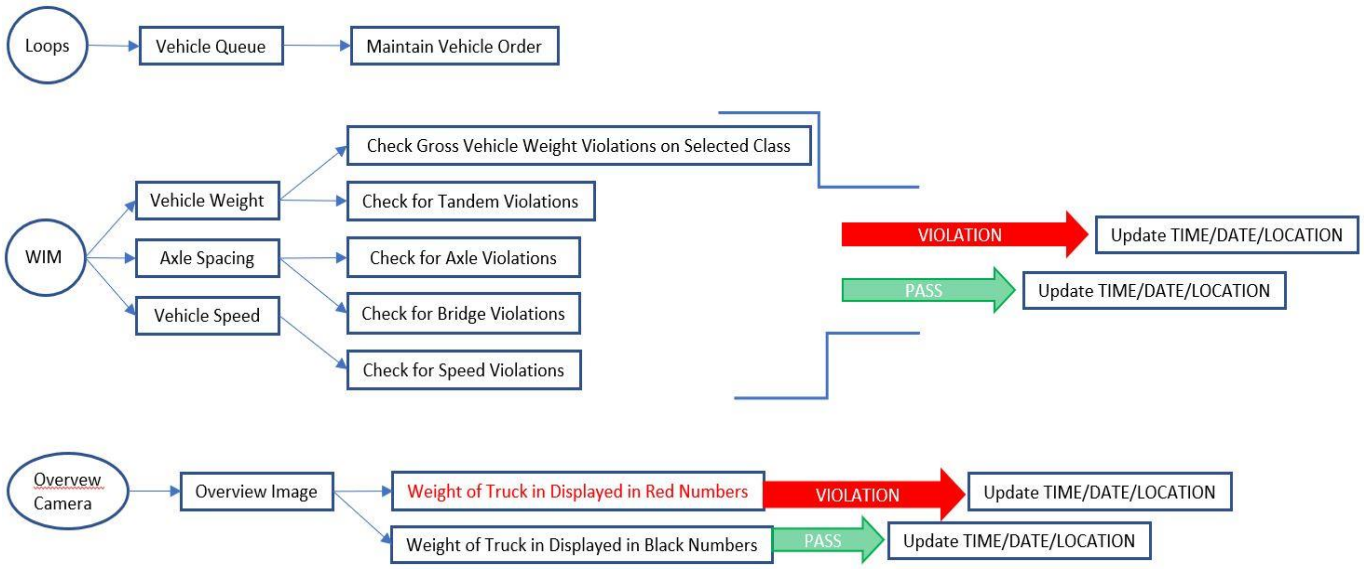
The WIM screening station lies approximately 930 feet upstream of the static scale house entrance. The station consists of an overview camera, WIM piezometer strips and inductive loops. Figure 6 shows the decision process as the vehicle passes through the WIM screening station.

Figure 6: Plantation Key Weigh Station Decision Process



There are several data points captured for each vehicle when it passes the WIM screening station. The loops track the vehicle from the point when it passes through the screening zone until it enters the static weigh scales. The WIM piezometers measure the wheel load and measure the axle spacings. The overview camera captures a picture of the front of the vehicle at a skewed angle. Figure 7 summarizes the inputs of the three devices mentioned.

Figure 7: Plantation Key WIM Screening Station Devices



At this time, the Plantation Key weigh station does not have license plate reader (LPR) cameras implemented. License plates are used to uniquely identify vehicles and cross reference them against known databases such as the Federal Motor Carrier Safety Administration's Performance and Registration Information Systems Management (PRISM), Florida Department of Highway Safety and Motor Vehicles, the Florida Highway Patrol Hot List, and the Florida Department of Agriculture and Consumer Services Ag List.

3.3.5. Communications

The SunGuide TMC is connected to the existing traffic signals by cellular communications except for the traffic signals in the City of Key West. The TMC connects to ITS equipment, including CCTV cameras and DMSs, through a combination FDOT owned wireless communications system and leased communication lines.

The TMC also connects to the Florida Keys by means of microwave towers at Big Pine Key (Key West), Tea Table Fill (Key Largo), Everglades Academy and Coral Reef Interchange, which are used for emergency radio communications. The microwave network is not used for ITS communications in the Florida Keys. The microwave network is used for statewide emergency management communications (EMC) as part of the Statewide Radio Bridging (SRB) microwave network. It is not known if the microwave system in the Florida Keys has the capacity or capability to assist with CV message traffic.

FDOT's ITS Communications Program Management coordinates deployment of a Statewide ITS Communications Network (SICN), interconnecting regional transportation management centers (RTMC) across the state. This SICN provides an operational network allowing Florida's RTMCs to share traffic information, ITS roadside device control, and video images.

The SICN provides connectivity throughout the state by utilizing the statewide microwave system (SMS). The SMS supports video and data sharing between operational RTMCs. The SMS uses a digital DS-3 backbone to create a seamless and blended statewide network. The SMS has a data network overlay to facilitate data and video transport across the state. This high-speed data network can transmit up to 48 Mbps between hub sites and up to 3 Mbps from remote sites to hub sites. The SMS can also support transmission of multiple streams of Intranet-based traffic information from remote field devices to RTMCs connected to the microwave system data network.

The SICN takes advantage of FDOT Districts' installed fiber optic facilities, where available, along with the SMS in other areas, to effectively complete interconnections. The SICN will advance ITS in Florida by providing statewide interconnectivity for the RTMCs.

FDOT's SMS includes installation and maintenance of microwave radios, fiber optic multiplexers, channel banks, timing and synchronization equipment, network management systems, and adequate lightning protection and grounding at all relevant sites. The SMS increases capacity at the transportation management centers to accommodate ITS deployment and communications capability.

3.4. User Profiles

In the proposed project implementation area, users of the traffic control system, as it is today, include the TMC staff and drivers. TMC staff can interact with the traffic signals to check signal status. Vehicles actuate detectors whereas pedestrians may push a signal button for crosswalk access. Drivers receive signal status only through the signal heads mounted above the roadway. Drivers at intersections can make judgment errors with respect to space and speed, leading to crashes.

3.4.1. Stakeholders

The list of stakeholders is summarized in Table 3. FDOT will hold meetings with the stakeholders to discuss the project. Stakeholders will signify endorsement of the ConOps through letters of support, upon their approval.

Table 3: Stakeholders

Stakeholder	Project Role
FDOT District 6	Owner
FDOT District 6 TSM&O	Engineering & ATSPM user
FDOT District 6 SunGuide TMC	Operator
FDOT Motor Carrier Size and Weight	Operator
FDOT District 6 Maintenance	Operator
FDOT District 6 TSM&O	Signal Maintenance

Stakeholder	Project Role
FDOT District 6 Network IT	Communications
FDOT District 6 and Asset Maintenance Contractor Fleet Drivers	CV User
Drivers (general public)	CV User
Emergency Services	CV User
Transit	CV User
Freight	CV User
Pedestrians & Cyclists	CV User

3.4.2. FDOT District 6

FDOT District 6 is the owner of the roadway and signal system. Its TMC is the operator of the signals and will operate the CV system. The TMC Arterial Operators will also use the ATSPM to improve signal coordination. FDOT and volunteer agency participant fleet drivers will be the initial users. At the Snake Creek bridge, FDOT D6 Maintenance is the operator of the BE PREPARED TO STOP WHEN FLASHING beacons.

3.4.3. FDOT Motor Carrier Size and Weight

The FDOT Motor Carrier Size and Weight (MCSAW) is the operator of the OPEN and CLOSE signs preceding the Plantation Key Weigh Station.

3.4.4. Florida Keys Transit Services

The Florida Key Transit Services will be one of the CV users. The agencies that will be involved include:

- Miami-Dade Transit Bus
  - Route 301 – Dade Monroe Express
  - Florida City to Marathon Key (MM 50)
- Key West Transit
  - Lower Keys Shuttle
  - Other routes - Blue, Orange, Green, Red and Duval Loop

Figure 8 shows the various routes of the transit agencies.

Figure 8: Florida Keys Transit Services

3.4.5. Freight Operators

Another class of CV users are the freight operators. Sources of freight trips include seaports, airports, retail outlets, and weigh stations. These are shown in Figure 9.

Figure 9: Freight Trip Generators

3.4.6. Emergency Services

Emergency services include the following agencies: Florida Highway Patrol and Monroe County Sheriff's Office, City of Key West and Key West Police.

3.4.7. Other CV Users

Other CV users include the general public.

3.5. Support Environment

FDOT is responsible for traffic control equipment and operations[4] at the subject intersections on US 1 (Figure 20, Appendix C). The traffic signals are coordinated through the FDOT District 6 SunGuide TMC. Fiber is not present, only cellular communications. Signal maintenance is contracted through a third-party contractor.

[4] The operations and maintenance of the traffic signals in Key West would be starting July 1,2020

4. Justification and Nature of the Changes

This section describes the shortcomings of the current system and the situation that motivates the modifications proposed for the existing system.

4.1. Justification for Changes

The current traffic system does not address user needs for safety and mobility that features of CV can provide at intersections. Additional means to reduce crash frequency and improve mobility at intersections are sought with CV technology to enhance traffic signals with in-vehicle alerts and signalization timing improvements. ATSPM also adds another tool to improve signal timing.

4.1.1. User Needs

FDOT D6 is the primary stakeholder and user in this deployment. FDOT D6 SunGuide TMC operatorsTMC Arterial Operators will oversee the CV system's effects on the traffic stream and use the ATSPM to evaluate and tune signal timings. Other stakeholders include FDOT D6 Maintenance, the operator of the Snake Creek Drawbridge, and FDOT Motor Carrier Size and Weight, who operates the Plantation Key Weigh Station. Initially, FDOT OBU equipped-vehicle drivers will be the only CV users primarily during the initial testing and integration phase of the project. Subsequently, volunteers from the general driving public, pedestrians, emergency vehicles, transit operators, drawbridge operators, and freight operators will participate, so their needs are considered in this project as well. User needs are treated in Table 4. The User Need Identification Number (ID), UNxxx, will be used in the Requirements Traceability Verification Matrix (RTVM) for reference of each need. User needs will help to identify:

- Requirements that will follow in the RTVM
- Performance criteria that will be used to evaluate the project's success in the System Validation Plan

The systems engineering process will be used to validate that each user need is, or is not, met by means of a performance measure.

Table 4: High-Level User Needs

User Need ID	User	Need
UN001	System Owner	Improve mobility of fleet vehicles/reduce delay
UN002	System Owner	Improve safety of driving and pedestrian population
UN003	Emergency Services	Fast response to incidents
UN004	System Owner	Ensure CV system data security (SCMS or equivalent)
UN005	System Owner	Reliable and low-latency CV system communications
UN006	System Operators	Evaluate system effectiveness - number of arrivals on green/red and other performance measures of signal control
UN007	System Operators	Data warehousing to support system evaluation
UN008	System Owner	Maintain RSUs, OBUs, communications
UN009	System Operators	Signal timing optimization/improvement (ATSPM)
UN010	System Operators	Notification of CV equipment or communications failure
UN011	System Operators	Notification of safety alerts
UN012	System Operators	Notification of incidents and bridge closings
UN013	Drivers	Trip time optimization/improvement, fewer stops on red
UN014	Drivers	Fewer crashes/safer transportation system
UN015	Drivers	V2V safety alerts
UN016	Drivers	V2I messaging for signal timing
UN017	Drivers	Data and privacy security
UN018	Drivers	User-friendly Human Machine Interface (HMI)
UN019	Drivers	Maintenance on OBU
UN020	Drivers	Upstream information on bridge closings
UN021	Pedestrians & Cyclists	Fewer incidents with vehicles
UN022	Transit	Better on-time performance and travel time
UN023	Transit	Increased ridership
UN024	Freight	Better on-time performance and travel time
UN025	Freight	Vehicle violation notification

4.1.2. Performance Measures

CV system performance measures, shown in Table 5, will be further refined, as needed, in the System Validation Plan that will follow this ConOps. Data will be available through standard TMC operations and with the installation of the ATSPM. These Measures of Effectiveness validate the project and its effectiveness in meeting user needs. Measures of Performance verify that equipment meets requirements in testing, which is part of the RTVM and System Verification Plan. Each user need should have an associated performance measure to see if the system met user needs.

Table 5: User Needs and Performance Measures

User Need ID	Need	Performance Measure
UN001	Improve mobility of fleet vehicles/reduce delay	Number of stops on red
UN002	Improve safety of driving and pedestrian population	Number of crashes
UN003	Fast response to incidents	Time to respond
UN004	Ensure CV system data security (SCMS or equivalent)	Number of privacy breaches
UN005	Reliable and low-latency CV system communications	Mean, median, maximum latency
UN006	Evaluate system effectiveness	Number of arrivals on green/red and other performance measures of signal control
UN007	Data warehousing to support system evaluation	Memory use, lost data, data security statistics
UN008	Maintain RSUs, OBUs, communications	Mean Time Before Failure
UN009	Signal timing optimization/improvement	ATSPM suite measures
UN010	Notification of CV equipment or communications failure	Number of alerts for maintenance
UN011	Notification of safety alerts	Number of alerts per time period
UN012	Notification of incidents	Number of incidents per time period
UN013	Notification of bridge closings	Number per time period, delay
UN014	Fewer crashes/safer transportation system	Number of crashes per time period
UN015	V2V safety alerts	Number of alerts per time period
UN016	V2I messaging for signal timing	Number of messages made
UN017	Data and privacy security	Number of attempted/successful breaches
UN018	User-friendly Human Machine Interface (HMI)	Driver information survey
UN019	Maintenance on OBU	Number of calls for maintenance, time required
UN020	Upstream information on bridge closings	Length of queue, delay
UN021	Fewer pedestrian incidents with vehicles	Number of pedestrian incidents
UN022	Better on-time performance and travel time of transit	Delay, vehicle probe data, travel time
UN023	Increased ridership	Transit ridership numbers – before after
UN024	Better on-time performance and travel time for freight	Delay, vehicle probe data, travel time
UN025	Vehicle violation notification to enter weigh station	Increase motor carrier compliance

4.2. Description of the Desired Changes

This section is a summary of the new or modified capabilities, functions, processes, interfaces, and other changes needed to respond to the justifications previously identified. Table 6 is an explanation of change categories and Table 7 is a list of desired changes.

Table 6: Desired Changes: explanation of categories

Change Type	Change
Capability	*(i.e., functions and features to be added, deleted, or modified)*
System Processing	*(i.e., changes to data uses, such as for communications, performance measures, etc.)*
Interface	*(i.e., changes to the system interfaces)*
Personnel	*(i.e., changes in personnel caused by new requirements)*
Environment	*(i.e., changes in the operational environment)*
Operations	*(i.e., changes in the operational environment)*
Support	*(i.e., changes in the support or maintenance requirements)*
Other	*(i.e., other changes not mentioned)*

Table 7: Desired Changes from US 1 CV/ATSPM project

Change Type	Change	User Need ID
Capability	ATSPM use for signal timing evaluation and coordination	UN009
Capability	CV V2I communications – SAE J2735 message set, WAVE, etc.	UN005
Capability	DSRC system security with SCMS	UN004
System Processing	ATSPM use for signal timing evaluation and coordination	UN009
System Processing	Cloud hosting service for two-way communications with CV data, as needed	UN005
System Processing	Update server and data storage for ATSPM and CV data	UN007
Interface	Install ATSPM software for operator use.	UN009
Interface	Upgrade controllers (e.g., Linux card, latest firmware)	UN005
Interface	Develop smartphone application. Use APIs from USDOT OSADP for pedestrian module.	UN002
Personnel	Current staff training for: ATSPM use, CV software use, CV equipment installation and maintenance. No new professional personnel	UN008
Environment	Installing: ATSPM in SunGuide TMC, CV RSUs in field, OBUs in FDOT fleet and asset maintenance contractor fleet vehicles	UN008
Operations	ATSPM and CV software in RTMC	UN006
Support	Field maintenance of RSU as needed	UN008

Change Type	Change	User Need ID
Other	Test Plan and Operational Readiness Testing prior to deployment	UN008

4.3. Change Priorities

The changes in Section 4.2 are all considered essential for the project deployment. Where priorities might be exercised is in the choice of service packages enabled. There are several CV service package architectures under development. Developing the rationale for and defining each service package is part of the task of this ConOps.

Before anything else, the system needs to build and test the basic functionality of V2I communications. The priority is that the system first test for basic DSRC message sending between the OBUs and RSU infrastructure (i.e., SPaT, MAP, TIM, BSM, SRM, and SSM). Wireless Access in Vehicular Environments (WAVE)and SCMS messages are necessary for the CV system to work at a basic level. OBUs also use the Global Navigational Satellite System (GNSS), which is the generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage. After that, the various service packages would be tested.

The pedestrian PID will need a functional smartphone application to receive notices from an RSU of notification of an approaching vehicle, deliver vehicle approach alerts, and send Personal Information Device (PID) location information. PID applications might be leveraged from the USDOT CV Pilots or OSADP applications. The project will assign staff to test the pedestrian device. Drivers will slow down or stop per the notification from the RSU.

4.4. Changes Considered but Not Included

Fiber is unavailable on the Keys. The applicability of cellular and the use of cloud computing are under discussion. There may be a possibility to use the Statewide ITS Communications Network (SICN) Statewide Microwave System (SMS). The SMS can also support transmission of multiple streams of Intranet-based traffic information from remote field devices to RTMCs connected to the microwave system data network[5].

With respect to drawbridge beacon assembly, some additional cellular connections will be needed for both RSUs. Just like emergency signals, there is no cellular coverage now.

The Plantation Key Weigh-In-Motion screening station will also require a cellular connection for the RSU.

Emergency, transit and freight CV services will follow on the Traffic Signal System (TM04) service package but are built together as a Use Case (see Section 5.3.1.2). Vehicle platooning is an option in the auto and freight priority service packages and is intended for future use.

[5] http://www.fdot.gov/traffic/its/Projects_Telecom/WAN.shtm

4.5. Assumptions and Constraints

This section describes assumptions or constraints applicable to the changes and new features.

