# FDOT V2X-DEP ConOps-Reqs

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# 1. Overview

This combined Concept of Operations (ConOps) and Requirements document was developed by Southwest Research Institute® (SwRI®) for the Florida Department of Transportation (FDOT) Vehicle-to-Everything (V2X) Data Exchange Platform (DEP) project. The first section of the document provides six elements: system identification, purpose and audience, an overview of the document, a high-level overview of the proposed system, stakeholders, and references. These elements are described in the following sections.

Please note that this is a living document. Version 1.x was for the proof-of concept release. This version 2.0 is for the first production release. Major version numbers will increase with each contractual release.

Also, note that any references specific to the DEP using the terminology “real time” should be considered near real time. Refer to Section 7.2.1 for latency requirements.

## 1.1 Identification

Project Name: Vehicle-to-Everything (V2X) Data Exchange Platform (DEP)

Software revision: Phase 2 Release 2
Financial Project Identification: BEB93
Federal Aid Project Number: N/A

## 1.2 Purpose and Intended Audience

The purpose of this ConOps and Requirements document is to describe user needs to be met by the DEP, methods by which users and external systems will interact with the DEP to meet these needs (i.e., operational scenarios), and ensuing system requirements. To that end, this document will:

- Describe intended users, use cases and operational scenarios, and needs the DEP will meet
- Define DEP functionality required to meet user needs
- Describe the overall design of components and data flows to implement the DEP
- Define the external system interfaces used to implement the DEP

The intended audience for this ConOps document is:

- Non-technical program management and sponsors
- Technical management of participating agencies
- System developers
- Operations managers and operators
- Technical managers providing oversight of the project

## 1.3 Document Overview

This document describes the existing situation of V2X data exchange, or lack thereof, the shortcomings or unmet needs, changes that would address the needs, and the final system after implementation. This document will be developed in an iterative fashion across multiple project phases and according to an agile process such that descriptions will be included as necessary and to the level of detail needed to sufficiently describe plans and current state of development for each project phase.

## 1.4 High-Level System Overview

The DEP will collect and store data generated from FDOT’s Connected and Autonomous Vehicle (CAV) deployments across the state, enabling FDOT to consolidate data from numerous disparate transportation systems/projects across the state, each with its own purposes, features, capabilities, constraints, and

technical architectures, and make it available to similarly disparate FDOT offices and other stakeholders to utilize for strategic planning, equitable access, improved safety and mobility, and other functions to achieve objectives outlined in the CAV Business Plan.

The DEP will collect, store, and provide analytics on a wide range of data from CAV deployments and other systems, including but not limited to SunGuide®, Data Integration and Video Aggregation System (DIVAS), SunStore, and the Florida Advanced Traveler Information System. Data from various 3rd-party systems will also be consumed and used, including data from vehicle OEMs, weather systems, and 3rd-party traffic data systems like HERE and Waze, among others. The DEP will also make data available to vehicles by providing alerts and other data to SunGuide and other external systems (such as Regional Integrated Transportation Information System (RITIS)) that will then push the alerts and other data to roadside units (RSU) or vehicles. A list of data providers and consumers that have been identified at this time is included in Table 1. Stakeholders. The platform will support modular expansion to enable adding new data sources as they are made available, new analytics processes on collected data, and flexible reporting and distribution of information.

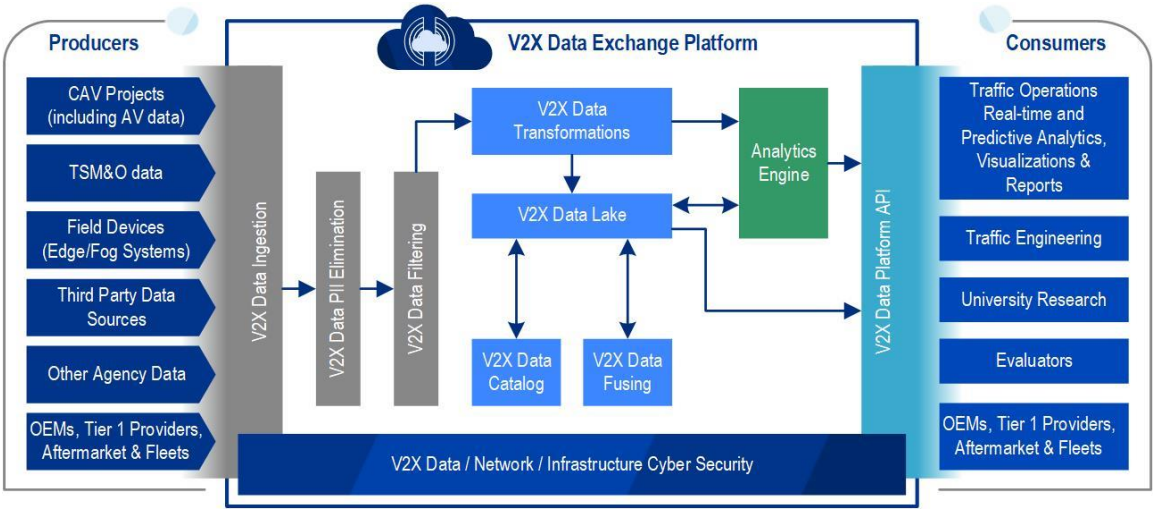



**Figure 1. V2X DEP High-level Components**

## 1.5 Stakeholders

Stakeholders for this project include the following: FDOT Districts, FDOT Central Office, Florida Toll Authorities, First Responders, Automotive OEMs, Commercial Fleet Operators, Equipment Suppliers, Hardware Vendors, Data Analytics Vendors, Non-FDOT Government Agencies, Other CAV Automotive Equipment Suppliers, Automotive Consortia, and traveling public. Note that Table 1. Stakeholders will evolve appropriately over time.