The project management recognizes several assumptions:

- The project timeline and budget are sufficient.
- FDOT will receive the necessary DSRC FCC licensing within schedule.
- Some CV applications will be leveraged from USDOT CV Pilots (e.g., smartphone app, etc.).
- Controllers and RSUs will come from the FDOT Approved Products List (APL) or can pass testing by Transportation Engineering Research Laboratory (TERL).
- An OBU vendor will supply the contracted devices on time, within budget.
- The OBU design will be approved by FDOT TERL.
- A credential management vendor will be provided for SCMS installation and operational tests.
- Operational tests will not be compromised by drivers in the study area with Original Equipment Manufacturers (OEM) or aftermarket CV OBUs in operation in their vehicles. Drivers with their own CV equipment will be protected from potential interference during the tests. For example, drivers from another CV deployment (e.g., Tampa) will not inadvertently affect tests or be affected by tests.
- DSRC messages have a transmission of 300 feet. This may limit drawbridge transmissions to approaching traffic inadequately.
- Pedestrian smartphone software will receive messages from the RSU.
- OBU will receive messages from the RSU.
- RSU and related equipment (e.g., antennas, mounting brackets, etc.) will be installed on existing poles and mast arms.
- Conduit may be available for new wiring to the poles from the communication cabinet.
- Power is available to connect Power over Ethernet (POE) modules/injectors to power the POE devices.
- Switch ports are available for the communications back to the SunGuide TMC over cellular or a new cell connection or switch will be required.
- GPS will be installed on the cabinet for processing timing.
- Signal controller will support data connection.
- External access to SCMS service will be allowed.
- All interfaces will be compatible.

Only FDOT fleet and asset maintenance contractor vehicles will initially be involved and DSRC message sharing has been conceptually proven by FDOT in Tallahassee and is underway in the Tampa Hillsborough Expressway Authority (THEA) CV Pilot in Tampa. The Tallahassee SPaT Challenge deployed controllers and RSUs to transmit SPaT data along US 90 in Tallahassee. Also, the THEA CV Pilot deployed controllers and RSUs to transmit and receive DSRC messages with vehicles using OBUs. Both projects have been successful to date, so the CV technology and approach have been proven in concept and are considered to be within acceptable risks.

Further discussion of these and other assumptions can be found in the project PSEMP in the section on Identifying, Assessing and Mitigating Risk (PSEMP, Section 4.6).

5. Concepts for the Proposed System

This section includes a high-level description of the proposed system that indicates the operational features to be provided without specifying design details.

The following sections include information on the:

- Proposed system's objectives, and scope
- Operational polices or constraints imposed on the proposed system
- Description of the proposed system
- Modes of operation
- User involvement and interaction
- Support environment

5.1. Background, Objectives, and Scope

The traffic control system on US 1, is owned and operated by FDOT. FDOT plans to create a connected vehicle (CV) corridor consisting of 50 traffic control elements along 112.5 miles of US 1 from Key Largo to Key West, Florida. US 1 has McCain traffic controllers which are capable of upgrades to perform CV RSU functions with a Linux card and firmware. Some new controllers will be needed (see Section 3.3.1). The CV RSUs that will send DSRC-based SPaT, MAP, and TIM messages and OBUs will send/receive BSM data. Only V2I communications will be deployed and most processing will be done at the RSU, except for OBU and PID BSM/PSM transmissions and traveler warnings.

Additionally, as part of this CV deployment, ATSPM will be deployed in the RTMC in Miami. Operators will have access to performance measures of signals on US 1 over 112.5 miles of the Florida Keys. The ATSPM software is available through the FHWA OSADP where the ATSPM application can be downloaded. Information about the APACHE web server software licensing, operating requirements and installation can be found on the website cited in footnote 1. The APACHE License 2.0 is a permissive free software license written by the Apache Software Foundation (ASF).

5.2. Operational Policies and Constraints

5.2.1. CV

As part of this project, the RSU vendor will develop sufficiently accurate MAP intersection data, perform equipment development and installation, configure and test the RSU/OBU/PID system components in the field, and perform project management. FDOT will apply for the Federal Communications Commission (FCC) DSRC site licensing.

ORR will be performed by the vendor(s) and FDOT in the field on US 1. The field equipment will be fully operational at the stage at which it is developed in this deployment. The project is to install, field test, and operationally utilize the RSUs for communication with OBUs and the RMTC. Additional field tests with OBUs will extend to sending and receiving messages from among the SAE J2735 DSRC message set list which includes:

1. MAP*

2. SPaT
3. BSM*
4. Common Safety Request
5. Emergency Vehicle Alert
6. Intersection Collision Avoidance
7. NMEA corrections
8. Probe Data Management
9. Probe Vehicle Data
10. Road Side Alert
11. RTCM Corrections
12. Signal Request Message (SRM)*
13. Signal Status Message (SSM)*
14. Traveler Information Message (TIM)*
15. Personal Safety Message
16. Test Messages

The asterisked items (BSM, SPAT, MAP, TIM, SSR and SSM data) and, in addition, WAVE and SCMS messages are necessary for the CV system to work at a basic level. OBUs use the Global Navigational Satellite System (GNSS), which is the generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage.

Definitions from SAE are offered for the five key DSRC message sets:

- The MAP message is used to provide intersection and roadway lane geometry data for one or more locations (e.g. intersections and fragments of maps). Almost all roadway geometry information as well as roadway attributes (such as where a do not block region exists, or what maneuvers are legally allowed at a given point) is contained in the "generic lane" details of this message. MAP messages are used in intersections to number and describe lane level details of each lane, while the SPAT message provides the current state of each signal head controlling the ability to stop or pass in a given lane.
- The SPAT message is used to provide the current signal phase timing data (times at which signals will change) for one or more signalized intersections, as well as other time of day status details. All SPAT messages link to MAP messages to convey the roadway details and to link the signal controller phases to the correct set of lanes.
- The all-purpose BSM message used by both light duty vehicles and other types with various Part II content present, depending on the applications being supported. See the different J2945/x documents for further details. In simple terms, all equipped vehicles broadcast a stream of BSM messages at a 10Hz rate. Nearly all application exchanges (V2V, V2I, V2X) make use of the presence of BSMs as a prerequisite for operation.
- The TIM message is used to contain a variety of traffic conditions and "advanced traveler" messages. In this project it will deliver warning messages to pedestrians and drivers from the RSU.
- The SRM messages are used by authorized parties to request services from an intersection signal controller (i.e., the RSU). Vehicles approaching an intersection use this message to affect the signal operation. This is how traditional preemption and priority requests are handled for intersection safety in DSRC.

- The SSM messages, which are sent by the local DSRC Signal Controller (i.e., the RSU), are used to reflect the current operational state of the intersection signal control. Any prior request services (SRM messages) and their outcomes are reflected here as well. This message therefore serves as a means to acknowledge signal requests.
- Personal Safety Message (PSM) message is used to convey similar BSM-like information for at-risk pedestrian users (rather than being vehicle mounted). The PSM message is described in further detail in the J2945/9 standard. Broadcast by VRU devices is designed to announce their presence to approaching vehicles. VRUs can include pedestrians, bicycles, and road construction crews. Devices can include Cell Phones, Bike mounted H/W, Construction equipment (e.g., cones, barrels, badges, etc.). The PSM system is still under development.

In addition, the WAVE system is a radio communication system intended to provide seamless, interoperable services to transportation. These services include those recognized by the National Intelligent ITS Architecture (ARC-IT). A WAVE system advertises available services by way of sending periodic messages known as WAVE Service Advertisements (WSA). The WSA is used to advertise SCMS messages from the RSU, including IP addresses. OBUs must receive and process WSAs.

5.2.2. ATSPM

The ATSPM software is licensed under APACHE 2.0 per the FHWA OSADP website (footnote 1).

5.3. Description of the Proposed System

5.3.1. CV

The RSU devices shall support CV services and data flows from the signal controllers and broadcast DSRC messages to the vehicles and pedestrians. OBU devices shall be of the aftermarket type, a portable device for use in the vehicle and integrated into the vehicle system. Pedestrian smartphone software will receive messages from the RSU.

McCain, Inc., the extant signal controller vendor may be the RSU card vendor. The RSU vendor will provide a Software Development Kit (SDK) license to FDOT for the RSU. The Vendor shall provide troubleshooting guides, firmware upgrades and customer service plan throughout duration of the project, and warranty documentations and ensure all warranties are transferred to the Department. The Manufacturer's Warranty shall include all software and hardware upgrades required to comply with the latest version of the standards. The on-site service includes the hardware and software technical support, firmware upgrades, software upgrades, licenses, product upgrades, and hardware repair and support with guaranteed response times for diverse levels of problems. Section 3.3.1 has information on the existing McCain signal controllers and upgrade needs.

5.3.1.1. Field Installation

The equipment tests described later in Section 5.3.1.2 and training in Section 5.6 form the basis of the follow-up FDOT field installations and tests. These tests will be carried out at 50 signals along US 1. Figure 10 shows the data flows for the field test.

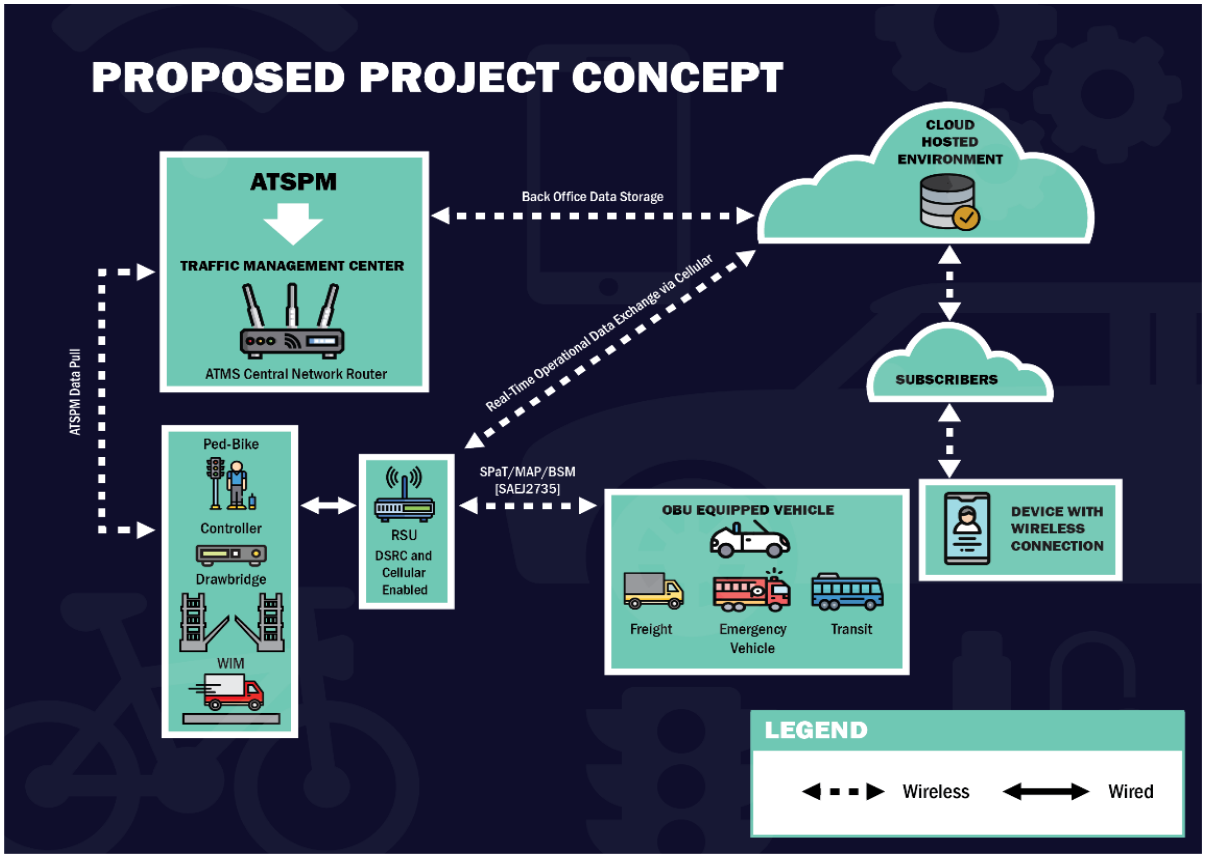
In the Field Test, the vendor will connect and test the RSU, antenna(s), and other support equipment (e.g., mounting accessories, connectors for power and communications) at the 50 controllers installed on US 1. FDOT will oversee the vendor's installation, integration, and testing.

The vendor will connect and test their system using the portable aftermarket OBUs and document their findings. The goal of the testing is to ensure:

- RSU message compliance with SAE J2735_201603
- BSMs and PSMs comply with SAE J2735_201603 and J2945/1
- SPaT message status agrees with the Signal Head status per DSRC refresh rate
- WSAs and SCMS are operating and performing to specifications

The figure shows how the CV system is configured for communications and data flows. The SunGuide TMC connects over cellular to the controller cabinets in the field which will house the RSU Linux card. The RSU is connected to the controller over Ethernet or hardwired NTCIP connection. The DSRC messages (e.g., SPaT, MAP, BSM) transmit between the vehicle's OBU and the RSU and controller. The vehicle is connected to the RSU via DSRC and to the SunGuide TMC via cellular in a real-time operational data exchange environment via the cloud-hosted environment as shown. The system will offer low latency, secure applications, TMC control, and minor infrastructure modifications.

Figure 10: Overall CV Concept (OMNI eX ICS)



5.3.1.2. Service Packages and Use Cases

The project will deploy several CV service packages with the RSUs, OBUs and supporting communications. Generic service packages are defined in the National ITS Reference Architecture, ARC-IT and are presented in Appendix A. The final approved service package concepts will be drawn up in RAD-IT to update the District's RITSA.

The CV system will operate National ITS Architecture (i.e., ARC-IT) service packages that include:

- CVO06 – Freight Signal Priority
- CVO08 – Smart Roadside and Virtual WIM
- PS03 – Emergency Vehicle Preemption
- PT09 – Transit Signal Priority
- TM04 – CV Traffic Signal System
- TM18 – Drawbridge Management
- VS12 – Pedestrian and Cyclist Safety
- VS02 – Vehicle to Vehicle (V2V) Basic Safety

In the generic service package physical diagrams (Appendix A), CV Traffic Signal System (TM04) may be considered the core service package for any systems related to intersection control. Three

of the service packages (CVO06, PS03, and PT09) are similar and are combined with TM04 into a Use Case for Traffic Signal Priority/Preemption (Use Case TSP/P) for auto, emergency, transit and freight CVs. These are grouped together, and their system and user interdependencies are presented under System and User Interdependencies in Appendix B (see also Section 6).

The Drawbridge Management (TM18), Pedestrian and Cyclist Safety (VS12) and Vehicle to Vehicle (V2V) (VS02) service packages do not afford themselves to combination into Use Cases in this project and are treated as individual service packages.

SCMS is represented in ARC-IT as a Systems Support service package, SU08 - Security and Credentials Management. SCMS will be purchased according to the current state of the practice and vendor capabilities, so its ARC-IT service package details are not discussed at length in this ConOps. It may need to be included in the RITSA along with the six other service packages in this section.

5.3.1.2.1 TSP/P Use Case (TM04, CV006, PS03 and PT09)

The CV Traffic Signal System (TM04), is the core service package for any systems related to intersection control. Three of the service packages (CVO06, PS03, and PT09) are similar and are combined with TM04 into a Use Case for Traffic Signal Priority/Preemption (Use Case TSP/P) for auto, emergency, transit and freight CVs. These are grouped together, and their system and user interdependencies are presented under System and User Interdependencies in Appendix B (see also Section 6). Auto and freight vehicles are capable of encouraging "vehicular platooning" (self-organization of vehicles into cohesive groups) to improve signal throughput through intersections. The system is presented in Appendix B.

5.3.1.2.2 Drawbridge Service Package (TM18)

The bridge Tender automatically activates the CV system when turning on the control panel as done now. The Tender will do exactly the same job as currently done, but the point-to-point wireless activated RSU will automatically send omnidirectional DSRC messages to drivers on each side of the bridge that there is a closing and, later, an opening to traffic. DSRC messages have a range of 300 feet. The RSU will notify the SunGuide TMC of a delay at the bridge, which may be used to adjust signal timings at locations on each approaching direction. The users of this service package are the drivers who receive the alert as outlined in the User Needs Table 4, UN020.

The timing intervals for the amber and red signals are mechanically timed through relay timers. All operations are performed via the pushbuttons on the control panel and wired to a large circuit board. The bridge controls are hardwired to the control panel.

The new operations for the drawbridge bridge follow with the RSU's role shown in steps 7 and 13:

1. Control Panel rests in an "Off" state; completely off.
2. When the bridge Tender receives a request, the Tender will turn on the control panel, which will also immediately activate the warning audible bells and flashing lights.
3. The Tender will then actuate the "Red" button to cycle the traffic signals from green into the amber and red intervals.

4. The amber interval will initiate a signal from an extant primary radio, located in the Bridge Tender's House.
5. Secondary radios, co-located with the future installed flashing beacons at both northbound and southbound bridge approaches, will receive the signal.
6. The secondary radios will activate the RSU.
7. The RSU will send an alert to the Drivers and to the SunGuide TMC.
8. Once the traffic signals are all red, the Tender will verify that traffic has cleared the bridge and lower the bridge gates.
9. Subsequently, the barrier on the northside of the bridge will rise and the bridge span will be unlocked.
10. The bridge span will rise and stay open for the necessary time for a boat to clear.
11. The Tender will then perform the above-mentioned steps in reverse order to open the bridge to vehicular traffic.
12. Once the gates are up, the Tender will actuate the Green indication and turn-off the control panel.
13. The RSU will deactivate the alert to the Drivers and the SunGuide TMC.

The generic physical diagram for the TM18 – Drawbridge Management service package, in Appendix A, shows that the driver will receive a message from the RSU when the crossing status changes. Presently control is by a Bridge Tender by hardwire traffic signal and gate closure. The CV system will add an RSU that will connect to the extant signal control and send an omnidirectional message to CV-equipped upstream drivers and to the TMC operator. Control is shown in the figure to be by the TMC operator. However, in this system, TMC Arterial Operators will not control the drawbridge but will be informed by RSU of the traffic interruption.

5.3.1.2.3 Pedestrian and Cyclist Safety Service Package (VS12)

One challenge for mobile apps is the accuracy of location and speed information supplied by smartphone GPS. Geofence detection of vehicle presence and pedestrian presence is the simplest approach but may be inadequate. All processing is done by the RSU. Alerts are sent from the RSU to the PID and OBU. The PID and OBU supply the alert system through the HMI. The PID and OBU devices need only read and interpret a DSRC Traveler Information Message (TIM) from the RSU.

Alerts consist of a beeping sound and a suitable pictographic image on the OBU and PID, as appropriate.

At midblock crossings direction isn't a concern, but at four-way intersections the user must add direction with the application on the PID.

For convenience, pedestrians and cyclists are referred to as non-motorized travelers (NMT) in the following discussion.

The entire generic V12 service package in ARC-IT offers many possible functions[6]:

[6] https://local.iteris.com/arc-it/html/servicepackages/sp50.html#tab-3

This service package supports the sensing and warning systems used to interact with pedestrians, cyclists, and other non-motorized users that operate on the main vehicle roadways, or on pathways that intersect the main vehicle roadways.

These systems allow automated warning or active protection for this class of users. It integrates traffic, pedestrian, and cyclist information from roadside or intersection detectors and new forms of data from wirelessly connected, non-motorized traveler-carried mobile devices to request right-of-way or to inform non-motorized travelers when to cross and how to remain aligned with the crosswalk or pathway based on real-time Signal Phase and Timing (SPaT) and MAP information. In some cases, priority will be given to non-motorized travelers, such as persons with disabilities who need additional crossing time, or in special conditions (e.g., weather) where non-motorized travelers may warrant priority or additional crossing time. This service package will enable a service call to be routed to the traffic controller from a mobile device of a registered person with disabilities after confirming the direction and orientation of the roadway that the individual is intending to cross. It also provides warnings to the non-motorized user of possible infringement of the crossing or pathway by approaching vehicles.

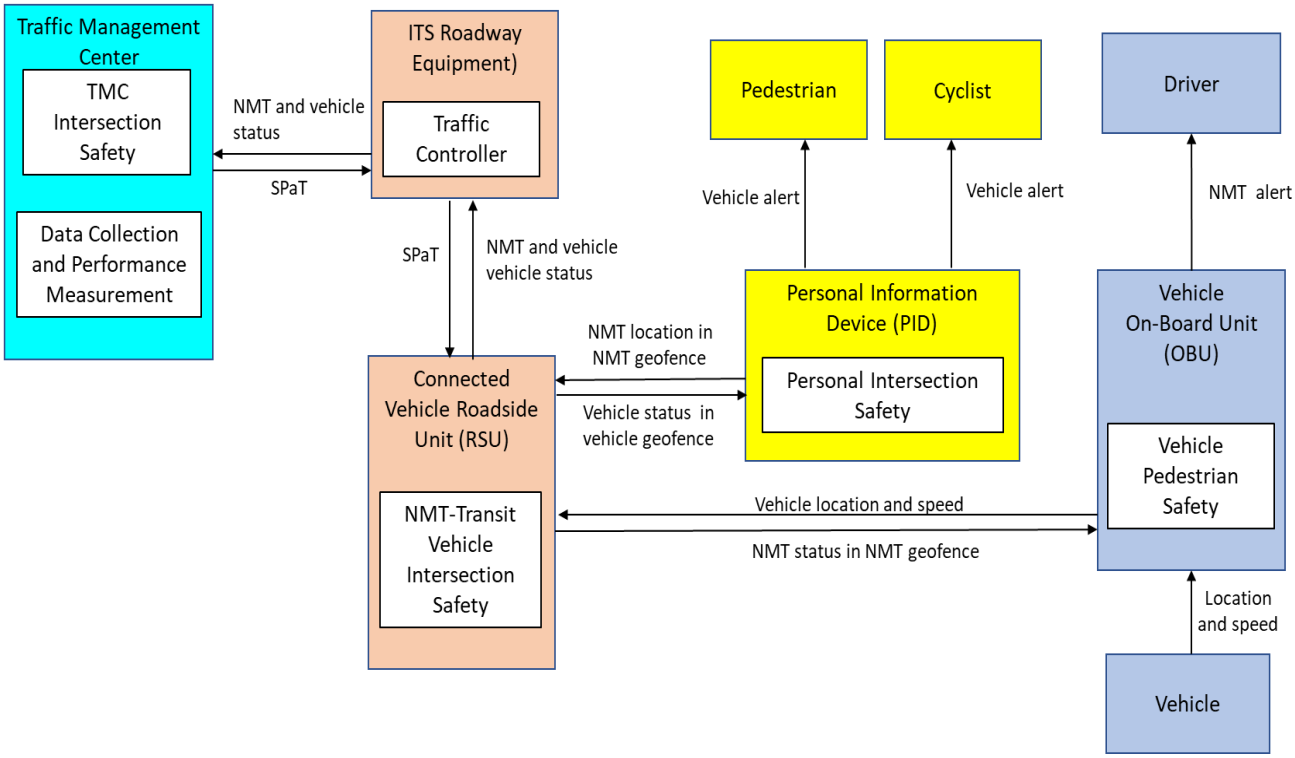
Of these, only some of the possibilities will be used for the NMTs initially:

- RSU to PID
  - Provide alert to the NMT of possible infringement of the crossing or pathway by approaching vehicles
- PID to RSU/controller
  - Send PSM data
- RSU to OBU
  - Provide alert to the driver of possible crossing by NMT
- OBU to RSU
  - Send BSM data

5.3.1.2.4 Vehicle to Vehicle (V2V) Basic Safety Service Package (VS02)

This service package exchanges basic safety messages with surrounding CAVs to support and augment the safety warning and control automation features. These exchanges support the CV safety applications defined in Society of Automotive Engineers (SAE) J2945/1. As a part of this project, a warning about approaching vehicles and pedestrians to all modes of transportation with onboard units (OBUs) will be implemented.

Figure 11: VS12 Service Package for NMT Safety



5.3.2. ATSPM

The Purdue research efforts created a new national standard of signal performance measurement using the following performance measures:

- **Cycle Length** - consistency over dedicated time periods over course of 24-hour day
- **Equivalent Hourly Flow Rate** – all phases, flow rate over course of 24-hour day
- **Green Time Plot** – all phases, green time of each cycle over course of 24-hour day
- **Volume to Capacity Ratio** – all phases, V/C over course of 24-hour day
- **Split Failures** – all phases, number of split failures over course of 24-hour day
- **Purdue Coordination Diagram** – single phase, time within cycle over course of 24-hour day indicating vehicle arrival, start of green, start of yellow, start of red splits
- **Percentage of Phases with Pedestrians** – four phases with pedestrian phase, and number of signal cycles in a 30-minute period that have a pedestrian activation

The ATSPMs are discussed in greater detail in publications dedicated to its installation and use, available at the FHWA OSADP[7] website.

[7] https://www.itsforge.net/

5.4. Modes of Operation

Modes of operation include:

- Installation/Testing/Maintenance
- Normal Operations
- Equipment or Communications Failure
- Emergency Operations

5.4.1. Installation, Testing, and Maintenance

Initial testing must allow for drivers with CV equipment passing through the study area to not interfere with nor be interfered with by the equipment installation and tests. The testers will use RSUs and OBUs to verify message compliance and will test messaging to the SunGuide TMC. Installation, testing, and maintenance of the CV equipment will be done according to the vendor's prescribed methods and with due diligence for maintenance and protection of traffic and CV messaging.

Installation and testing of the ATSPM is an in-house process and will not affect SunGuide TMC or field operations.

5.4.2. Normal Operations

In normal operations, the CV equipment will seamlessly allow communications messaging from V2V and V2I. Drivers will receive safety alerts and receive priority at signals when allowed. The Service Packages listed in Section 5.3.1 operate according to their prescribed functions.

Normal operations of the ATSPM software will not affect SunGuide TMC or field operations. SunGuide TMC Arterial Operators will routinely, per standard operating guidelines (SOG), analyze and calibrate signal timings on US 1 in the deployment area and analyze and report the effects noted of CV vehicles.

5.4.3. Equipment or Communications Failure

Fail safe failure should be designed into the CV system. Under failure of equipment or communications, the RSU system will notify the SunGuide TMC operator of a system problem. SunGuide TMC Arterial Operators will conduct due diligence in reducing the problem to its component failures and issue a response for maintenance. This corresponds to user need UN005 in Table 4. Drivers will receive a local message where the OBU system is inoperable.

The ATSPM software can indicate controller failures through its performance measures. As a performance measurement system, it does not control traffic signals or communicate with drivers, so it does not affect field operations and in that sense, is fail safe.

5.4.4. Emergency Operations

Priority of emergency vehicles will be built into the system.

The CV system has capability to use CV service packages to improve strategic signalization and driver information in the event of an emergency. While these will not currently be tested in the project, their potential is noted.

The SunGuide TMC Arterial Operators will use the ATSPM in conjunction with CV probes and traffic signal timings to improve traffic flow exiting the Florida Keys during an emergency. When people are headed out of the Keys, the CVs will have the ability to platoon with the ATSPM which will improve signal timings.

5.5. User Involvement and Interaction

In this CV deployment, FDOT signal system maintainers, SunGuide TMC Arterial Operators, fleet drivers, pedestrians and drawbridge Tenders are the intended initial users of the system. As described in Section 5.3, implementation and tests will follow the system vendor's training and instructions to FDOT staff who will carry out installation and testing on US 1 according to the TRR and ORR plans. Transit, freight, and emergency service vehicles can be included in the tests and follow up use per their respective stakeholder commitments in this ConOps development process. Beyond the scope of the deployment, CV users from the general public will be able to receive SPaT, MAP, and TIMs, and their BSMs will be received by the RSUs.

The ASTPM will be used according to SOGs that the SunGuide TMC will develop for TMC Arterial Operators and FDOT traffic engineers.

5.5.1. FDOT Signal System Maintainers

FDOT maintainers will be trained to install, test, and maintain the new equipment. Maintainers will attend the vendor training and employ the training to install and test the RSUs and ensure that the equipment works correctly with OBUs and PIDs. This includes:

- SPaT, MAP and TIM data comply with SAE J2735_201603
- SPaT message status matches the Signal Head status
- BSMs comply with SAE J2735_201603 and J2945/1

Vendor installers will be responsible to install and test the fleet vehicle OBUs according to TRR and ORR plans that are further explained in the PSEMP.

5.5.2. D6 SunGuide TMC Arterial Operators

D6 SunGuide TMC Arterial Operators will use their workstations to interpret CV data flows to and from RSUs and OBUs. The TMC connection step in the testing of this deployment will be integrated in the TRR and ORR plans.

The SunGuide TMC operators will train in the use of the ATSPM and use the performance measures according to the TMC SOGs.

5.5.3. Fleet Drivers

Fleet drivers will interact with CV service packages through their OBUs. FDOT will train its drivers in the use of the OBUs. Arrangements will be made as part of stakeholder input in this ConOps to test the OBUs on transit, freight, and emergency service vehicles.

5.5.4. Pedestrians

Staff from the D6 will train in the use of the PID application and test it at midblock and intersection crossings.

5.5.5. Drawbridge Tenders

The Tender will do exactly the same job as currently done, but the point-to-point wireless-activated RSU will automatically send directional DSRC messages to drivers on each side of the bridge that there is a closing and, later, an opening to traffic.

5.6. Support Environment

FDOT owns and operates the traffic signals on US 1 (Figure 2), except for the city of Key West signals which are operated and maintained by City of Key West. The Department will assume the operations and maintenance starting July 1, 2020. FDOT fleet vehicles are housed at the District 6 Maintenance Yards and installations of OBUs will be done there. The vendor(s) will furnish, install, integrate, test, and carry out training (FIITT). CV training, installation, integration, configuration, monitoring, and ATSPM training are discussed next.

The support environment will include maintenance contracts on CV equipment and the cloud environment. Details of these are not available but will be part of requirements specifications and the Request for Proposals (RFP).

5.6.1. CV Training

The RSU provider will supply classroom training(s) of equipment installation, configuration, integration, and commissioning of its RSU, equipment, assemblies, and all related components and capabilities.

The OBU vendor will be responsible for installation and will provide training to FDOT and asset maintenance contractor in the installation, replacement, and use of the OBU.

The vendor(s) will supply classroom training(s) and related materials (handouts, slides, booklets, etc.) on equipment installation, configuration, integration, and commissioning of the RSU equipment assemblies, and other related components. The classroom training session(s) on the equipment shall be provided to FDOT signal maintenance staff (RSU) and fleet maintenance staff (OBU). The vendor will provide handouts, slides, and training booklets and other material. FDOT will provide the training facility. The contractor shall provide a Certificate of Completion to all individuals who successfully complete this training.

5.6.2. CV Installation, Integration, Configuration, Monitoring

The vendor(s) will install the RSUs and any additional equipment (e.g., antennas) with oversight and training of FDOT. The vendor will supply the RSUs, OBUs, and related equipment and undertake or oversee installation by FDOT, as determined by FDOT. The vendor will supply field installation oversight and integration support (by phone and on-site, as needed).

FDOT District 6 will test and assure proper operations and DSRC message sending between the RSUs, RTMC, and OBUs, as per Section 4.6.1 in Florida's SEMP for TRR and ORR plans. As part of this testing and approval effort, FDOT District 6 will work with TERL for approval of any equipment new to the APL, as needed, and will support the SCMS vendor with testing the SCMS. The District will work with the SCMS vendor in coordination with FDOT Central Office TSM&O.

5.6.3. ATSPM Training

The vendor(s) will arrange for training of SunGuide TMC Arterial Operators in the use of the ATSPM software. The software is available online and FDOT or an appropriate Department contractor entity will perform the installation and test.

5.6.4. ATSPM Installation, Integration, Configuration, and Monitoring

FDOT will install the ATSPM software as detailed on the FHWA OSADP website (footnote 1).

6. Operational Scenarios

Operational scenarios give a picture of how users interact with the system from the user's point of view. In the subsections below are brief descriptions of how users will experience the system. The intention is for the systems engineers to see the system operation as a user would, and to enable visualization, not only of the advantages to travelers and operators, but also where problems or shortcomings might arise.

A second treatment is offered that is more technical and detailed, termed System and User Interdependencies, and is presented in tabular form in Appendix B. The tables give a representation of how the TSP/P Use Case and Pedestrian Safety and Drawbridge Management service packages will work under normal and degraded modes of operation.

Four CV service packages are combined into the Use Case TSP/P, and their System and User Interdependencies are shown in the tables in Appendix B. For Use Case TSP/P, a multiple requests mode is included (Scenario 5) and the degraded modes treated include diminished communications (Scenario 6). The Scenarios treated for Use Case TSP/P include:

- Scenario 1: Normal Operating Conditions – Auto CV Signal Priority/Intent to Platoon Priority
- Table 10: Use Case TSP/P – Scenario 2: Normal Operating Conditions – Emergency Vehicle Preempt
- Table 11: Use Case TSP/P – Scenario 3: Normal Operating Conditions – FSP/Intent to Platoon Priority

- Table 12: Use Case TSP/P – Scenario 4: Normal Operating Conditions – Transit Signal Priority
- Table 13: Use Case TSP/P – Scenario 5: Normal Operating Conditions – Multiple Priority/Preemption Requests
- Table 14: Use Case TSP/P – Scenario 6: Degraded Condition – TSP/P Diminished Communications

The Pedestrian and Cyclist Safety (VS12) and Drawbridge Management (TM18) service packages do not afford themselves to combination into Use Cases in this project and are treated as service packages:

- Scenario 7: Normal Operating Conditions – Pedestrian Safety (VS12)
- Scenario 8: Degraded Conditions – Pedestrian Priority Degraded Conditions (VS12)
- Table 10: Use Case TSP/P – Scenario 2: Normal Operating Conditions – Emergency Vehicle Preempt Management (TM18)
- Table 14: Use Case TSP/P – Scenario 6: Degraded Condition – TSP/P Diminished Communications(TM18)

The ATSPM component is not treated in System and User Interdependencies in Appendix B, since users of ATSPM do not interact with CV technology.

6.1. SunGuide TMC Arterial Operators and TSM&O Staff

6.1.1. CV

SunGuide TMC operators are able to monitor and manage incidents along US 1 in the FL Keys using CCTV cameras and DMS. Although Road Ranger (service patrols) services are not available in this area, operators use existing standard operating guidelines to respond to incidents. In addition to the existing ITS, with this CV system the SunGuide TMC Arterial Operators would be able to get CV alerts sent to their workstations and record instances of incidents that involve CVs. Operators will be able to verify conditions visually with existing CCTV cameras if in close proximity to RSU locations and future CCTV cameras planned for installation at existing traffic signal locations.

6.1.2. ATSPM

SunGuide TMC Arterial Operations staff or District 6 TSM&O traffic engineers will monitor the ATSPM on a regular basis to observe the performance of the system and to gather data for analysis and signal maintenance. The ATSPM will analyze the CV vehicle priority effects on arrivals on green, and so forth as listed in Section 1.4.

ATSPM is not available to other users, so its discussion in the following operational scenarios in this section ends here.

6.2. Fleet Drivers, Emergency Vehicle Drivers, Transit Drivers, and Freight Drivers

The following service packages will be available to TSP/P drivers:

- Use Case TSP/P
- TM18 – Drawbridge Management
- VS12 – Pedestrian and Cyclist Safety
- VS02 – V2V Basic Safety

In this scenario, as part of a road maintenance project in Key West, Alex is having a smooth trip due to the CV signal preemptions. Alex encounters one red signal and arrives in Key West with only a brief delay. As a user Alex doesn't see a lost RSU signal that causes his vehicle to stop at a signal, but the system recovers. Within Scenario 6 (see above and Table 14), the RSU lost connection with the OBU and a signal priority request was not received.

Driving from Key Largo to Key West Alex passes through the US 1 signals and about 328 feet before the Snake Creek Drawbridge a beep goes off and a symbol appears on the OBU screen with an open drawbridge symbol, allowing Alex to slow down easily before reaching the end of the queue.