Project stakeholders are involved at differing levels throughout the project, and will be assessed by a combination of their involvement and power. Those with low power, but high interest as well as those with high power, but low interest will be kept informed primarily through progress reviews and product demonstrations. Those with high power and high interest will be actively engaged primarily through planning and ideation meetings. They will also be invited to the product reviews held after every development iteration. As mentioned in the PMP, the bulk of stakeholders will be identified through the various ideation sessions. Others will be identified through industry forums, conferences, etc. New stakeholders will be vetted through the FDOT before being actively engaged.

If we receive data directly from an entity, they are a stakeholder. For example, if District 5 provides data from a device, District 5 is the stakeholder - not the device manufacturer (unless D5 requests including

the manufacturer as a stakeholder). If SwRI coordinates with a vendor, the vendor's information will be put in the Stakeholder list. If FDOT coordinates with a vendor, FDOT is accountable for providing the vendor's information. Data source is a technical resource. Stakeholder is a relationship.

**Table 1. Stakeholders**

| Stakeholder | Project Role | Contact Information |
|---|---|---|
| FDOT Traffic Engineering and Operations | Oversight, management, and liaison to local agencies | JoAnna Hand joanna.hand@dot.state.fl.us |
| FDOT District 1 | Operator, maintainer, oversight, management, and technical expertise | Steven Davis steven.davis@dot.state.fl.us |
| FDOT District 2 | Operator, maintainer, oversight, management, and technical expertise | Pete Vega peter.vega@dot.state.fl.us |
| FDOT District 3 | Operator, maintainer, oversight, management, and technical expertise | Amy DiRusso amy.dirusso@dot.state.fl.us |
| FDOT District 4 | Operator, maintainer, oversight, management, and technical expertise | Alexandra Lopez alexandra.lopez@dot.state.fl.us |
| FDOT District 5 | Operator, maintainer, oversight, management, and technical expertise | Jeremy Dilmore Jeremy.Dilmore@dot.state.fl.us |
| FDOT District 6 | Operator, maintainer, oversight, management, and technical expertise | Javier Rodriguez javier.rodriguez2@dot.state.fl.us |
| FDOT District 7 | Operator, maintainer, oversight, management, and technical expertise | Megan Arasteh megan.arasteh@dot.state.fl.us |
| FDOT Office of Information Technology (OIT) | Oversight of architecture and security aspects | John Mallette john.mallette@dot.state.fl.us |
| FDOT Office of General Counsel (OGC) | Oversight of legal and policy aspects | https://www.fdot.gov/legal/default.shtm |
| FDOT Office of Communications | Communications with industry, other public agencies, and the public as regards V2X DEP | https://www.fdot.gov/info/default.shtm |

| Stakeholder | Project Role | Contact Information |
|---|---|---|
| FDOT Office of Design | Data consumer | https://www.fdot.gov/design/default.shtm |
| FDOT Office of Emergency Management | Data provider, consumer | https://www.fdot.gov/emergencymanagement/default.shtm |
| FDOT Office of Environmental Management | Data provider, consumer | https://www.fdot.gov/environment/default.shtm |
| FDOT Traffic Engineering Research Laboratory (TERL) | Data consumer/disseminator for demonstration purposes | Derek Vollmer<br>Derek.vollmer@dot.state.fl.us |
| FDOT Office of Maintenance | Data provider, consumer | Angel Birriel<br>Angel.birriel@dot.state.fl.us |
| FDOT 511 | Data provider, consumer | James Landini<br>James.landini@dot.state.fl.us |
| Florida's Turnpike Enterprise (FTE) | Operator, maintainer, oversight, management, technical expertise data provider, consumer | John Easterling<br>john.easterling@dot.state.fl.us |
| Collier County | Operator, maintainer, oversight, management, and technical expertise data provider, consumer | Haris Domond<br>Haris.domond@CollierCountyFl.gov |
| Tampa Hillsborough Expressway Authority (THEA) | Operator, maintainer, oversight, management, and technical expertise data provider, consumer | Bobo Frey<br>bobf@tampa-xway.com |
| First Responders | Data provider, consumer | N/A |
| Ford Motor Company | Data provider, consumer | Andy Meyer<br>ameyer41@ford.com |
| Amazon Fleet | Data provider, consumer | Erica Moore<br>mooerica@amazon.com |
| DriveWyze | Data provider, consumer | Brian Mofford |
| Waze | Data provider, consumer | Andrew Stober<br>andrewstober@waze.com |

| Stakeholder | Project Role | Contact Information |
|---|---|---|
| HERE | Data provider, consumer | Jared Causseaux<br>(850) 414-4336<br>Jared.Causseaux@dot.state.fl.us |
| Applied Information | Data provider, consumer | Peter Ashley<br>pashley@appinfoinc.com |
| Iteris | Data provider | Anita Vandervalk-Ostrander<br>avandervalk@iteris.com |
| Kapsch | Data provider | Dan Toohey<br>Dan.toohey@kapsch.net |
| Yunex | Data provider | Iouri Nemirovski<br>Iouri.nemirovski@yunextraffic.com |
| Alabama DOT | Data provider, consumer | Bryson Moultry<br>moultryb@dot.state.al.us |
| Georgia DOT | Data provider, consumer | Alan Davis<br>aladavis@dot.ga.gov |
| City of Tallahassee, FL | Data provider, consumer | Joshua Hollingsworth<br>joshua.hollingsworth@talgov.com |
| Florida Highway Patrol | Data provider, consumer | https://www.flhsmv.gov/florida-highway-patrol/about-fhp/ |
| Traveling public | System user | N/A |

### 1.5.1 Emergent Stakeholders

Throughout the course of the project, it is expected that the above list of stakeholders will grow and shrink. Take Amazon Fleet who was actively engaged during the early stages of the project but is unlikely to participate in a data exchange before completion of this project due to internal re-prioritization of strategic goals. New stakeholders may come from many sources such as new FDOT projects, conferences, industry outreach, etc. The basic management philosophy for managing new Stakeholders is as follows:

1. Execute a non-disclosure agreement (NDA) to protect all parties.
2. Review the data-sharing agreement to ensure all parties are aware of the requirements.
3. Determine the data, its quality, and the frequency that the entity is willing to share with the DEP.
4. Determine the data, its quality, and the frequency that the DEP is willing to share with the entity.
5. Determine the mechanisms for data sharing (push, pulled, streamed, etc.).