Up ahead, Alex notices the alternating flashing beacons that are activated. The beacons are drawing attention to the "BE PREPARED TO STOP AHEAD WHEN FLASHING" warning sign. The beacons commenced it's flashing cycle during the yellow phase of the bridge traffic signal which was activated when the bridge tender pushed the "RED" button. The beacons continue to flash, and the open drawbridge symbol remains as the traffic signal cycles to red. All the barrier gates are raised. Oncoming gates and outgoing gates are lowered. The bridge tender raises the bridge.

After the boat channel traffic clears, the bridge tender lowers the bridge back down. The barrier gates are lowered, oncoming and outgoing gates are raised, and the bridge tender presses the "GREEN RESET" button. The green ball of the traffic signal illuminates, the flashing beacons are deactivated and the open drawbridge symbol on the OBU screen disappears.

Then, at a midblock crossing at 121st Street, Alex gets a beep and a symbol of a pedestrian on the OBU screen and takes extra caution.

6.3. Pedestrians

The following service packages will be available to pedestrians in their smartphone:

- VS12 – Pedestrian and Cyclist Safety

In this scenario, at the midblock crossing at 121st Street, Chris receives a beep on a smartphone that a CV vehicle is approaching and waits for clearance as the CV stops at the stop bar.

6.4. Drawbridge Tender

While the Drawbridge Tender would appear to be a system user, the Tender will operate the bridge in entirely the same way as presently done and does not interact with the RSU. The RSU is

wirelessly activated by the bridge control system and automatically announces to the CV users that the bridge is closed to traffic after the Drawbridge Tender enacts the closing. The reverse process then reopens the bridge to traffic. The Tender does not get feedback from the system, nor does the Tender initiate the CV function directly, only indirectly from the drawbridge controls.

6.5. Emergency Vehicle Driver

The following service packages will be available to emergency vehicle drivers:

- PS03 – Emergency Vehicle Preemption
- TM04 – CV Traffic Signal System
- TM18 – Drawbridge Management
- VS12 – Pedestrian and Cyclist Safety
- VS02 – V2V Basic Safety

6.6. Transit Driver

The following service packages will be available to transit drivers:

- PT09 – Transit Signal Priority
- TM04 – CV Traffic Signal System
- TM18 – Drawbridge Management
- VS12 – Pedestrian and Cyclist Safety
- VS02 – V2V Basic Safety

6.7. Freight Driver

The following service packages will be available to freight drivers:

- CVO06 – Freight Signal Priority
- CVO08 – Smart Roadside and Virtual WIM
- TM04 – CV Traffic Signal System
- TM18 – Drawbridge Management
- VS12 – Pedestrian and Cyclist Safety
- VS02 – V2V Basic Safety

The weigh station OPEN and CLOSED message signs are currently controlled by the weigh station operator using a manual toggle switch. The northbound sign is controlled by the first switch and the southbound sign controlled by the second switch. These switches will also activate the RSUs, located upstream of the Plantation Key Weigh Station. The RSU will emanate a message indicating whether the station is open or closed.

When compliant vehicles pass through the WIM screening station, the RSU will emanate a message to bypass the weigh station. If the vehicle weight exceeds the Class requirement, then the broadcasted message will request that the truck pull into the weigh station.

7. Summary of Impacts

There is a need for a substantial testing endeavor to ensure SAE J2735 DSRC messages work properly, as well as SCMS and SunGuide TMC functions, so TRR and ORR plans will be drawn up by the vendor. TERL approval may be needed.

It is expected that CV market penetration will increase as OEMs and aftermarket OBU suppliers include more CV features in coming years. Expansion of the service packages to include CV features will be an ongoing endeavor, as cars, trucks, and transit vehicles require new capabilities. FDOT will need to provide new V2I CV capabilities and address reports of CV operational and security failures. As more drivers get V2V capability, safety alerts will enhance driver abilities to sense queuing in the traffic ahead, avoid intersection crashes and negotiate other dangerous situations. V2I software runs in the RSU and sends alert messages to the OBUs. FDOT will operate CV in the V2I environment. V2V will be the domain of OBU providers, however, the project will leverage on available BSM for implementation

The CV deployment puts in place the elements necessary for CV V2I intersection operations and drawbridge and NMT safety alerts. Impacts to RTMC operations are limited to ATSPM analysis of signal efficiency. The ATSPM will aid the FDOT SunGuide TMC to maintain its traffic signal system with timely coordination done more simply and economically than with use of field crews every few years.

There will be a short term need for training. For RSUs and FDOT fleet and asset maintenance contractor fleet OBUs, maintenance will be ongoing, as with all signal equipment. Once installed and tested, the equipment problems are expected to be minor.

Drivers with CV equipment will see benefits from the service packages based on their functions and the instances when they occur (e.g., priority at a signal).

8. Analysis of the Proposed System

The system offers several advantages:

- Efficiency improvements to traffic flow with preemption of controllers
- Efficiency improvements to traffic flow from RTMC oversight of controller timings with ATSPM
- Alerts to drivers of drawbridge closings so they may safely anticipate queues ahead
- Alerts to pedestrians and drivers to improve crossing safety.
- Advanced warning to commercial vehicle operators of the open/closed status of the weigh station

The project begins with a manageable fleet of FDOT vehicles, asset maintenance fleet vehicles and is extensible to the larger public, once a preliminary sample of fleet vehicles is outfitted with OBUs and tested. The project has the potential to improve safety, reduce delays due to crashes and improve trip time in a narrow and busy travel corridor with few opportunities for capacity expansion, except through efficiency-improving electronics.

The proposed project schedule is shown in Table 8.

Table 8: Proposed Project Schedule

PROJECT ACTIVITY	Start	Finish	2018	2019	2020	2021	2022
			9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
FDOT Work Program Approval for Add'l Funds	12/18	10/19		X Additional Funds in FDOT Work Program			
NEPA Process	12/18	12/19		X NEPA Complete			
SYSTEMS ENGINEERING							
Systems Engineering and Project Concept	9/18	3/19					
FHWA Review of SE Documents	10/19	2/20			X FHWA Approval of SE		
PROJECT ACTIVITIES - EXISTING CONTRACTS							
Issue work orders (FY based funds)	3/19	8/20					
Construction Oversight - CEI Consultant	3/19	8/21					
Design - Push Button Design Consultant	3/19	12/19					
Construction - Push Button Const'n Contractor*	3/19	8/21					
PS&E Approvals - TSM&O Consultant Support	3/19	12/19					
PROJECT ACTIVITIES - DESIGN-BUILD SERVICES							
Procurement of Design Build	3/19	8/20					
RFP Development	3/19	11/19					
Industry Forum	9/19	9/19					
Advertisement and Selection Process	12/19	5/20					
Technology Demonstration	2/20	3/20					
Final Selection and Notice to Proceed	6/20	8/20			X D-B Procurement Complete		
Design-Build Activities	8/20	2/22					
CV Application Development	8/20	4/21					
RSU and OBU Deployment	10/20	7/21					
Testing and Integration	7/21	12/21					
Training	12/21	12/21					
System Launch/Acceptance Period	1/22	2/22					
FDOT Final Acceptance	2/22	2/22					X Final Accept
FDOT Construction Oversight	8/20	2/22					
FDOT Approvals (Plans, Specs, Test/Training)	8/20	12/21					
BEFORE AND AFTER PROJECT EVALUATION							
Before Project Period	2/20	7/20		Start Before Evaluation	X		Approved B/A Eval
After Project Period	2/22	9/22					X

X - Indicates Milestone
* Assumption - FDOT programmed FY 22/23 push button contract funding would be advanced if INFRA grant is awarded.
*Construction of project elements will be sequenced so that there is no conflict amongst contractors. FDOT has full control since push button contracts are being used.

9. Notes

None at present.

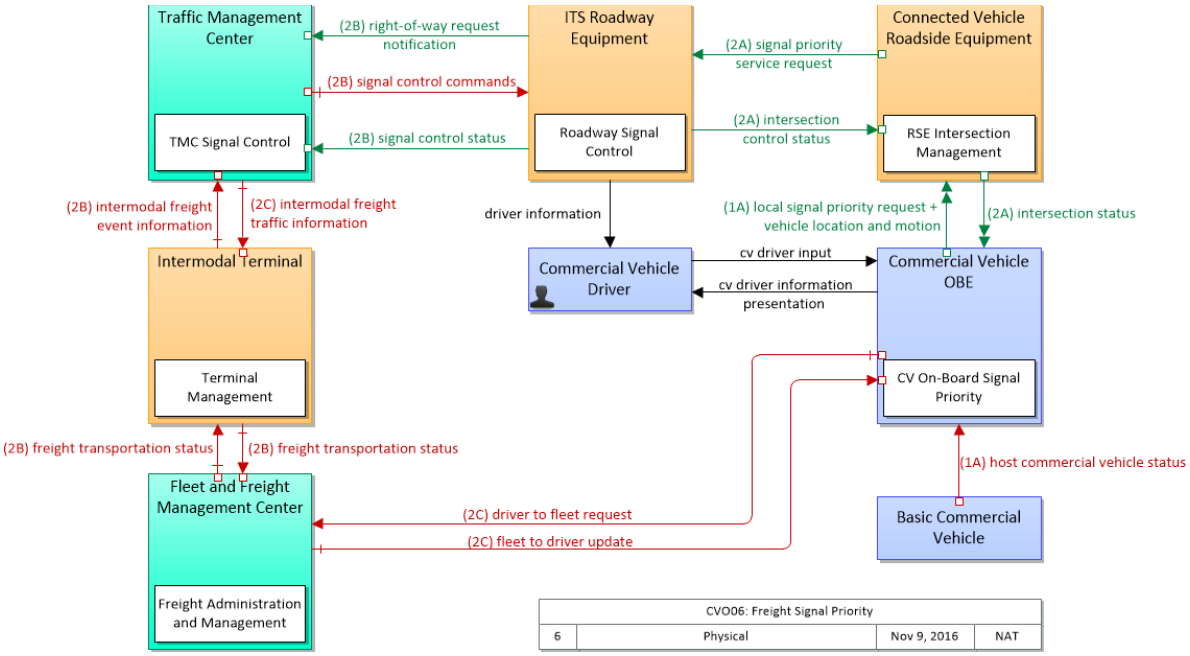
10. Appendices A, B and C

Appendix A: Generic ARC-IT Service Packages

CVO06 – Freight Signal Priority

The Freight Signal Priority service package (FSP) provides traffic signal priority for freight and commercial vehicles traveling in a signalized network. The goal of the freight signal priority service package is to reduce stops and delays to increase travel time reliability for freight traffic, and to enhance safety at intersections.

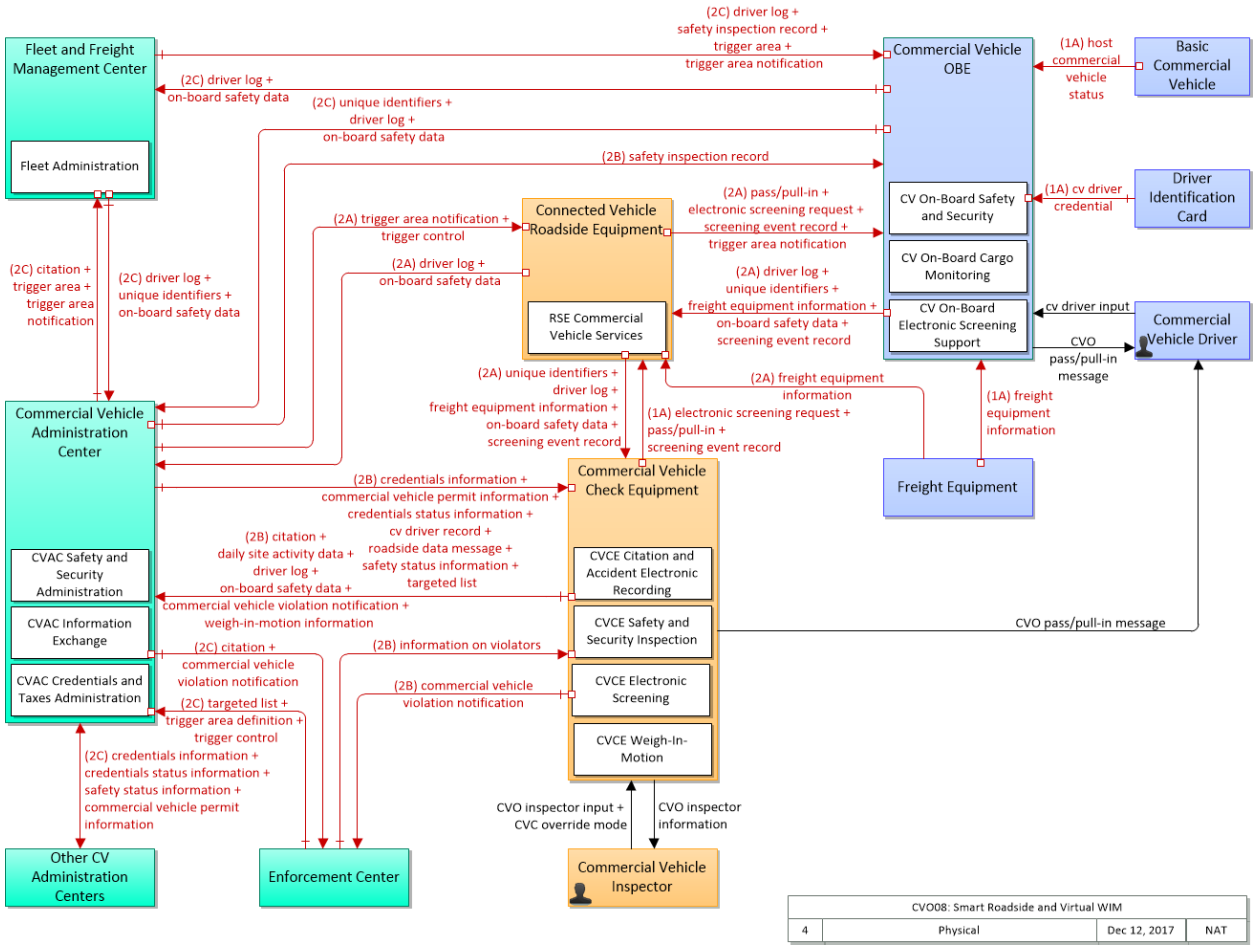
Figure 12: Physical Diagram of Generic Freight Signal Priority SP



CV008 – Smart Roadside and Virtual WIM

This service package includes the delivery of capabilities related to wireless roadside inspections and electronic screening/virtual weigh stations. Wireless roadside inspection is defined by a safety screening capability that employs communications technologies to obtain information from a commercial vehicle that will allow safety screening of the vehicle and its driver.

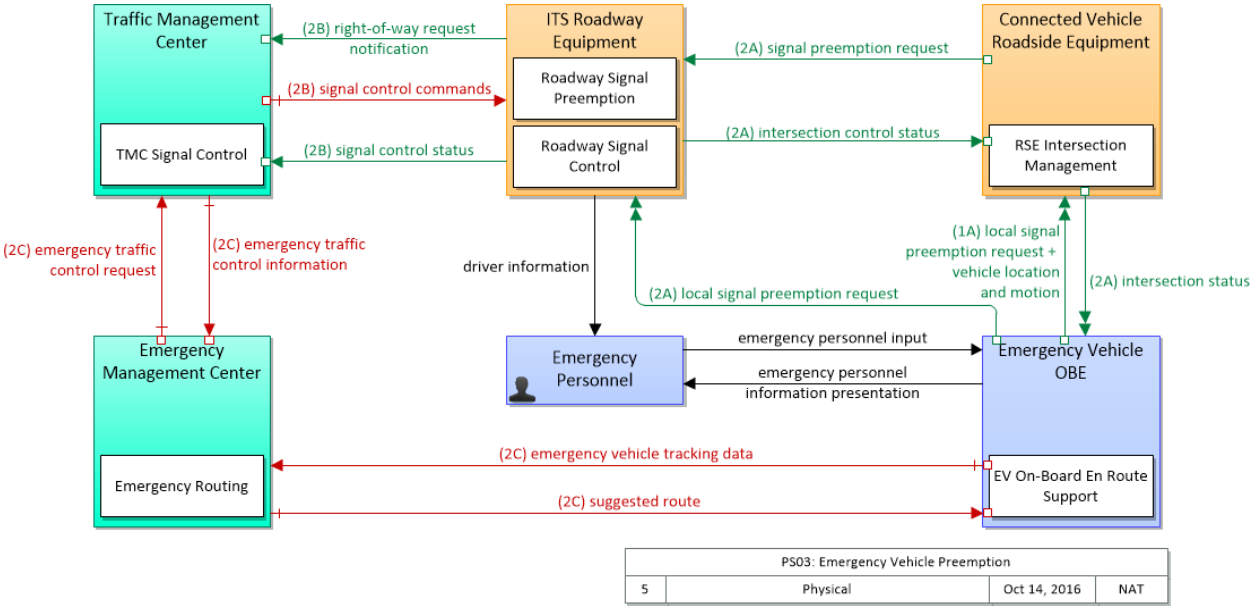
Figure 13: Physical Diagram of Generic Smart Roadside and Virtual WIM



PS03 – Emergency Vehicle Preemption

This service package provides signal preemption for public safety-first responder vehicles. Both traditional signal preemption systems and new systems based on connected vehicle technology are covered. In more advanced systems, movement of public safety vehicles through the intersection can be facilitated by clearing queues and holding conflicting phases. In addition, this SP also covers the transition back to normal traffic signal operations after providing emergency vehicle preemption.

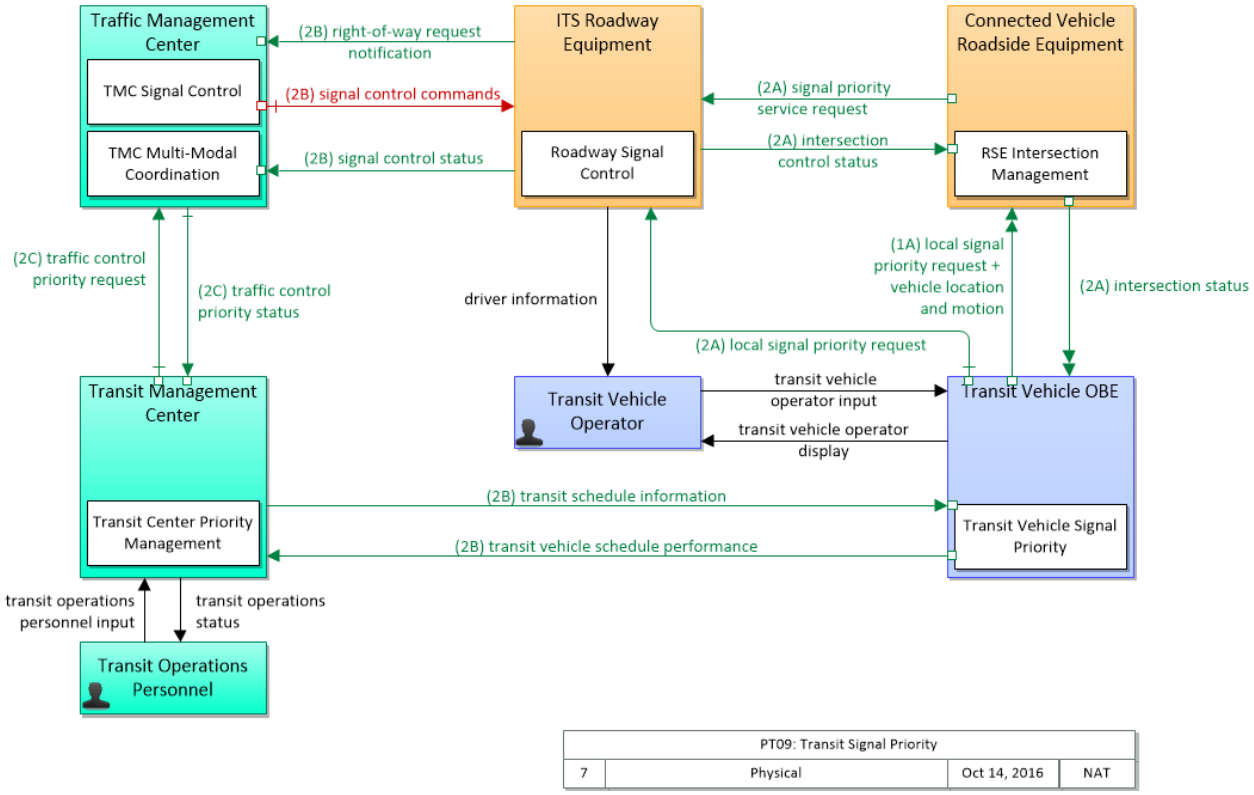
Figure 14: Physical Diagram of Generic Emergency Vehicle Preemption SP



PT09 – Transit Signal Priority

The Transit Signal Priority service package uses transit vehicle to infrastructure communications to allow a transit vehicle to request priority at one or a series of intersections. The service package provides feedback to the transit driver indicating whether the signal priority has been granted or not. This service package can contribute to improved operating performance of the transit vehicles by reducing the time spent stopped at a red light.

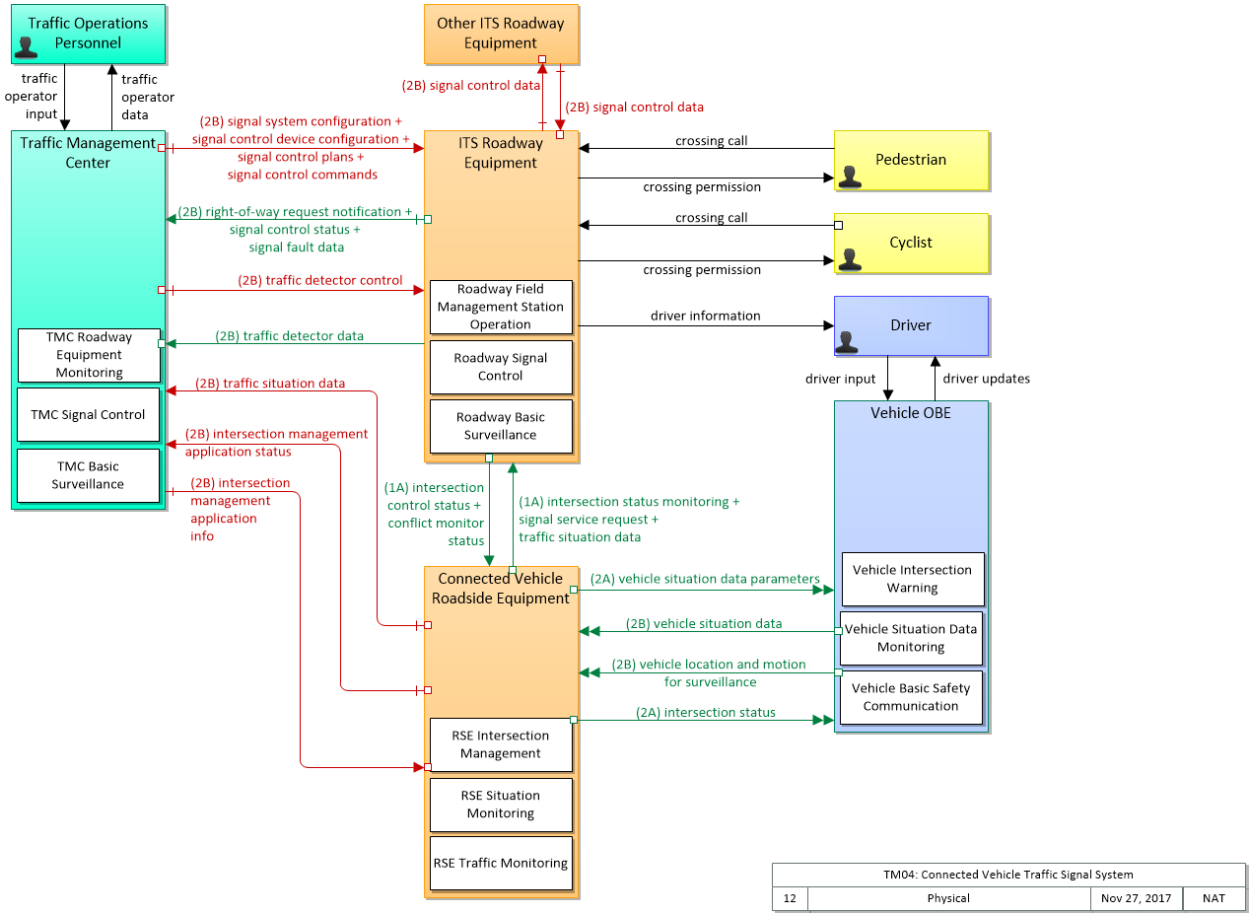
Figure 15: Physical Diagram of Generic Transit Signal Priority SP



TM04 – CV Traffic Signal System

This service package uses both vehicle location and movement information from connected vehicles as well as infrastructure measurement of non-equipped vehicles to improve the operations of traffic signal control systems. The service package utilizes the vehicle information to adjust signal timing for an intersection or group of intersections in order to improve traffic flow, including allowing platoon flow through the intersection. Other service packages provide related mobility services such as Transit Signal Priority, Freight Signal Priority, Emergency Vehicle Preemption, and Pedestrian Mobility to maximize overall arterial network performance.

Figure 16: Physical Diagram of Generic CV Traffic Signal System SP



TM18 – Drawbridge Management

This service package relates to User Need 020, for upstream information on bridge closings.

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

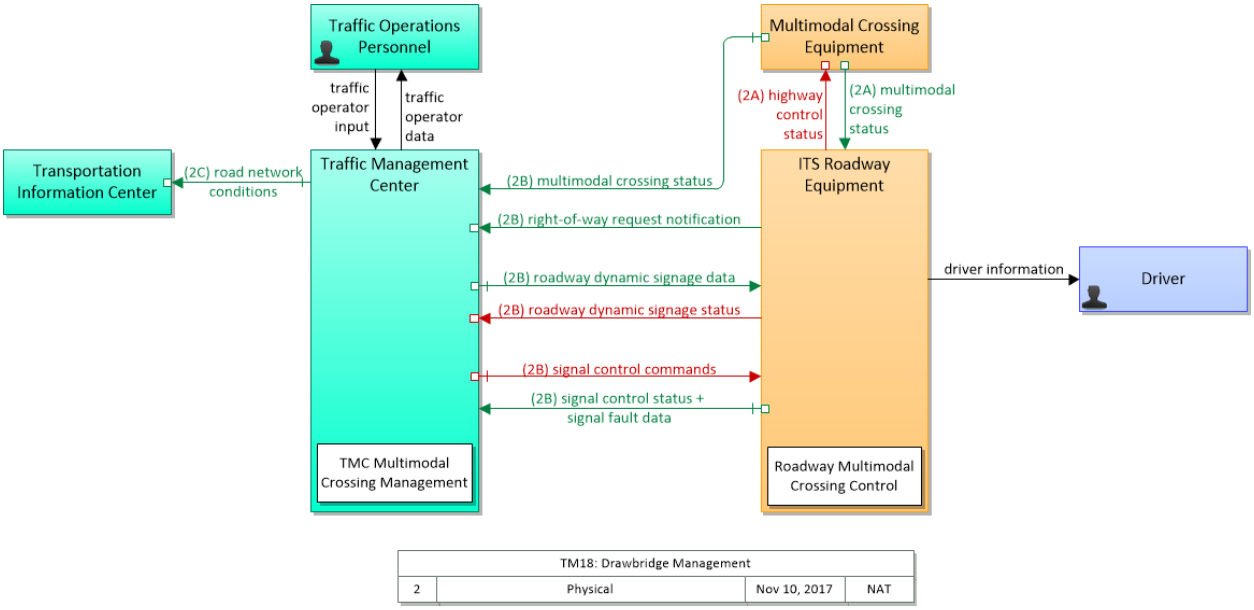
The bridge Tender automatically activates the CV system when turning on the control panel as is done now. The Tender will do exactly the same job as currently done, but the point-to-point wireless activated RSU will automatically send omnidirectional DSRC messages to drivers on each side of the bridge of a closing, and later, an opening to traffic. DSRC messages have a range of 300 feet. The RSU will notify the SunGuide TMC of a delay at the bridge, which may be used to affect signal timings upstream. The users of this service package are the drivers who receive the alert as in the User Needs Table 4, UN019.

The timing intervals for the yellow and red signals are mechanically timed through relay timers. All operations are performed via the pushbuttons on the control panel and wired to a large circuit board. The bridge controls are hardwired to the control panel.

The new operations for the drawbridge bridge follow with the RSU's role shown in steps 7 and 13:

1. Control Panel rests in an "Off" state; completely off.
2. When the bridge Tender receives a request, the Tender will turn-on the control panel, which will also immediately activate the warning audible bells and flashing lights.
3. The Tender will then actuate the "Red" button to cycle the traffic signals from green into the yellow and red intervals.
4. The amber interval will initiate a signal from an extant primary radio, located in the Bridge Tender's house.
5. Secondary radios, co-located with the future installed flashing beacons at both northbound and southbound bridge approaches, will receive the signal.
6. The secondary radios will activate the RSU.
7. The RSU will send an alert to the Drivers and to the SunGuide TMC.
8. Once the traffic signals are all red, the Tender will verify that traffic has cleared the bridge and will lower the bridge gates.
9. Subsequently, the barrier on the northside of the bridge will rise and the bridge span will be unlocked.
10. The bridge span will rise and stay open for the necessary time for a boat to clear.
11. The Tender will then perform the above-mentioned steps in reverse order to open the bridge to vehicular traffic.
12. Once the gates are up, the Tender will actuate the Green indication and turn-off the control panel.
13. The RSU will deactivate the alert to the Drivers and the SunGuide TMC.

Figure 17: Physical Diagram of Generic Drawbridge Management SP



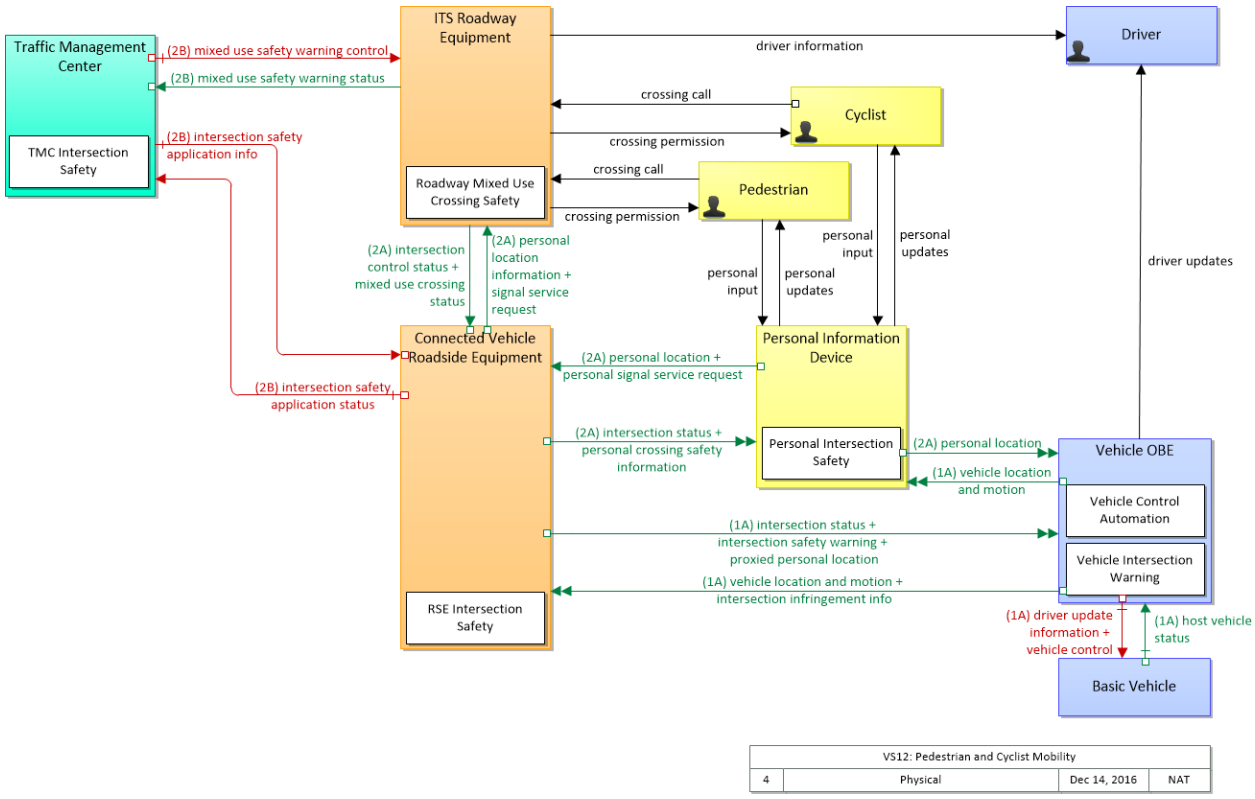
Source: ARC-IT

VS12 – Pedestrian and Cyclist Safety

This service package supports the sensing and warning systems used to interact with pedestrians, cyclists, and other non-motorized users that operate on the main vehicle roadways, or on pathways that intersect the main vehicle roadways.

These systems allow automated warning or active protection for this class of users. It integrates traffic, pedestrian, and cyclist information from roadside or intersection detectors and new forms of data from wirelessly connected, non-motorized traveler-carried mobile devices to request right-of-way or to inform non-motorized travelers when to cross and how to remain aligned with the crosswalk or pathway based on real-time Signal Phase and Timing (SPaT) and MAP information. In some cases, priority will be given to non-motorized travelers, such as persons with disabilities who need additional crossing time, or in special conditions (e.g., weather) where non-motorized travelers may warrant priority or additional crossing time. This service package will enable a service call to be routed to the traffic controller from a mobile device of a registered person with disabilities after confirming the direction and orientation of the roadway that the individual is intending to cross. It also provides warnings to the non-motorized user of possible infringement of the crossing or pathway by approaching vehicles.

Figure 18: Physical Diagram of Generic Pedestrian and Cyclist Safety SP

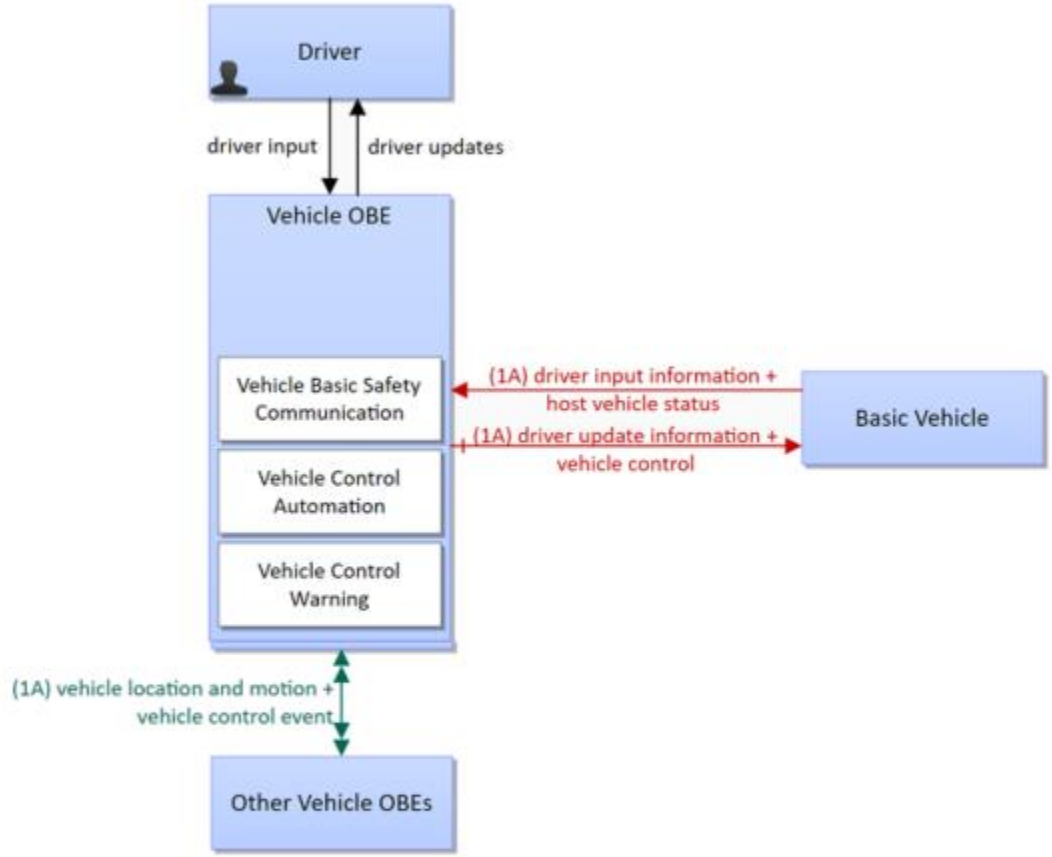


VS02 – Vehicle to Vehicle (V2V) Basic Safety

This service package exchanges basic safety messages with surrounding Connected Vehicles to support and augment the safety warning and control automation features identified in VS01.