6. Provide access to the DEP following the procedures outlined in the Security Plan.
7. Engage with the entity to explore the data and build functionality to support corresponding use cases as needed.

### 1.5.2 Project Ideation Meetings

SwRI, FDOT personnel, district personnel, and Subject Matter Experts (SMEs) meet periodically to discuss and iterate use cases, design options, integration approaches, security, and privacy concerns, all of which are supported by the existing system architecture. That said, the architecture is evolutionary and has been modified since the proposal; most notably, the central data streaming pipeline has been revised to ensure the DEP is able to support the five-second latency requirement at scale. This architectural revision follows in-depth discussions with Amazon Web Services (AWS) and other industry SMEs.. These ideation meetings serve to express current plans and obtain input to shape those plans as the project moves forward.

### 1.5.3 External Entities Engagement Plan

A separate document, V2X DEP External Entities Engagement Plan, contains the external entity engagement plan which also includes an Industry Engagement Plan as well as an Interstate Cooperation Plan. In addition, it contains outcomes and timelines for future activities. FDOT has carefully selected organizations with which to share data with the goal of supporting the use cases listed below in Section 1.6 (Referenced Documentation). These use cases align with FDOT strategic goals which center around safety and mobility. Particularly relevant to external entity engagement are the phases of this project:

**Table 2: Project Release Phases**

| Phase | Description |
|---|---|
| Phase 1, Release 1 (P1R1) | Concerned with a proof of concept (POC) system that provides some level of data ingestion and dissemination |
| Phase 2, Release 1 (P2R1) | Builds on P1R1 by strengthening the foundation system as well as focusing on data ingestion |
| Phase 2, Release 2 (P2R2) | Concentrates on making data available to consumers |
| Phase 2, Release 3 (P2R3) | Concentrates on analytics |
| Phase 2, Release 4 (P2R4) | Focused on expansion including cross-state coordination |

**Table 3: Data Sources by Project Release**

| Data Source | Project Release |
|---|---|
| CAV | Phase 1, Release 1 (P1R1) [Various District Projects]<br>Phase 2, Release 1 (P2R1) [Various District Projects]<br>Phase 2, Release 1 (P2R2) [Various District Projects]<br>Phase 2, Release 3 (P2R3) [PLANNED – FL 511 City of Tallahasse, Iteris BlueVantage] |

| | |
|---|---|
| SunGuide | Phase 1, Release 1 (P1R1)<br>Phase 2, Release 1 (P2R1) |
| Waze | Phase 1, Release 1 (P1R1) |
| HERE | Phase 1, Release 1 (P1R1) |
| Ford | Phase 2, Release 1 (P2R1)<br>Phase 2, Release 2 (P2R2) [DISABLED] |
| 511 | Phase 2, Release 3 (P2R3) [PLANNED] |

Specifics for the incoming data sources and APIs that facilitate dissemination are described in the V2X DEP System Design Document.

## 1.6 Referenced Documentation

The following documents are referenced or were used in the preparation of this document to the extent specified herein. If a referenced document conflicts with this document, this document shall take precedence. Note that document links will be added as final shared names and locations are determined.

This document is one in a series of Systems Engineering (SE) documents that are updated periodically throughout the project and baselined at particular milestones. All SE documents are kept in sequence. When referring to other SE documents this document refers to the latest version.

**Table 4. References**

| Document No. | Document Title | Link/Contact Info |
|---|---|---|
| DOT-ITN-20-9104-SJ | Request for Proposal: Vehicle-to-Everything (V2X) Data Exchange Platform | |
| BEB93 | Vehicle to Everything Data Exchange Platform Contract | |
| SOW-012634 | AWS Documentation | https://docs.aws.amazon.com/https://docs.aws.amazon.com/ |
| | Use Cases/User Stories Jira Repository | |
| n/a | V2X DEP Project Management Plan | FDOT-V2X-DEP-PMP-V3_2023_0729.pdf |
| n/a | V2X DEP System Design Document | System Engineering Documents |
| n/a | V2X DEP Security Plan | System Engineering Documents |
| n/a | V2X DEP System Test Plan | System Engineering Documents |
| | | |
| | | |
| | | |
| n/a | V2X DEP External Entities Engagement Plan | System Engineering Documents |

| Document No. | Document Title | Link/Contact Info |
|---|---|---|
| n/a | V2X DEP Requirements Traceability Verification Test Matrix (RTVM) | System Engineering Documents |
| | FL V2X DEP Statewide Architecture | https://teo.fdot.gov/architecture/architectures/statewide/html/projects/projarch16.htmlhttps://teo.fdot.gov/architecture/architectures/statewide/html/projects/projarch16.html |
| | IEEE Systems Engineering Guidance | |
| | FHWA SE guidance | |
| 4.1 | RSU specification | |
| | FDOT GIS (source for ARBM data) | https://www.fdot.gov/statistics/gis/default.shtmhttps://www.fdot.gov/statistics/gis/default.shtm |
| | Communications and Data Processing – Chapter 282, Florida Statutes Communications and Data Processing – Chapter 282, Florida Statutes | http://www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&URL=0200-0299/0282/0282ContentsIndex.html&StatuteYear=2019&Title=-%3E2019-%3Echapter%20282 |
| | Cloud First Policy – Chapter 282, Section 282.206, Florida Statutes Cloud First Policy – Chapter 282, Section 282.206, Florida Statutes | http://www.leg.state.fl.us/statutes/index.cfm?App_mode=Display_Statute&URL=0200-0299/0282/0282.html |
| | Security of Data and Information Technology Resources Act – Chapter 282, Section 282.318, Florida Statutes Security of Data and Information Technology Resources Act – Chapter 282, Section 282.318, Florida Statutes | http://www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0200-0299/0282/Sections/0282.318.html |
| | Computer Related Crimes Law – Chapter 815, Florida Statutes Computer Related Crimes Law – Chapter 815, Florida Statutes | http://www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&URL=0800-0899/0815/0815ContentsIndex.html |
| | Florida Cybersecurity Standards – Chapter 60GG-2, Florida Administrative Code: Information Technology Florida Cybersecurity Standards – Chapter 60GG-2, Florida Administrative Code: Information Technology | https://www.flrules.org/gateway/ChapterHome.asp?Chapter=60GG-2 |
| | Public Records Law – Chapter 119, Florida Statutes Public Records Law – Chapter 119, Florida Statutes | https://www.dms.myflorida.com/content/download/57145/241125#:~:text=Every%20person%20who%20has%20custody,the%20fee%20prescribed%20by%20law. leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&URL=0100-0199/0119/0119ContentsIndex.html |
| | Safety and Security Services – Section 281.301, Florida Statutes Safety and Security Services – Section 281.301, Florida Statutes | http://www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0200-0299/0281/Sections/0281.301.html |

| Document No. | Document Title | Link/Contact Info |
|---|---|---|
| | Project Management and Oversight – Chapter 60GG-1, Florida Administrative Code Project Management and Oversight – Chapter 60GG-1, Florida Administrative Code | https://www.flrules.org/gateway/ChapterHome.asp?Chapter=60GG-1 |
| | FDOT Development Standards – Azure DevOps FDOT Development Standards – Azure DevOps | https://dev.azure.com/fdot/Standards/ |
| 2.1 | FDOT System Requirements Template | https://www.fdot.gov/docs/default-source/content-docs/it/pdm/3_requirements/System_Requirements_Template.docx |

# 2. Current System Situation

This section describes Florida's current situation with respect to data collection, usage, and information exchange from Florida's CAV deployments.

## 2.1 Background, Objectives, and Scope

Currently there are numerous disparate CAV transportation systems and projects in various phases of deployment across the state, each with their own purposes, features, capabilities, constraints, and technical architectures that do not inherently allow for unification and/or further dissemination to other disparate systems/projects with differing architectures, nor do they allow for V2X communications within this mix. As these projects develop, V2X data gathered within each district may also be useful at a regional or even state level, but there currently is no standardized method for collecting and sharing this data.

The goal of V2X DEP is to fulfill the agency's safety (e.g., Target Zero), mobility, environment, and economic development goals by reducing crashes and congestion, and by providing real time CAV information to road users via agency-managed Intelligent Transportation Systems (ITS) devices, and indirectly via automobile OEM and 3rd-party systems/applications (refer to the V2X DEP External Entities Engagement Plan for details), FDOT operations staff, research organizations, and others. In addition to data from CAV corridors, Transportation Systems Management and Operations (TSM&O) data from freeway management systems, arterial management systems, and commercial vehicle and freight management systems will be collected and integrated into the platform.

It is not the purpose of the V2X DEP to replace any of the existing FDOT systems. Rather, it is meant to augment them. For example, FDOT's SunGuide software both feeds and consumes DEP data. In feeding the DEP, data across the different SunGuide installations may be aggregated and used as a whole – the DEP's workzone data exchange (WZDx) as an example. Likewise, data provided by the DEP may enhance capabilities of SunGuide, i.e., by giving the ability to consume proposed traveler information messages (TIMs) generated by the DEP via analysis of third-party data.

The V2X DEP will collect, store, and provide analytics on a wide range of data from CAV deployments and other systems, including data from various state, OEM, and 3rd-party systems. The DEP will make data available to various systems and vehicles by pushing it to RSUs or vehicles via SunGuide and other external systems such as Regional Integrated Transportation Information System (RITIS). The platform will support modular expansion to enable adding new data sources as they are made available, new analytics processes on collected data, and flexible reporting and distribution of information. Users of the platform will have access to real time data as well as back-end data analytics solutions and reporting systems to

support operational CAV scenarios and decision making that can be accomplished in real time or on historical data, and short-term and long-term planning and performance assessments.

Data privacy and the handling of personally identifiable information (PII) in both data ingestion and aggregation algorithms used by the platform is described in the V2X DEP Security Plan, and specific design decisions are detailed in the V2X DEP System Design Document. The stance of the DEP is to not collect PII. Any PII sent to the DEP is discarded, stripped, or hashed before further handling. Sensitive data (for example VINs and license plate numbers) which can be used to derive PII is hashed or discarded. Further information and details are in the aforementioned supplementary documents.

## 2.2 Operational Constraints

FDOT has been deploying connected vehicle (CV) devices along roadways in Florida for several years. The data from these deployments either reside at the local agency or at the District's regional transportation management center. The current operational situation is constrained in that there is no single, centralized, public system that gathers and combines CAV data from numerous distinct sources, stores it in a single repository, and then makes it available to multiple users (such as RSUs, vehicles, SunGuide, and other systems and organizations) through various means. Note that existing systems were not designed to scale to meet these needs, and, therefore, the decision was made to develop the DEP. For system constraints on the DEP see section 4.1 which enumerates a list of software, hardware, and policy constraints.

Architecturally, for the state, it is important that SunGuide be the primary operational interface with equipment so that it provides a standardized and consistent interface with ITS field equipment. This way, when response plans are implemented, they are managed consistently across any ITS field device providing information (e.g., DMS or RSUs).

Below is a list of operational deployments that represent the current state of the CAV Program.