These exchanges support Connected Vehicle safety applications defined in SAE J2945/1: Emergency Electronic Brake Lights, Forward Crash Warning, Blind Spot Warning/Lane Change Warning, Intersection Movement Assist, Left Turn Assist, and Control Loss Warning. It also supports Do Not Pass Warning, Motorcycle Approaching indication, Tailgating Advisory, Stationary Vehicle, and Pre-Crash Actions applications from CVRIA.

Figure 19: Physical Diagram of Generic Vehicle to Vehicle (V2V) Basic Safety SP



VS02: V2V Basic Safety			
3	Physical	Nov 17, 2016	NAT

Appendix B. System and User Interdependencies

In this project, four CV service packages that use signal priority or preemption for auto, emergency, transit and freight vehicles (TM04, PS03, PT09 and CVO06) are combined into a single Use Case, termed Use Case TSP/P for Traffic Signal Priority/Preemption. Their System and User Interdependencies are shown in the tables that follow along with the service packages for Pedestrian and Cyclist Safety (VS12) and Drawbridge Management (TM18). The CVO03, VS12, and TM18 service packages do not afford themselves to combination into Use Cases in this project and so are treated as individual service packages.

Because of their similarities, TSP/P is treated here as a single Use Case that contains scenarios associated with Auto CV priority, Emergency Vehicle Preemption, Transit Signal Priority, and Freight Vehicle Priority. Multiple requests are an important effect of these operating in the same environment. Normal and Degraded Communications conditions are represented, as listed:

1. Table 9: Use Case TSP/P – Scenario 1: Normal Operating Conditions – Auto CV Signal Priority/Intent to Platoon Priority
2. Table 10: Use Case TSP/P – Scenario 2: Normal Operating Conditions – Emergency Vehicle Preempt
3. Table 11: Use Case TSP/P – Scenario 3: Normal Operating Conditions – FSP/Intent to Platoon Priority
4. Table 12: Use Case TSP/P – Scenario 4: Normal Operating Conditions – Transit Signal Priority
5. Table 13: Use Case TSP/P – Scenario 5: Normal Operating Conditions – Multiple Priority/Preemption Requests
6. Table 14: Use Case TSP/P – Scenario 6: Degraded Condition – TSP/P Diminished Communications
7. Table 13: Use Case TSP/P – Scenario 5: Normal Operating Conditions – Multiple Priority/Preemption Requests Pedestrian Safety
8. Table 16: Service Package VS12 – Scenario 8: Degraded Condition – Pedestrian Safety
9. Table 13: Use Case TSP/P – Scenario 5: Normal Operating Conditions – Multiple Priority/Preemption Requests Management
10. Table 18: Service Package TM18 – Scenario 10: Degraded Condition Table 13: Use Case TSP/P – Scenario 5: Normal Operating Conditions – Multiple Priority/Preemption Requests Management
11. Table 19: Service Package CVO03 – Scenario 11: Normal Operating Conditions – Weigh Station Management
12. Table 20: Service Package CVO03 – Scenario 12: Degraded Condition – Weigh Station Management

Table 9: Use Case TSP/P - Scenario 1: Normal Operating Conditions - Auto CV Signal Priority/Intent to Platoon

Use Case	**Traffic Signal Priority/Preemption**			
Scenario ID and Title	*UC TSP/P – S1: Normal Operating Conditions – Auto CV Signal Priority*			
Scenario Objective	• Provide safe and efficient movement through intersections for auto CVs.			
Operational Event(s)	• Auto CV sends signal priority requests to approaching intersections.			
Actor(s)	Actor	Role		
	Auto CV	Quickly and safely traverse an intersection to improve mobility.		
Key Actions and Flow of Events	Source	Step	Key Action	Comments
	Auto CV Operator	1	Approaches an intersection.	Could be intending to proceed through intersection.
	Auto CV OBU	2	Communicates signal priority request to the intersection.	Requests signal preemption.
	Message Handler/ Processor	3	Determines if signal priority request can be accommodated.	May forward priority request to TMC, which would provide a response if the priority request should be granted.
	RSU	4	Sends signal status message to Auto CV.	Indicates that the signal priority request has been accepted.
	TSC	5a	Green phase on approach is called early.	On the auto CV approach.
	TSC	5b	Green phase on approach is extended.	On the auto CV approach.
	Auto CV Operator	6	Proceeds through intersection.	On green indication.
	Auto CV Operator	7	Clears intersection.	Single auto CV.
	TSC	8	Resumes normal intersection operations.	
Post-Conditions	• Auto CV Operator experiences improved mobility at the intersection.			
Policies and Business Rules	Florida statute: N/A MUTCD: Section 4D.27 • Priority control is typically given to certain non-emergency vehicles such as light-rail transit vehicles operating in a mixed-use alignment and buses. • The displaying of early or extended green signal indications at an intersection to assist public transit vehicles in remaining on schedule.			

Use Case	Traffic Signal Priority/Preemption
Traceability	See User Needs Table 4
Inputs Summary	**Auto CV OBU:** System Initialization Input: Auto CV OBU signal status notification, and priority level assessment algorithm set at time of configuration. Human Inputs: None. CV Data: SPAT and MAP data from roadside, signal status message. GNSS: Time and location data. **TSC:** System Initialization Input: Signal timing adjustment algorithm set at time of configuration or remote updated by TMC. **RSU:** CV Data: Signal Priority request from auto CV OBU.
Output Summary	**Auto CV OBU:** CV Data: Signal Priority Request message. Signal Status Notification audio/visual output from auto CV OBU to auto CV operator. **RSU:** CV Data: SPAT, MAP, signal status message.

Table 10: Use Case TSP/P – Scenario 2: Normal Operating Conditions – Emergency Vehicle Preemption

Use Case	Traffic Signal Priority/Preemption			
Scenario ID and Title	*UC TSP/P – S2: Normal Operating Conditions – Emergency Vehicle Preempt*			
Scenario Objective	• Provide safe and efficient movement through intersections for emergency vehicles actively responding to an emergency situation.			
Operational Event(s)	• Emergency vehicle operator activates lights and siren, and the emergency vehicle sends signal priority requests to approaching intersections.			
Actor(s)	Actor	Role		
	Emergency Vehicle Operator	Quickly and safely traverse an intersection to improve mobility while responding to an emergency.		
Key Actions and Flow of Events	Source	Step	Key Action	Comments
	Emergency Vehicle Operator	1	Approaches an intersection.	Lights and sirens activated.
	Emergency Vehicle OBU	2	Communicates signal priority request to the intersection.	Requests signal preemption.
	Message Handler/ Processor	3	Determines if signal priority request can be accommodated.	May forward priority request to TMC, which would provide a response if the priority

Use Case	Traffic Signal Priority/Preemption			
				request should be granted.
	RSU	4	Sends signal status message to emergency vehicle.	Indicates that the signal priority request has been accepted.
	TSC	5	Services the approach taken by the emergency vehicle.	
	General	6	Queue at intersection dissipates.	On the emergency vehicle approach.
	Emergency Vehicle Operator	7	Proceeds through intersection.	On green indication.
	TSC	8	Resumes normal intersection operations.	
Post-Conditions	• Emergency Vehicle Operator experiences improved mobility at the intersection. • Emergency Vehicle Operator is able to provide improved emergency response service.			
Policies and Business Rules	Florida statute: 316.003 (92) • Any system or device with the capability of activating a control mechanism mounted on or near traffic signals which alters a traffic signal's timing cycle. MUTCD: Section 4D.27 • The prompt displaying of green signal indications at signalized locations ahead of fire vehicles, law enforcement vehicles, ambulances, and other official emergency vehicles. • A special sequence of signal phases and timing to expedite and/or provide additional clearance time for vehicles to clear the tracks prior to the arrival of rail traffic. A special sequence of signal phases to display a steady red indication to prohibit turning movements toward the tracks during the approach or passage of rail traffic.			
Traceability	See User Needs Table 4			
Inputs Summary	**Emergency Vehicle OBU:** System Initialization Input: Emergency vehile OBU signal status notification, and priority level assessment algorithm set at time of configuration. Human Inputs: Emergency vehicle operator activates lights/siren. CV Data: SPAT and MAP data from roadside, signal status message. GNSS: Time and location data. **TSC:** System Initialization Input: Signal timing adjustment algorithm set at time of configuration or remote updated by TMC. **RSU:**			

Use Case	Traffic Signal Priority/Preemption
	CV Data: Signal Priority request from emergency vehicle OBU.
Output Summary	**Emergency Vehicle OBU:** CV Data: Signal Priority Request message. Signal Status Notification audio/visual output from host OBU to emergency vehicle operator. **RSU:** CV Data: SPAT, MAP, signal status message.

Table 11: Use Case TSP/P – Scenario 3: Normal Operating Conditions – FSP/Intent to Platoon Priority

Use Case	Traffic Signal Priority/Preemption			
Scenario ID and Title	*UC* TSP/P *– S3: Normal Operating Conditions – Freight Signal Priority/Intent to Platoon Priority*			
Scenario Objective	• Provide safe and efficient movement through intersections for freight vehicles.			
Operational Event(s)	• The freight vehicle sends signal priority requests to approaching intersections.			
Actor(s)	Actor	Role		
	Freight Vehicle Operator	Quickly and safely traverse an intersection to improve mobility.		
Key Actions and Flow of Events	Source	Step	Key Action	Comments
	Freight Vehicle Operator	1	Approaches an intersection.	Could be intending to proceed through intersection.
	Freight Vehicle OBU	2	Communicates signal priority request to the intersection.	Request signal priority.
	Message Handler/ Processor	3	Determines if signal priority request can be accommodated.	May forward priority request to TMC, which would provide a response if the priority request should be granted.
	RSU	4	Sends signal status message to Freight Vehicle.	Indicates that the signal priority request has been accepted.
	TSC	5a	Green phase on approach is called early.	On the freight vehicle approach.
	TSC	5b	Green phase on approach is extended.	On the freight vehicle approach.
	Freight Vehicle Operator	6	Proceeds through intersection.	On green indication.

Use Case	Traffic Signal Priority/Preemption			
	Freight Vehicle Operator	7	Clears intersection.	Single freight vehicle.
	TSC	8	Resumes normal intersection operations.	
Post-Conditions	• Freight Vehicle Operator experiences improved mobility at the intersection.			
Policies and Business Rules	Florida statute: N/A MUTCD: Section 4D.27 • Priority control is typically given to certain non-emergency vehicles such as light-rail transit vehicles operating in a mixed-use alignment and buses. • The displaying of early or extended green signal indications at an intersection to assist public transit vehicles in remaining on schedule.			
Traceability	See User Needs Table 4			
Inputs Summary	**Heavy-Duty Vehicle OBU:** System Initialization Input: Heavy-duty vehicle OBU signal status notification and priority level assessment algorithm set at time of configuration. Human Inputs: None. CV Data: SPAT and MAP data from RSU, signal status message. GNSS: Time and location data. **TSC:** System Initialization Input: Signal timing adjustment algorithm set at time of configuration or remote updated by TMC. **RSU:** CV Data: Signal Priority request from heavy-duty vehicle OBU. ITS Data: Signal state data.			
Output Summary	**Heavy-Duty Vehicle OBU:** CV Data: Signal Priority Request message. Signal Status Notification audio/visual output from heavy-duty OBU to freight vehicle operator. **RSU:** CV Data: SPAT, MAP, Signal Status Message.			

Table 12: Use Case TSP/P – Scenario 4: Normal Operating Conditions – Transit Signal Priority

Use Case	**Traffic Signal Priority/Preemption**			
Scenario ID and Title	*UC TSP/P- S4: Normal Operating Conditions – Transit Signal Priority*			
Scenario Objective	• Provide safe and efficient movement through intersections for transit vehicles that may be falling behind schedule.			
Operational Event(s)	• The transit vehicle sends signal priority requests to approaching intersections.			
Actor(s)	Actor		Role	
	Transit Vehicle Operator		Quickly and safely traverse an intersection to improve mobility.	
Key Actions and Flow of Events	Source	Step	Key Action	Comments
	Transit Vehicle Operator	1	Approaches an intersection.	
	Transit Vehicle OBU	2	Communicates a signal priority request to the intersection.	
	Message Handler/ Processor	3	Determines if signal priority request can be accommodated.	May forward priority request to TMC, which would provide a response if the priority request should be granted. Priority will be granted based on agreement between COTA and DPS.
	RSU	4	Sends signal status message to Transit Vehicle OBU.	Indicates that the signal priority request has been accepted.
	TSC	5a	Green phase on approach is called early.	On the transit vehicle approach.
	TSC	5b	Green phase on approach is extended.	On the transit vehicle approach.
	Transit Vehicle Operator	6	Proceeds through intersection.	On green indication.
	TSC	7	Resumes normal intersection operations.	
Post-Conditions	• Transit Vehicle Operator experiences improved mobility at the intersection. • Transit Vehicle Operator gets route back on schedule.			

Use Case	Traffic Signal Priority/Preemption
Policies and Business Rules	Florida statute: N/A MUTCD: Section 4D.27 • Priority control is typically given to certain non-emergency vehicles such as light-rail transit vehicles operating in a mixed-use alignment and buses. • The displaying of early or extended green signal indications at an intersection to assist public transit vehicles in remaining on schedule.
Traceability	See User Needs Table 4
Inputs Summary	**Transit Vehicle OBU:** System Initialization Input: Transit vehicle OBU signal status notification and priority level assessment algorithm set at time of configuration. Human Inputs: None. CV Data: SPAT and MAP data from RSU, signal status message. GNSSL Time and location data. Existing Transit Vehicle System: On-Time status. **TSC:** System Initialization Input: Signal timing adjustment algorithm set at time of configuration or remote updated by TMC. **RSU:** CV Data: Signal Priority Request from Transit Vehicle OBU ITS Data: Signal state data.
Output Summary	**Transit Vehicle OBU:** CV Data: Signal Priority Request message Signal Status Notification audio/visual output from host OBU to transit vehicle operator. **RSU:** CV Data: SPAT, MAP, Signal Status Message.

Table 13: Use Case TSP/P – Scenario 5: Normal Operating Conditions – Multiple Priority/Preemption Requests

Use Case	**Traffic Signal Priority/Preemption**			
Scenario ID and Title	*UC* TSP/P – *S5: Normal Operating Conditions – Multiple Priority/Preemption Requests*			
Scenario Objective	• Intersection is able to arbitrate and service multiple priority requests.			
Operational Event(s)	• Multiple signal priority requests are received from conflicting approaches. • The TSC arbitrates between priority messages. • Priority requests are served in priority order as determined by arbitration. • This scenario focuses on an emergency vehicle and a transit vehicle but could take place between any two vehicles requesting signal priority.			
Actor(s)	Actor	Role		
	Emergency Vehicle Operator	Quickly and safely traverse an intersection to improve mobility while responding to an emergency.		
	Transit Vehicle Operator	Quickly and safely traverse an intersection to improve mobility.		
Key Actions and Flow of Events	Source	Step	Key Action	Comments
	Emergency Vehicle Operator	1	Approaches an intersection.	
	Emergency Vehicle OBU	2	Communicates signal priority request to the intersection.	Request signal preemption.
	Transit Vehicle Operator	3	Approaches an intersection.	
	Transit Vehicle OBU	4	Communicates signal priority request to the intersection.	Request signal priority.
	Message Handler/ Processor	5	Prioritizes the requests and assigns levels of priority.	May forward priority requests to TMC, which would provide a response if the priority request should be granted. Determines emergency vehicle has highest priority.
	Message Handler/ Processor	6	Determines if signal priority requests can be accommodated.	
	RSU	7	Sends signal status message to Emergency Vehicle OBU.	Indicates that the signal priority request has been accepted.

Use Case	Traffic Signal Priority/Preemption			
	RSU	8	Sends signal status message to Transit Vehicle OBU.	Indicates that the signal priority request has been accepted but delayed.
	TSC	9	Services the approach taken by the Emergency Vehicle Operator.	
	General	10	Queue at intersection dissipates.	On the emergency vehicle approach.
	Emergency Vehicle Operator	11	Proceeds through intersection.	On green indication.
	TSC	12	Resumes intersection operations.	
	TSC	13	Cycles through phases to service transit vehicle approach as quickly as possible.	
	Transit Vehicle Operator	14	Proceeds through intersection.	On green indication.
	TSC	15	Resumes normal intersection operations.	
Post-Conditions	• TSC properly arbitrates between competing signal priority requests. • All users experience improved mobility compared to current operations.			
Policies and Business Rules	Florida statute: 316.003 (92) • Any system or device with the capability of activating a control mechanism mounted on or near traffic signals which alters a traffic signal's timing cycle. MUTCD: Section 4D.27 • Some types or classes of vehicles supersede others when a traffic control signal responds to more than one type or class. In general, a vehicle that is more difficult to control supersedes a vehicle that is easier to control. Option:			
Traceability	See User Needs Table 4			
Inputs Summary	**Emergency, Heavy-Duty, Transit Vehicle OBU:** System Initialization Input: Vehicle OBU signal status notification and priority level assessment algorithm set at time of configuration. Human Inputs: Emergency vehicle operator activates lights/siren. CV Data: SPAT and MAP data from RSU, signal status message. GNSS: Time and location data. **TSC:** System Initialization Input: Signal timing adjustment algorithm set at time of configuration or remote updated by TMC.			

Use Case	Traffic Signal Priority/Preemption
	RSU: CV Data: Signal Priority Request from vehicle OBU. ITS Data: Signal state data.
Output Summary	**Emergency, Heavy-Duty, Transit Vehicle OBU:** CV Data: Signal Priority Request message. Signal Status Notification audio/visual output from host OBU to vehicle operator. **RSU:** CV Data: SPAT, MAP, Signal Status Message.