**US 90 Signal Phase and Timing (SPaT)** – The US 90 SPaT Tallahassee project has been operational since the spring of 2018. The project encompasses 22 signalized intersections from Duval Street to Walden Road on US 90 in Tallahassee. The RSUs deployed in this project are some of the first-generation RSUs and do not have much processing capability on their own, merely acting as pass-through devices to the traffic controllers which generate the SPaT data. Currently, no data is being collected.

**Gainesville SPaT** – This project consists of CV technologies and applications along SR 121 (SW 34$^{th}$ St), SR 26 (W University Ave), US 441 (SW 13$^{th}$ St), and SR 24 (SW Archer Rd) in Gainesville and has been operational since September 2019. The project aims to improve travel time safety and vehicle throughput while providing information to road users. The University of Florida (UF) currently receives data from the project via the City of Gainesville. Gainesville SPaT RSUs also utilize the lower 45 MHz, but FDOT District 2 has indicated they will upgrade the RSUs as well.

**Pinellas SPaT** – This SPaT project is deployed at 23 traffic signals along a portion of US 19 corridor in Clearwater. The data from the dual-mode RSUs goes through the Pinellas County network and back to the vendor's cloud. Because the contract with the vendor has ended, its server is no longer being used and no data is being collected from the RSUs. Pinellas County has indicated plans to add 90 RSUs in the future with its Advanced Transportation and Congestion Management Technologies Deployment grant received in 2020.

FDOT also has multiregional CV projects that include more applications.

**I-75 FRAME** (Florida's Regional Advanced Mobility Elements) project is located on the I-75 and US 301/441 corridors, connecting east-west arterials between these two corridors. The project length comprises of FDOT Districts 2 (Gainesville) and 5 (Ocala) jurisdictions where the northern and southern areas of this

regional effort are located. Each District led the efforts of their areas to deploy CV technologies to better manage, operate, and maintain the multi-modal system and create an integrated corridor management solution. CV applications include SPaT, ped-safe, transit signal priority, and automated traffic signal performance measures (ATSPMs).

I-75 FRAME in Gainesville consists of 103 RSUs using Channel 180 DSRC. The RSU data resides either on the District 2 network or on the City of Gainesville network (the networks are separate). District 2 would like to connect its RSUs to SunGuide.

I-75 FRAME in Ocala consists of 104 dual-mode RSUs. FDOT District 5 has a robust CV data distribution that is connected to SunGuide, third parties, and the District's Regional Integrated Corridor Management System.

There are several other projects and CV deployments in Florida that are in various stages of procurement, deployment, or operation. Additional details will be included as they are available. These projects include but are not limited to: I-4 FRAME, PedSafe Greenway, US 41 FRAME, SPaT Trapezium, SunTrax, US 1 Keys COAST, State Road 434, and Smart Bay (US 98), and of course the V2X DEP itself as it is incrementally developed over four releases.

### 2.3 Support Environment

Each of the various disparate existing systems described above may have their own mechanisms for support and maintenance. Nonetheless, there is no single unified system at this time, nor is there an intent that this project will address unification of support environments. During Phase 1, Release 1, there was not a specific support environment for the DEP. After moving into Phase 2, a separate "staging" environment was created to add stability for IV&V and related testing. To date, no other DEP environments (including a production environment) exist.

The DEP is an AWS-based project and details of the implementation may be found in the V2X DEP System Design Document. AWS is a highly scalable cloud-based platform capable of handling mass amounts of data with pre-determined reliability and throughput. These were among the reasons for its choice as the cloud provider of the DEP. In addition, AWS provides customer support to its clients in terms of architectural guidance, recommendations, and troubleshooting. Phase 1, Release 1 of this project was the proof of concept (POC) stage. During the POC, the base architecture was developed and vetted. In Phase 2, Release 1, the base architecture was updated with lessons learned and further stabilized according to industry best practices. Additional updates are expected as the project progresses and new AWS functionality becomes available.

## 3. Change Justification

This section describes reasons why the proposed system is needed with respect to individual user (class) needs.

### 3.1 Justification for Changes

FDOT and other stakeholders need a unified platform for gathering, storing, and sharing CAV data that has been gathered in real time and is made available to others both in real time (specific time frame defined later in document) and periodically (as needed) for further analysis. Data is currently available in various forms from a range of sensors, field equipment, FDOT software suites, and 3rd-party systems; it is needed across these project and system boundaries for use in making operational and driving decisions, long-term planning, and performance assessments. There is also a need to provide flexible reporting and analysis tools and support modular expansion to enable the addition of new data sources and distribution methods over time. The DEP will ultimately fulfill the agency's safety, mobility, environment, and

economic development goals by reducing crashes and congestion through the gathering, consolidating, analysis, and dissemination of CAV data from and to various stakeholders in ways that existing systems cannot. For instance, other CAV projects do not have the ability to easily scale statewide because they were not built for that need. Finally, the V2X DEP is positioned to help FDOT achieve its Target Zero.

## 3.2 User Needs

This section describes how the V2X DEP will be used to meet the needs of the various user profiles/cases for stakeholders within FDOT and outside of FDOT. While certain stakeholders may be data producers that provide input to the DEP and others may be data consumers receiving information from the V2X DEP, it is expected that most users will be both data providers and consumers. In the context of use cases, these are separate and will be described individually.

Table 5, below, lists user needs to be met by the V2X platform; these user needs (described as epics in Jira) are linked to associated Jira items describing individual use cases/user stories. Initially, the team attempted to maintain requirements separately, but the manual linkage was cumbersome and not used consistently. The team has since ceased that practice (beginning with Phase 2, Release 1), and requirements are stated in the user stories. Functionality included here is from a user perspective, focused mainly on interfaces for viewing, analyzing, and retrieving data managed within the DEP 7.2 System Requirements.. Note that some user needs may not be completely met in a single release.

Please see Table 2: Project Release Phases for official releases. Note that the DEP architecture may be modified with each release. Unless these changes are specific to the concept of operations or requirements, such changes will be described in the design document and not herein.

Note that in the interest of brevity, the user story titles generally do not reference all the respective users identified in the "User" column. The "User" column's values are detailed in Section 4.6, "User Class Profiles".

**Table 5. User Needs to Be Met by the V2X Platform**

| ID | Release | User | Need |
|---|---|---|---|
| **FDOTV2XUC-15524** | POC, P2R1 | F1, F2, F3, F4, F5, F6, F7 | District staff need to share CV data |
| **FDOTV2XUC-13824** | POC | F1, F3, F4, F5, F6, F7 | FDOT users need to monitor traffic (congestion) conditions |
| **FDOTV2XUC-10596** | POC | F1, F3, F4, F5, F6 | FDOT users need to monitor traffic safety (crash, lane closure) conditions |
| **FDOTV2XUC-19561** | POC | F1, F2, F3, F5, F6, F7 | District staff need to share device status data |
| **FDOTV2XUC-12977** | POC, P2R1 | F1, F2, F3, F5, E* | External entities need to consume live data (APIs) |

| ID | Release | User | Need |
|---|---|---|---|
| **FDOTV2XUC-19445** | POC, P2R1 | F2, F3, F4 | FDOT users need to monitor DEP performance metrics |
| **FDOTV2XUC-12593** | POC | F2 | FDOT needs a baseline cloud infrastructure to support centralized data exchange |
| **FDOTV2XUC-19785** | POC, P2R1 | F2 | District staff need to share work zone data |
| **FDOTV2XUC-17836** | POC | F1, F2, F3, F4, F5, F6, F7 | DEP users need a robust system validated using simulated CV data sources |
| **FDOTV2XUC-19472** | P2R1 | F1, F2, F3, F4, F5, F6, F7 | FDOT needs to provide access management for platform users |
| **FDOTV2XUC-12898** | P2R1 | F2 | DEP users need a robust system validated against simulated CV data sources |
| **FDOTV2XUC-16163** | P2R1 | F1, F2, F5, F6 | FDOT needs to collect SunGuide Road Weather Information System (RWIS) data |
| **FDOTV2XUC-18853** | P2R1 | F1, F2, F5, F6 | FDOT needs to collect SunGuide event data |
| **FDOTV2XUC-14257** | P2R1 | F1, F2, F5, F6 | FDOT needs to collect and store SPaT data |
| **FDOTV2XUC-19684** | P2R1 | F1, F2, F5, F6 | FDOT needs to collect and store MAP data |
| **FDOTV2XUC-10036** | P2R1 | F1, F2, F5, F6 | FDOT needs to collect and store CV Basic Safety Message (BSM) data |
| **FDOTV2XUC-15271** | P2R1 | F1, F2, F5, F6, F7 | FDOT needs to share work zone information from SunGuide |
| **FDOTV2XUC-19727** | P2R1 | F1, F2, F6 | FDOT needs the platform to connect to SunGuide and CV sources |
| **FDOTV2XUC-15482** | P2R1 | E8, E9, F1, F2 | FDOT needs to collect Ford OEM fleet data |
| **FDOTV2XUC-19830** | P2R1 | F2, F3, F4 | FDOT needs to monitor DEP performance metrics |
| **FDOTV2XUC-15008** | P2R1 | F1, F2, F3 | FDOT needs to visualize RSU coverage |
| **FDOTV2XUC-10333** | P2R1 | F1, F2, F4 | FDOT needs to collect, store, and share traveler information to CV and third parties |
| **FDOTV2XUC-11495** | P2R1 | F1, F2, F4, F8 | FDOT needs the platform communicated via presentations and documentation |
| **FDOTV2XUC-12878** | P2R1 | F1, F2 | FDOT needs a robust cloud infrastructure to support centralized data exchange |

| ID | Release | User | Need |
|---|---|---|---|
| **FDOTV2XUC-13336** | P2R1 | F5 | DEP users need to visualize DEP data |
| **FDOTV2XUC-19940** | P2R1 | F2 | FDOT needs an efficient platform versioning and deployment mechanism |
| **N/A*** | N/A | F1, F3, F4 | FDOT needs to ensure the DEP does not store sensitive information. |

*This user need was not tracked as a JIRA Epic. This was an emerging user need requested by FDOT project management.

# 4. Concepts for the Proposed System

The following describes the concept for the proposed system. The preliminary concept described here will be updated to reflect the new system features and data added, changes to the technical architecture, operational policies, and related enhancements developed for each release.

## 4.1 Background, Objectives, and Scope

FDOT and other stakeholders need a unified platform for gathering, storing, and sharing CAV data that has been gathered in real time and is made available to others both in real time (specific time frame specified later in document) and periodically (as needed) for further analysis. The V2X DEP is intended to consume data from and provide data to all FDOT's operational, in development, and planned CAV project corridors and deployments, as well as other stakeholders such as transit agencies, toll authorities, and more. Data that is currently available in various forms from a range of sensors, field equipment, FDOT software suites, and 3rd-party systems will be made available by the V2X DEP across these project and system boundaries for use in making operational and driving decisions, long-term planning, and performance assessments. V2X DEP will also provide alerts and information out to consumers that include FDOT, 3rd-party systems, the traveling public, and many other potential entities; this includes safety alerts to vehicles for applications where low-latency is not required, such as when an obstacle is detected in the roadway, indirectly through SunGuide or other systems.

The V2X DEP is intended to provide back-end solutions to data management and analytics for operational CAV scenarios that can be accomplished in real time or on historical data. Flexible reporting and analysis tools will be made available to support this functionality.

The DEP will be designed to scale easily, supporting future growth through modular expansion enabling accelerated deployment of new CAV data sources and facilitate the implementation of new applications and analytics tools. The V2X DEP will allow for new/different ingestion interfaces to be added over time without changing core functionality. Anticipated scale dependencies have been estimated in the Data Storage Plan of the V2X DEP System Design Document.