Table 14: Use Case TSP/P – Scenario 6: Degraded Condition – TSP/P Diminished Communications

Use Case	Traffic Signal Priority/Preemption			
Scenario ID and Title	*UC* TSP/P *– S6: Degraded Condition – TSP/P Diminished Communications*			
Scenario Objective	• Provide safe and efficient movement through intersections for emergency vehicles actively responding to an emergency situation.			
Operational Event(s)	• This scenario focuses on an emergency but could be focused on any vehicle requesting signal priority. • This scenario effectively represents a failure condition if neighboring RSUs are not able to receive the signal priority request. • Emergency vehicle operator activates lights and siren, and the emergency vehicle sends signal priority requests to approaching intersections. • Intersection does not receive signal priority request because of RSU malfunction. • Neighboring RSU receives priority request and forwards it to the proper intersection.			
Actor(s)	Actor	Role		
	Emergency Vehicle Operator	Quickly and safely traverse an intersection to improve mobility while responding to an emergency.		
	Network Manager	Diagnose and repair connectivity issue.		
Key Actions and Flow of Events	Source	Step	Key Action	Comments
	Emergency Vehicle Operator	1	Approaches an intersection.	
	Emergency Vehicle OBU	2	Broadcasts signal priority request.	
	RSU	3	Is not able to receive messages.	
	Neighboring RSU	4	Receives signal priority request.	

Use Case	Traffic Signal Priority/Preemption			
	Neighboring RSU	5	Forwards signal priority request to TSC at correct intersection.	
	Message Handler/ Processor	6	Determines if signal priority request can be accommodated.	May forward priority request to TMC, which would provide a response if the priority request should be granted.
	Neighboring RSU	7	Sends signal status message to Emergency Vehicle.	Indicates that the signal priority request has been accepted.
	TSC	8	Services the approach taken by the Emergency Vehicle Operator.	
	General	9	Queue at intersection dissipates.	On the emergency vehicle approach.
	Emergency Vehicle Operator	10	Proceeds through intersection.	On green indication.
	TSC	11	Resumes normal intersection operations.	
	Network Manager	12	Receives notification regarding connectivity issue.	If infrastructure connectivity is the source of the diminished communications.
	Network Manager	13	Diagnoses and repairs connectivity issue.	
Post-Conditions	• Emergency Vehicle Operator experiences improved mobility at the intersection. • Emergency Vehicle Operator is able to provide improved emergency response service.			
Policies and Business Rules	Florida statute: 316.003 (92) • Any system or device with the capability of activating a control mechanism mounted on or near traffic signals which alters a traffic signal's timing cycle. MUTCD: Section 4D.27 • The prompt displaying of green signal indications at signalized locations ahead of fire vehicles, law enforcement vehicles, ambulances, and other official emergency vehicles. • A special sequence of signal phases and timing to expedite and/or provide additional clearance time for vehicles to clear the tracks prior to the arrival of rail traffic.			

Use Case	Traffic Signal Priority/Preemption
	• A special sequence of signal phases to display a steady red indication to prohibit turning movements toward the tracks during the approach or passage of rail traffic.
Traceability	See User Needs Table 4.
Inputs Summary	**Emergency Vehicle OBU:** System Initialization Input: Emergency vehicle OBU signal status notification and priority level assessment algorithm set at time of configuration. Human Inputs: Emergency vehicle operator activates lights/siren. CV Data*: ~~SPAT and MAP data from RSU~~, signal status message. GNSS: Time and location data. **TSC:** System Initialization Input: Signal timing adjustment algorithm set at time of configuration or remote updated by TMC. **RSU:** CV Data*: ~~Signal Priority Request from Emergency Vehicle OBU~~, Signal Priority Request from Emergency Vehicle OBU (via Neighboring RSU) ITS Data: Signal state data. **Neighboring RSU:** CV Data: Signal Priority Request from Emergency Vehicle OBU.
Output Summary	**Emergency Vehicle OBU:** CV Data: Signal Priority Request Message. Signal Status Notification audio/visual output from host OBU to Emergency vehicle operator. **RSU:** CV Data*: ~~SPAT, MAP, Signal Status Message.~~ **Neighboring RSU:** CV Data: Signal Status Message.
*Strikethrough indicates Data that would normally be available were there not a diminished or failed condition.	

Table 15: Service Package VS12 – Scenario 7: Normal Operating Conditions – Pedestrian Safety

Service Package	Pedestrian Safety (VS12)
Scenario ID and Title	*SP VS12 – S7: Normal Operating Conditions – Pedestrian Safety*
Scenario Objective	• Provide safe and efficient movement at midblock crossings for pedestrians with CVs.
Operational Event(s)	• The crosswalk is controlled by a midblock warning signal. • Driver CV sends BSM as approaching midblock intersection RSU.

<table>
<tr><th>Service Package</th><th colspan="4">Pedestrian Safety (VS12)</th></tr>
<tr><td></td><td colspan="4">• Pedestrian CV sends BSM as approaching midblock intersection RSU.
• Pedestrian has smartphone “on” with Pedestrian CV software.
• Pedestrian CV receives message of vehicle approaching.
• Pedestrian CV receives message to go or no message.
• Driver receives message pedestrian approaching or occupying crosswalk.
• Driver to yield by slowing or stopping behind crosswalk stop bar.
• Driver may be any of auto, emergency, transit, freight vehicles.</td></tr>
<tr><td rowspan="3">Actor(s)</td><td colspan="2">Actor</td><td colspan="2">Role</td></tr>
<tr><td colspan="2">Driver CV</td><td colspan="2">Uses OBU to stop or go through midblock crossing.</td></tr>
<tr><td colspan="2">Pedestrian CV</td><td colspan="2">Uses vehicle-alert app on smartphone to use midblock crosswalk.</td></tr>
<tr><td rowspan="10">Key Actions and Flow of Events</td><td>Source</td><td>Step</td><td>Key Action</td><td>Comments</td></tr>
<tr><td>Pedestrian</td><td>1</td><td>Approaches the crosswalk.</td><td>Intends to occupy crosswalk.</td></tr>
<tr><td>Pedestrian CV</td><td>2a</td><td>Broadcasts location 10x/sec from smartphone.</td><td>PII protected.</td></tr>
<tr><td>Driver CV</td><td>2b</td><td>Broadcasts BSM 10x/sec from OBU.</td><td>SCMS protected.</td></tr>
<tr><td>RSU</td><td>3a</td><td>Receives pedestrian location over DSRC.</td><td>RSU is compatible with mobile device wireless media, such as Wi-Fi or cellular, depending upon performance required.</td></tr>
<tr><td>RSU</td><td>3b</td><td>Validates/corrects pedestrian location.</td><td>Mobile device may not provide location accuracy required.</td></tr>
<tr><td>RSU</td><td>3c</td><td>Transmits corrected pedestrian BSM on wireless media of OBU.</td><td>Proxy message appears to the OBU as if transmitted directly by the pedestrian mobile device.</td></tr>
<tr><td>RSU</td><td>4a</td><td>Compares pedestrian location to crosswalk location and to lane placement location.</td><td>Determine if the pedestrian is in the driving lanes but not the crosswalk.</td></tr>
<tr><td>RSU</td><td>4b</td><td>If pedestrian is in roadway but not in crosswalk, warns pedestrian to use crosswalk.</td><td>“Jaywalking” warning issued regardless of whether a vehicle is approaching.</td></tr>
<tr><td>RSU</td><td>5a</td><td>Sends message to Driver CV to slow to stop.</td><td>Determines if driver has enough stopping distance.</td></tr>
</table>

Service Package	Pedestrian Safety (VS12)			
	Driver CV	5b	Informs Driver HMI for Driver to slow to stop.	HMI presents symbol and beeps.
	RSU	5c	Verifies Driver is slowing to stop.	BSM and computation.
	RSU	5d	Sends message to pedestrian CV to proceed to cross with caution.	Allows for stopping time of Driver.
	Pedestrian CV	5e	Informs pedestrian CV to display crossing message.	Smartphone HMI. presents symbol, sound, haptic message.
	RSU	6b	Fails to verify Driver slowing to stop.	BSM and computation.
	RSU	6c	Sends message to pedestrian CV not to proceed to cross.	Maintains no-go until go is good.
	Pedestrian CV	6d	Informs pedestrian CV to display no-crossing message.	Smartphone HMI presents no-go symbol, no sound or haptic message.
	RSU	7a	Verifies vehicle(s) has passed crosswalk.	BSM location-based.
	RSU	7b	Sends message to pedestrian CV to proceed to cross with caution.	Determines no other vehicle coming.
		7c	Informs pedestrian CV to display crossing message.	Smartphone HMI presents symbol, sound, haptic message.
	Pedestrian	8	Proceeds through crosswalk or waits for new message.	Occupies the crosswalk.

Post-Conditions	• Pedestrian with Ped app
	  ○ Stops as "jaywalker" in roadway outside of crosswalk.
	  ○ Stops before entering crosswalk.
	  ○ Exits crosswalk away from traffic, having crossed US 1.
	  ○ Waits for Driver to pass and for new go signal.
	• Driver with app
	  ○ Slows or stops before yield bar.
	  ○ Allows pedestrian to pass.
	  ○ Driver fails to stop and proceeds through crosswalk.
	  ○ Driver to be aware pedestrians may not have app.			

Policies and Business Rules	Florida statute: 316.130 • Pedestrian in the crosswalk has right-of-way over driver. • Silent regarding pedestrians occupying the sidewalk who may or may not be waiting to cross. According to MUTCD: Section 2B.51 • The warning signal assigns right-of-way to traffic approaches.			

Service Package	Pedestrian Safety (VS12)
	• Vehicles controlled by a warning signal need to slow down to a speed that is reasonable for conditions. • Vehicles to Stop when necessary to avoid interfering with conflicting traffic, in this case, pedestrians.
Traceability	See User Needs Table 4
Inputs Summary	**Driver CV OBU:** System Initialization Input: None – BSM location comparisons. Human Inputs: None. CV Data: MAP data. GNSS: Time and location data. **Pedestrian CV:** System Initialization Input: None – BSM location comparisons. Pedestrian. smartphone must be "on" with settings loud enough to hear or feel. Human Inputs: Setting on smartphone for audio and/or haptic messages. CV Data: MAP data. GNSS: Time and location data. **RSU:** CV Data: MAP data for Pedestrian and Driver from BSM.
Output Summary	**Driver CV OBU:** CV Data: Alert message sent from RSU of pedestrian CV presence. **RSU:** CV Data: MAP.

Table 16: Service Package VS12 – Scenario 8: Degraded Conditions – Pedestrian Safety

Service Package	Pedestrian Safety (VS12)
Scenario ID and Title	*SP VS12 – S8: Degraded Conditions – Pedestrian Safety*
Scenario Objective	• Provide safe shut down of Pedestrian CV at midblock crossings.
Operational Event(s)	Under degraded failure/anomaly/exception" conditions: • A pedestrian approaching the crosswalk fails to receive a notification that a vehicle is approaching or in the crosswalk (False Negative). • A pedestrian approaching the crosswalk receives a notification when a vehicle is not approaching or not in the crosswalk (False Positive). • A driver approaching the crosswalk fails to receive a notification that a pedestrian is approaching or in the crosswalk (False Negative). • A driver approaching the crosswalk receives a notification when a pedestrian is not approaching or is not in the crosswalk (False Positive).

Service Package	**Pedestrian Safety (VS12)**			
Actor(s)	Actor		Role	
	Driver CV		Uses OBU to stop or go through midblock crossing.	
	Pedestrian CV		Uses vehicle-alert app on smartphone to use midblock crosswalk.	
Key Actions and Flow of Events	Source	Step	Key Action	Comments
	Pedestrian	1	Approaches the crosswalk.	Intends to occupy crosswalk.
	Pedestrian CV	2a	Broadcasts location 10x/sec from smartphone.	Refer to above list of operational events.
	Driver CV	2b	Broadcasts BSM 10x/sec from OBU.	Refer to above list of operational events.
	RSU	3a	Receives pedestrian location over DSRC.	Refer to above list of operational events.
	RSU	3b	Validates/corrects pedestrian location.	Refer to above list of operational events.
	RSU	3c	Transmits corrected pedestrian BSM on wireless media of OBU.	Refer to above list of operational events.
	RSU	4a	Compares pedestrian location to crosswalk location and to lane placement location.	Refer to above list of operational events.
	RSU	4b	If pedestrian is in roadway but not in crosswalk, warns pedestrian to use crosswalk.	Refer to above list of operational events.
	RSU	5a	Sends message to Driver CV to slow to stop.	Refer to above list of operational events.
	Driver CV	5b	Informs Driver HMI for Driver to slow to stop.	Refer to above list of operational events.
	RSU	5c	Verifies Driver is slowing to stop.	Refer to above list of operational events.
	RSU	5d	Sends message to pedestrian CV to proceed to cross with caution.	Refer to above list of operational events.
	Pedestrian CV	5e	Informs pedestrian CV to display crossing message.	Refer to above list of operational events.
	RSU	6b	Fails to verify Driver slowing to stop.	Refer to above list of operational events.
	RSU	6c	Sends message to pedestrian. CV not to proceed to cross.	Refer to above list of operational events.
	Pedestrian CV	6d	Informs pedestrian CV to display no-crossing message.	Refer to above list of operational events.
	RSU	7a	Verifies vehicle(s) has passed crosswalk.	Refer to above list of operational events.

Service Package	**Pedestrian Safety (VS12)**			
	RSU	7b	Sends message to pedestrian CV to proceed to cross with caution.	Refer to above list of operational events.
		7c	Informs pedestrian CV to display crossing message.	Refer to above list of operational events.
	Pedestrian	8	Proceeds through crosswalk or waits for new message.	
Post-Conditions	• Pedestrian with Ped app o Stops as "jaywalker" in roadway outside of crosswalk. o Stops before entering crosswalk. o Exits crosswalk away from traffic, having crossed US 1. o Waits for Driver to pass and for new go signal. • Driver with app o Slows or stops before yield bar. o Allows pedestrian to pass. o Driver fails to stop and proceeds through crosswalk. o Driver to be aware pedestrians may not have app.			
Policies and Business Rules	Florida statute: 316.130 • Pedestrian in the crosswalk has right-of-way over driver. • Silent regarding pedestrians occupying the sidewalk who may or may not be waiting to cross. According to MUTCD: Section 2B.51 • The warning signal assigns right-of-way to traffic approaches. • Vehicles controlled by a warning signal need to slow down to a speed that is reasonable for conditions. • Vehicles to Stop when necessary to avoid interfering with conflicting traffic, in this case, pedestrians.			
Traceability	See User Needs Table 4			
Inputs Summary	**Driver CV OBU:** System Initialization Input: None – BSM location comparisons. Human Inputs: None. CV Data: MAP data. GNSS: Time and location data. **Pedestrian CV:** System Initialization Input: None – BSM location comparisons. Pedestrian smartphone must be "on" with settings loud enough to hear or feel. Human Inputs: Setting on smartphone for audio and/or haptic messages. CV Data: MAP data. GNSS: Time and location data. **RSU:** CV Data: MAP data for Pedestrian and Driver from BSM			

Service Package	Pedestrian Safety (VS12)
Output Summary	**Driver CV OBU:** CV Data: Alert message sent from RSU of pedestrian CV presence. **RSU:** CV Data: MAP.

Table 17: Service Package TM18 – Scenario 9: Normal Operating Conditions – Drawbridge Management

Service Package	Drawbridge Management (TM18)			
Scenario ID and Title	*SP TM18- S9: Normal Operating Conditions – Drawbridge Management*			
Scenario Objective	• Provide safe stopping at drawbridge for vehicles with CVs.			
Operational Event(s)	• Drawbridge is controlled with hardwired control panel by Tender. • RSU is wirelessly activated by the control panel. • RSU sends message of bridge closing to traffic. • Driver CV sends BSM as approaching midblock intersection RSU. • Driver receives alert that bridge is closed to traffic. • Driver to yield by stopping behind drawbridge stop bar/vehicle in front. • Driver may be any of auto, emergency, transit, freight vehicles.			
Actor(s)	Actor		Role	
	Driver CV		Uses OBU to stop or go at drawbridge	
	Tender		Uses control panel to close and open bridge to traffic	
Key Actions and Flow of Events	Source	Step	Key Action	Comments
	Tender	1a	Tender closes bridge to traffic.	Uses extant control panel wired to primary radio.
	RSU	1b	Sends stop message to CVs.	Secondary radio to master radio to control panel.
	Driver CV	1c	Sends signal request message from OBU.	
	Driver CV	1d	Receives stop message on OBU.	Same as any traffic signal.
	Tender	2a	Tender opens bridge to traffic.	Uses extant control panel wired to primary radio.
	RSU	2b	Sends go message to CVs.	Secondary radio to master radio to control panel.
	Driver CV	2c	Sends signal request message from OBU.	
	Driver CV	2d	Receives go message on OBU.	Same as any traffic signal. .

Service Package	Drawbridge Management (TM18)
Post-Conditions	• Driver with CV o Informed of bridge closing to traffic. o Stops safely before yield bar. o Stops safely behind vehicle ahead. o Resumes journey.
Policies and Business Rules	Florida statute: N/A According to MUTCD: Section 2C.39 • A draw bridge sign shall be used in advance of movable bridge signals and gates. • The traffic signals for movable bridges are operated in coordination with the opening and closing of the movable bridge, and with the operation of movable bridge warning and resistance gates, or other devices and features used to warn, control, and stop traffic to give warning to road users, except in urban conditions where such signing would not be practical.
Traceability	See User Needs Table 4
Inputs Summary	Driver CV OBU: System Initialization Input: Signal request message. Human Inputs: None. CV Data: MAP data. GNSS: Time and location data. RSU: CV Data: None.

Table 18: Service Package TM18 – Scenario 10: Degraded Conditions – Drawbridge Management

Service Package	Drawbridge Management (TM18)	
Scenario ID and Title	*SP TM18 – S10: Degraded Conditions – Drawbridge Management*	
Scenario Objective	• Provide safe stopping at drawbridge for vehicles with CVs.	
Operational Event(s)	Under degraded failure/anomaly/exception" conditions: • A driver approaching the bridge fails to receive a notification that the bridge is closing to traffic (False Negative). • A driver approaching the bridge receives a notification of closing when the bridge is not closing to traffic (False Positive). • A driver waiting in the bridge queue fails to receive a notification that the bridge is opening to traffic (False Negative). • A driver waiting in the bridge queue receives a notification the bridge is opening to traffic when it is not (False Positive).	
Actor(s)	Actor	Role
	Driver CV	Uses OBU to stop or go at drawbridge.

<table>
<tr><th>Service Package</th><th colspan="4">Drawbridge Management (TM18)</th></tr>
<tr><td></td><td colspan="2">Tender</td><td colspan="2">Uses control panel to close and open bridge to traffic</td></tr>
<tr><td rowspan="9">Key Actions and Flow of Events</td><td>Source</td><td>Step</td><td>Key Action</td><td>Comments</td></tr>
<tr><td>Tender</td><td>1a</td><td>Tender closes bridge to traffic.</td><td>Uses extant control panel.</td></tr>
<tr><td>RSU</td><td>1b</td><td>Sends stop message to CVs.</td><td>Refer to first two bullets in above list of operational events.</td></tr>
<tr><td>Driver CV</td><td>1c</td><td>Sends signal request message from OBU.</td><td></td></tr>
<tr><td>Driver CV</td><td>1d</td><td>Receives stop message on OBU.</td><td>Refer to first two bullets in above list of operational events.</td></tr>
<tr><td>Tender</td><td>2a</td><td>Tender opens bridge to traffic.</td><td></td></tr>
<tr><td>RSU</td><td>2b</td><td>Sends go message to CVs.</td><td>Refer to last two bullets in above list of operational events.</td></tr>
<tr><td>Driver CV</td><td>2c</td><td>Sends signal request message from OBU.</td><td></td></tr>
<tr><td>Driver CV</td><td>2d</td><td>Receives go message on OBU.</td><td>Refer to last two bullets in above list of operational events.</td></tr>
<tr><td>Post-Conditions</td><td colspan="4">• Driver with CV
o Misinformed of bridge closing to traffic when it is not – hard stop (False Negative)
o Misinformed of bridge closing to traffic when it is not – slows unnecessarily (False Positive)
o Misinformed of bridge opening to traffic – follows traffic ahead as it moves (False Negative)
o Misinformed of bridge opening to traffic – waits until traffic actually moves (False Positive)
o In each case aware CV is not functioning properly and is hesitant to trust it for other purposes as well; return CV for repair
o Repair to RSU upon reporting by CV Drivers of malfunction</td></tr>
<tr><td>Policies and Business Rules</td><td colspan="4">Florida statute: N/A
According to MUTCD: Section 2C.39
• A draw bridge sign shall be used in advance of movable bridge signals and gates.
• The traffic signals for movable bridges are operated in coordination with the opening and closing of the movable bridge, and with the operation of movable bridge warning and resistance gates, or other devices and features used to warn, control, and stop traffic to give</td></tr>
</table>

Service Package	Drawbridge Management (TM18)
	warning to road users, except in urban conditions where such signing would not be practical.
Traceability	See User Needs Table 4
Inputs Summary	Driver CV OBU: System Initialization Input: Signal request message. Human Inputs: None. CV Data: MAP data. GNSS: Time and location data. RSU: CV Data: None.

Table 19: Service Package CVO03 – Scenario 11: Normal Operating Conditions – Weigh Station Management

Service Package	Weigh Station Management (CVO03)			
Scenario ID and Title	*SP CVO03- S11: Normal Operating Conditions – Weigh Station Management*			
Scenario Objective	• Provide weigh station bypass for compliant commercial vehicles.			
Operational Event(s)	• Southbound vehicle OBU recognized by RSU. • OBU vehicle credentials cross checked with stakeholder's central database. • Southbound vehicular weights are captured with weigh-in-motion strips. • Simultaneously, license plate reader uniquely identifies vehicle. • Size, weight and license plate information sent to weigh station. • Size and weight data are updated on the stakeholder's central database. • Southbound compliant vehicles bypass station. • Southbound non-compliant vehicles turn left into station. • All northbound commercial vehicles enter weigh station.			
Actor(s)	Actor		Role	
	Driver CV		Uses OBU to request bypass of weigh station	
	Weigh Station		Enforces non-compliant and oversize/weight vehicles	
Key Actions and Flow of Events	Source	Step	Key Action	Comments
	OBU	1	Sends the truck's unique identifier to RSU.	Southbound RSU will be co-located with weigh-in-motion screening station.
	RSU	2	RSU sends the unique identifier to stakeholder's container number database.	
	Commercial Number Database	3	Database screens unique identifier across law enforcement, agriculture,	

Service Package	Weigh Station Management (CVO03)			
			and national motor carrier lists, previous weigh station.	
	Local WIM strips and LPR	4	Captures real time vehicle size and weight.	
	Commercial Number Database	5	Database updated with latest size and weight.	
	RSU	6	Sends compliant or non-compliant message to OBU.	
	Driver CV	7	Receives go message on OBU.	
Post-Conditions	• Driver with CV o Informed compliance/noncompliance. o Pulls into weigh station. o Bypasses weigh station.			
Policies and Business Rules	Florida statute: 316.545 • Weight tables published pursuant to s. 316.535(7) shall include a 10-percent scale tolerance and shall thereby reflect the maximum scaled weights allowed any vehicle or combination of vehicles. According to MUTCD: Section 2D.49 • Weigh Station signing on freeways and expressways should have advance posting distance for the Exit Direction sign located a minimum of 1,500 feet in advance of the gore. • The traffic using this area or rest area remains within the right-of-way.			
Traceability	See User Needs Table 4			
Inputs Summary	Driver CV OBU: System Initialization Input: Signal request message. Human Inputs: None. CV Data: MAP data. GNSS: Time and location data. RSU: CV Data: None.			

Table 20: Service Package CVO03 – Scenario 12: Degraded Conditions – Weigh Station Management

Service Package	Weigh Station Management (CVO03)
Scenario ID and Title	*SP CVO03 – S12: Degraded Conditions – Weigh Station Management*
Scenario Objective	• Provide weigh station bypass for compliant commercial vehicles.

<table>
<tr><th>Service Package</th><th colspan="4">Weigh Station Management (CVO03)</th></tr>
<tr><td>Operational Event(s)</td><td colspan="4">Under degraded failure/anomaly/exception” conditions:
• A southbound commercial vehicle approaching the weigh station fails to receive a notification.
• All northbound commercial vehicles enter weigh station.</td></tr>
<tr><td rowspan="3">Actor(s)</td><td colspan="2">Actor</td><td colspan="2">Role</td></tr>
<tr><td colspan="2">Driver CV</td><td colspan="2">Uses OBU to request bypass of weigh station</td></tr>
<tr><td colspan="2">Weigh Station</td><td colspan="2">Enforces non-compliant and oversize/weight vehicles</td></tr>
<tr><td rowspan="4">Key Actions and Flow of Events</td><td>Source</td><td>Step</td><td>Key Action</td><td>Comments</td></tr>
<tr><td>OBU</td><td>1</td><td>Sends the truck’s unique identifier to RSU</td><td>Southbound RSU will be co-located with weigh-in-motion screening station</td></tr>
<tr><td>OBU</td><td>1a</td><td>Receives no acknowledgement</td><td></td></tr>
<tr><td>Driver CV</td><td>2</td><td>Pulls into the weigh station</td><td></td></tr>
<tr><td>Post-Conditions</td><td colspan="4">• Driver with CV
o Pulls into weigh station</td></tr>
<tr><td>Policies and Business Rules</td><td colspan="4">Florida statute: 316.545
• Weight tables published pursuant to s. 316.535(7) shall include a 10-percent scale tolerance and shall thereby reflect the maximum scaled weights allowed any vehicle or combination of vehicles.
According to MUTCD: Section 2D.49
• Weigh Station signing on freeways and expressways should have advance posting distance for the Exit Direction sign located a minimum of 1,500 feet in advance of the gore.
• The traffic using this area or rest area remains within the right-of-way.</td></tr>
<tr><td>Traceability</td><td colspan="4">See User Needs Table 4</td></tr>
<tr><td>Inputs Summary</td><td colspan="4">Driver CV OBU:
System Initialization Input: Signal request message.
Human Inputs: None.
CV Data: MAP data.
GNSS: Time and location data.

RSU:
CV Data: None.</td></tr>
</table>

Appendix C: Signal Controls on US 1

Figure 20: Signal Controls on US 1

MM	Main Street	Side Street	Device Type	Cabinet Type	Controller Type (Model - Make)	Controller Firmware Version	Existing Detection	Applicable to Emergency Signals Only					
								Fire Station	Fire Station Address	Fire Station Contact Number	Is Emergency Signal Controller Operational (as of 2/22/19)?	Comments	Actuation
0.00	US 1/N Roosevelt Blvd	Fleming St	Traffic Signal	332	2070E - McCain	2033	Inductive Loops						
0.09	US 1/N Roosevelt Blvd	Southard St	Traffic Signal	332	2070E - McCain	2033	Inductive Loops						
0.41	US 1/N Roosevelt Blvd	Truman Ave	Traffic Signal	332	2070E - McCain	2033	Inductive Loops						
0.49	US 1/N Roosevelt Blvd	Duval St	Traffic Signal	332	2070E - McCain	2033	Inductive Loops						
0.59	US 1/N Roosevelt Blvd	Simonton St	Traffic Signal	332	2070E - McCain	2033	Inductive Loops						
0.78	US 1/N Roosevelt Blvd	Windsor Ln	Traffic Signal	332	2070E - McCain	2033	Inductive Loops						
1.11	US 1/N Roosevelt Blvd	White St	Traffic Signal	332	2070E - McCain	2033	Inductive Loops						
1.24	US 1/N Roosevelt Blvd	Florida St	Traffic Signal (Mid-Block)	332	2070E - McCain	2033	None						
1.34	US 1/N Roosevelt Blvd	Eisenhower Dr	Traffic Signal	332	2070E - McCain	2033	Inductive Loops						
1.41	US 1/N Roosevelt Blvd	Fire Station	Emergency Signal	332	2070E - McCain	2033	None	City of Key West Fire Station	1600 N Roosevelt Blvd, Key West, FL 33040	305-809-3940	Yes	Wireless preemption was reported to be operational but with significant delay. It was also informed that the actuation switch has not being operational since the last roadway resurfacing.	Wireless preemption; also has actuation switch but it is not working.
1.64	US 1/N Roosevelt Blvd	First St	Traffic Signal	332	2070E - McCain	2033	Video Detectors						
1.75	US 1/N Roosevelt Blvd	US Customs Services	Mid-Block Pedestrian Hybrid Beacon (PHB)	332	2070LX - McCain	Omni eX (Version Unknown)	None						
1.96	US 1/N Roosevelt Blvd	Fifth St	Traffic Signal	332	2070E - McCain	2033	Video Detectors						
2.05	US 1/N Roosevelt Blvd	Fairfield Inn & Suites	Mid-Block Pedestrian Hybrid Beacon (PHB)	332	2070LX - McCain	Omni eX (Version Unknown)	None						
2.49	US 1/N Roosevelt Blvd	Overseas Market	Traffic Signal	332	2070E - McCain	2033	Video Detectors						
2.54	US 1/N Roosevelt Blvd	Key Plaza	Mid-Block Pedestrian Hybrid Beacon (PHB)	332	2070LX - McCain	Omni eX (Version Unknown)	None						
2.74	US 1/N Roosevelt Blvd	Kennedy Dr	Traffic Signal	332	2070E - McCain	2033	Video Detectors						
3.05	US 1/N Roosevelt Blvd	Searstown	Traffic Signal	332	2070E - McCain	2033	Video Detectors						
3.49	US 1/N Roosevelt Blvd	Capital City Bank	Mid-Block Pedestrian Hybrid Beacon (PHB)	332	2070LX - McCain	Omni eX (Version Unknown)	None						
3.69	US 1/N Roosevelt Blvd	North Hotel	Mid-Block Pedestrian Hybrid Beacon (PHB)	332	2070LX - McCain	Omni eX (Version Unknown)	None						

MM	Main Street	Side Street	Device Type	Cabinet Type	Controller Type (Model - Make)	Controller Firmware Version	Existing Detection	Applicable to Emergency Signals Only					
								Fire Station	Fire Station Address	Fire Station Contact Number	Is Emergency Signal Controller Operational (as of 2/22/19)?	Comments	Actuation
3.93	US 1/N Roosevelt Blvd	Roosevelt Blvd	Traffic Signal	332 (2 Cabinets - 2070E/ea)	2070E - McCain	2033	Video Detectors						
3.93	US 1/N Roosevelt Blvd	Roosevelt Blvd	Traffic Signal	332 (Secondary)	2070E - McCain	2033	None						
2.63	A1A/S Roosevelt Blvd	Flagler Ave	Traffic Signal	332	2070E - McCain	2033	Video Detectors						
4.23	US 1/N Roosevelt Blvd	College Rd	Traffic Signal	332	2070E - McCain	2033	Inductive Loops						
4.40	US 1/N Roosevelt Blvd	Cross St	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Inductive Loops						
4.60	US 1/Overseas Hwy	MacDonald Ave	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Inductive Loops						
4.90	US 1/Overseas Hwy	3rd St	Emergency Signal	Noted "*Type III, TypeIV, Type V*" on the cabinet door.	1880EL - TRANSYT	Unknown	None	Station 8 - Stock Island	5655 MacDonald Avenue Stock Island, FL 33040	305-292-2797	No	Not functional for an extended period of time. Believed not to be connected and is not compatible with Transparity.	No Actuation switch.
10.50	US 1/Overseas Hwy	Emerald Dr	Emergency Signal (Under Construction)	336	2070LX - McCain	Omni eX (Version Unknown)	None	Station 9 - Big Coppitt	28 Emerald Drive Big Coppitt, FL 33040	305-295-0587	Under Construction	Controller will be replaced and actuation switch will be operational after construction work is completed.	Existing actuation switch to be replaced.
19.20	US 1/Overseas Hwy	Crane Blvd	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Inductive Loops						
30.40	US 1/Overseas Hwy	Key Deer Blvd	Traffic Signal	332	2070LX - McCain	Omni eX - ver 1.11	Video Detectors						
48.80	US 1/Overseas Hwy	33rd St	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Plan shows inductive loops						
50.10	US 1/Overseas Hwy	Sombrero Beach Road	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Inductive Loops						
51.70	US 1/Overseas Hwy	89th St	Emergency Signal	332	2070E - McCain	2033	None	City of Marathon Fire Rescue Station #14	8900 Overseas Hwy, Marathon, FL 33050	305-743-5266	Yes		Has actuation switch and it is working.
52.60	US 1/Overseas Hwy	107th St	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	None						
52.70	US 1/Overseas Hwy	109th St	Traffic Signal				None						
53.30	US 1/Overseas Hwy	121st St	Traffic Signal (Mid-Block)	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	None						
53.70	US 1/Overseas Hwy	Sadowski Causeway	Traffic Signal	332	2070LX - McCain	Omni eX - ver 1.11	None						
54.20	US 1/Overseas Hwy	Coco Plum Dr	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Inductive Loops						

MM	Main Street	Side Street	Device Type	Cabinet Type	Controller Type (Model - Make)	Controller Firmware Version	Existing Detection	Applicable to Emergency Signals Only					
								Fire Station	Fire Station Address	Fire Station Contact Number	Is Emergency Signal Controller Operational (as of 2/22/19)?	Comments	Actuation
68.30	US 1/Overseas Hwy	Layton City Hall	Emergency Signal	Type III	LMD 8000 - Traffic Control Technologies (TCT)	Unknown	None	Station 18 - Layton	68260 Overseas Highway Layton, FL 33001	305-664-4217	Yes		No Actuation switch.
84.92	US 1/Overseas Hwy	Plantation Key Weigh Station	Weigh-In-Motion Screening Station				None						
85.70	US 1/Overseas Hwy	Drawbridge Signal	Drawbridge Signal				N/A						
85.76	US 1/Overseas Hwy	Drawbridge Signal	Drawbridge Signal				N/A						
89.90	US 1/Overseas Hwy	Woods Ave	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Inductive Loops						
90.40	US 1/Overseas Hwy	Bessie Rd	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Inductive Loops						
91.20	US 1/Overseas Hwy	Ocean Blvd	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Inductive Loops						
91.90	US 1/Overseas Hwy	Jo-Jean Way	Emergency Signal	336	2070E - McCain	2033	None	Station 22 - Tavernier	151 Marine Avenue Tavernier, FL 33070	305-852-6285	No	The Controller is backed up but there is an unknown issue with either the controller itself or the conflict monitor which will have to be replaced.	Has actuation switch, but it is not used for months. They believe it is working.
99.10	US 1/Overseas Hwy	Woodward Way/Fisherman's Terr	Emergency Signal	336	2070E - McCain	2033	None	Key Largo Fire Station #24	Overseas Highway and East Drive, Key Largo, FL 33037	305-451-2700	No	No operational based on comment from TransCore dated 2/12/2019.	Has actuation switch but it is not working.
99.20	US 1/Overseas Hwy	East Dr											
99.50	US 1/Overseas Hwy	Ocean Bay Dr/Atlantic Blvd	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Video Detectors						
99.74	US 1/Overseas Hwy	South of Bay Dr	Mid-Block Pedestrian Hybrid Beacon (PHB)	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	None						
101.40	US 1/Overseas Hwy	Tarpon Basin	Traffic Signal	332	2070E(1C CPU) - McCain	Omni eX - ver 1.11	Inductive Loops						
104.90	US 1/Overseas Hwy	North of Taylor Dr/Bowen Dr	Traffic Signal (Mid-Block)	332	2070LX - McCain	Omni eX - ver 1.11	None						
106.50	US 1/Overseas Hwy	CR905, Key Largo	Emergency Signal	336	2070E - McCain	2033	None	Key Largo Fire Station #25	220 Reef Dr, Key Largo, FL 33037	305-453-0025	Yes	Issue with the controller. This must be reinitialized.	Has actuation switch and it is working.

Glossary

No entries at present.