The V2X DEP will meet FDOT's current needs and scale to the future needs of FDOT's CAV and ITS programs; more detail on system scalability may be found in the V2X DEP System Design Document. The V2X Data Exchange Platform will be designed to be a secure, user-friendly, reliable, and extensible data sharing, analytics, and reporting platform for FDOT and other users. The platform will deliver real time, real time, and historical data for operational decision-making as well as short- and long-term planning and performance assessments. FDOT will maintain ownership over all the documentation and source code for the core V2X DEP (excluding existing external tools such as Ford Safety Insights) with the freedom to modify as needed without restriction and without recurring license fees for the core platform. Creating

an open platform that provides benefits back to data partners ensures there is a strong incentive for future partners to contribute data. Special training and expertise from FDOT to manage, maintain and scale the platform will be needed.

Utilizing an agile, iterative process, ideation meetings will be held throughout the project with FDOT, subject matter experts, and external entities. The results of these meetings will be used to guide the features that are delivered as the platform evolves. In accordance with this process, multiple iterations of systems engineering steps will be undertaken, culminating in incremental releases of the platform that will also include demonstrations and training for FDOT and other identified stakeholders as required.

Initially, the project will focus on the collection and presentation of data from existing CAV and ITS deployments, identifying adaptations necessary to account for existing system interfaces and capabilities. Based on prior experience and lessons learned from integration with these systems, guidance will be provided regarding needs and requirements of future system procurements and capabilities to support streamlined and consistent integration of data sources to the platform.

The main objective of the V2X DEP is to make data available at a level that aids the agency in achieving Target Zero.

## 4.2 Operational Policies and Constraints

Various districts/agencies, standards, and existing data sources stipulate operational policies that should be considered for the DEP, such as:

- F.A.C. 60 GG
- Florida's Cloud First Policy
- 60FF-3.010 Exemption for Computerized Traffic Systems and Control Devices
- FDOT OIT may have some cloud policies to consider
- Some Districts or Agencies may have policies that prohibit a direct connection from field equipment through the Internet
- Existing data sources like SunGuide and other FDOT systems
- Evolving policies with respect to personal and vehicular data
- Florida's public records law
- License Agreement section in FDOT contract C12299 with HERE, Exhibit A Scope of Services
- Data Usage agreement with Ford.

These policies may result in constraints on the DEP. At this time, the following constraints have been identified.

- **Data**: The core operational constraint of the DEP is that it is completely dependent on FDOT district, entity, and other external data providers regarding amount, quality, and timeliness of data available to the DEP, which then in turn provide analytics as well as data access and analysis via dashboard tools and APIs to users and third parties with the appropriate credentials. The DEP will utilize methods to validate data sources by analyzing similar datasets, however the success of such analysis and validation is dependent on the numbers of data sources available in addition to their own specific data quality. Furthermore, data identification numbers and/or other unique identifiers may differ depending on data source and must be conflated across types and districts. Successful conflation is dependent on the accurate labeling and input of data keys at the data input/source level.
- **Positional Accuracy**: Location coordinates are typically generated using GPS signals and are thus constrained by the accuracy of the signals at the time of generation. Thus, successful mapping of data points to associated map layers is contingent upon this accuracy. For CV data, specifically

Basic Safety Messages (BSM), it is assumed that field devices generating data are expected to be compliant with SAE J2945/1, which specifies positional accuracy requirements in specified environmental conditions. Note that BSMs do not contain personal information, and other CV data will be addressed as described below. Outside of these conditions, such as when in urban environments without open-sky, there are no standardized requirements with which devices must comply. During development, testing, and evaluation of the DEP data ingestion and analytics, observations will be made regarding the accuracy of data being provided to the DEP and subsequent constraints/limitations may be identified with respect to later use cases.

- **Lag/Timeliness**: The DEP will provide data identified as 'real time' in less than 5 seconds between ingestion into the DEP and availability to users and/or third parties via either API or dashboard tool. Timestamps will be logged and available to verify lag as it is introduced at various points throughout the data pipeline.
- **Host environment**: The DEP will be deployed in an AWS environment and as such, an AWS account will need to be created and maintained for this project. This environment must be configured to support performance requirements as stated in 7.2.1 Performance Requirements. Note that FDOT will need to maintain the AWS environment and account after conclusion of the project, and porting the project to a different cloud-hosting provider will incur additional work. A transition plan is contractually required. AWS services used include, but are not limited to:
    - Amazon EventBridge
    - Amazon Inspector
    - AWS API Gateway
    - AWS Athena
    - AWS CloudFormation
    - AWS CloudTrail
    - AWS CloudWatch
    - AWS Cognito
    - AWS Config
    - AWS Elastic Container Registry
    - AWS Elastic Container Service
    - AWS Glue
    - AWS Guard Duty
    - AWS IAM
    - AWS Key Management Service
    - AWS Kinesis
    - AWS Lightsail
    - AWS QuickSight
    - AWS Redshift
    - AWS S3
    - AWS Secret Manager
    - AWS Simple Notification Service
    - AWS Simple Token Service
    - AWS Virtual Private Cloud
- **Personally identifiable information (PII)**: The DEP will inspect and desensitize personal information and develop algorithms to follow emerging data privacy protection policies. It will additionally hash sensitive information (e.g. vehicle serial numbers, license plates, VINs, etc.) which could be used to derive PII prior to ingestion. Please refer to the Data Privacy section below as well as the V2X DEP Security Plan.

- **SunGuide**: This system will ingest data from and make data available to SunGuide. In doing so, it may not impede SunGuide operations. Additionally, the platform must support multiple, current SunGuide versions concurrently as specific deployments may not upgrade in synchrony.
- **CV communications**: Architecturally for the state it is important that SunGuide be the primary operational interface with equipment so that it provides a standardized and consistent interface with ITS field equipment (including RSUs). This way, when response plans are implemented, they are managed consistently across any ITS field device providing information (e.g. DMS or RSUs). The DEP shall be designed to be radio agnostic and handles the messages that are forwarded to it via the roadside communications infrastructure. Hence, DSRC and 5G are out of the scope for the DEP.

## 4.3 Description of the Proposed System

Following is a description of the DEP as regards compatibility with FDOT ITS communications standards, FDOT statewide and regional architectures, and relationships between the DEP and other FDOT district systems and external stakeholders' systems (statewide, local, and regional). Examples of such systems include District SunGuide instances. An overview of the DEP architecture is available through the Florida Statewide and Regional ITS Architectures website. Architectural details are described in the V2X DEP System Design Document.

### 4.3.1 Compatibility with ITS Architecture and Regional ITS Architecture

Network topologies and connections to the DEP at the FDOT District and FDOT Central Office will be designed to be compatible with all current (as of the date of this revision) and relevant FDOT ITS[1] and Regional ITS architectures as they are identified through the project ideation process. Currently it is assumed connections to the DEP will be a combination of districts aggregating entity connections and providing data to the central office where it will then be aggregated and sent to the DEP, as well as direct connections from districts and entities to the DEP when desired or deemed beneficial by all parties. Relevant regional architectures will be determined through ideation during the project.

[1] Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) v9.0, https://www.arc-it.net/

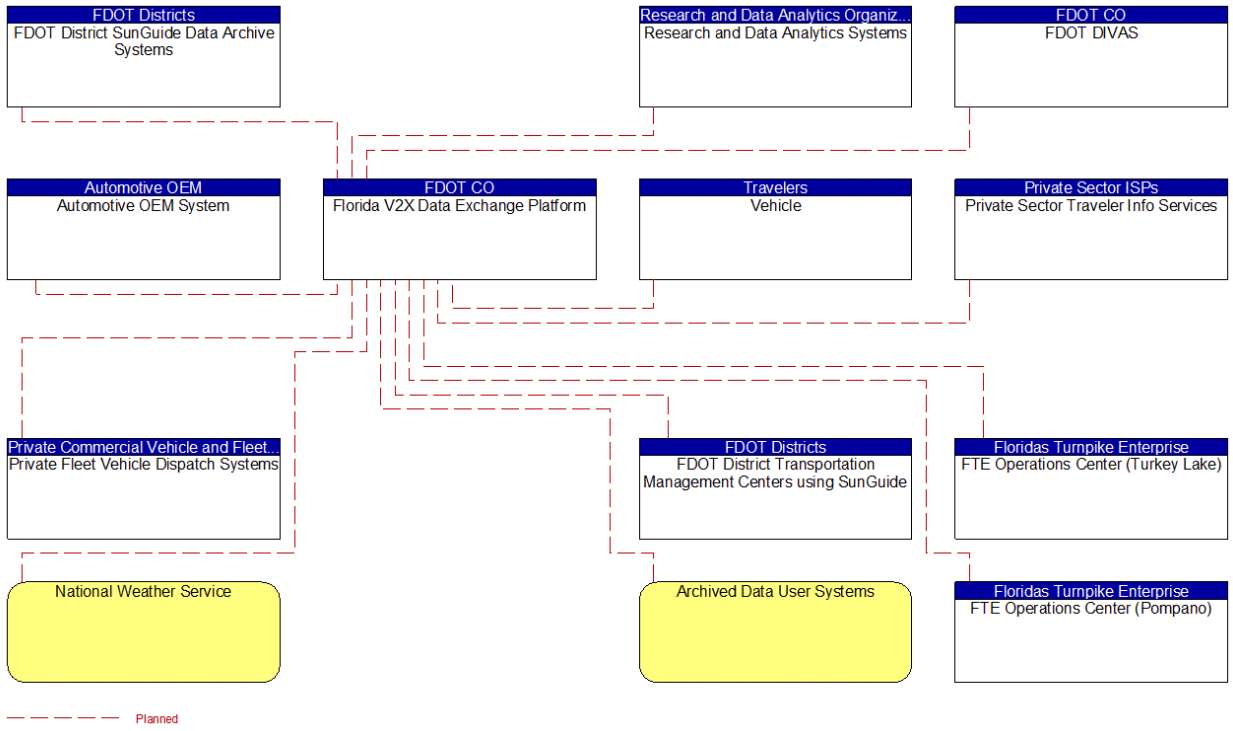



**Figure 2. Topology**

*(source: https://teo.fdot.gov/architecture/architectures/statewide/html/projects/graphics16.html)*

To connect to ITS networks, a single, centralized VPN connection from the platform to Florida's ITS Operations Network was built into the platform. This covers connectivity to FDOT SunGuide (Figure 2) and from CV devices (Figure 3).

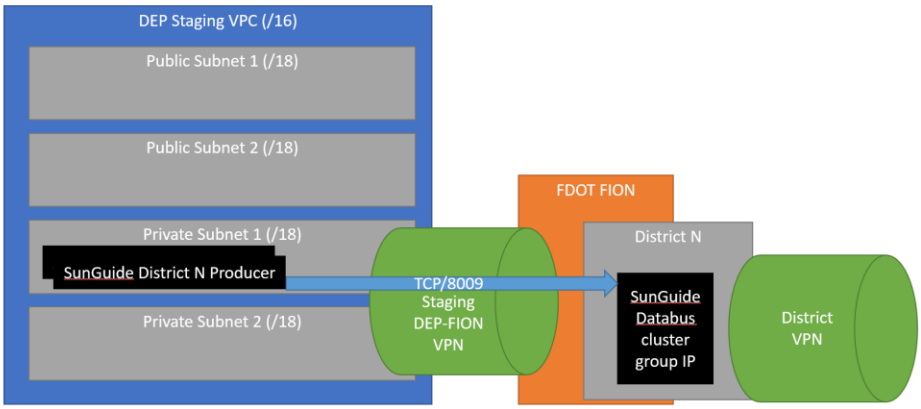



**Figure 3. DEP-SunGuide networking**

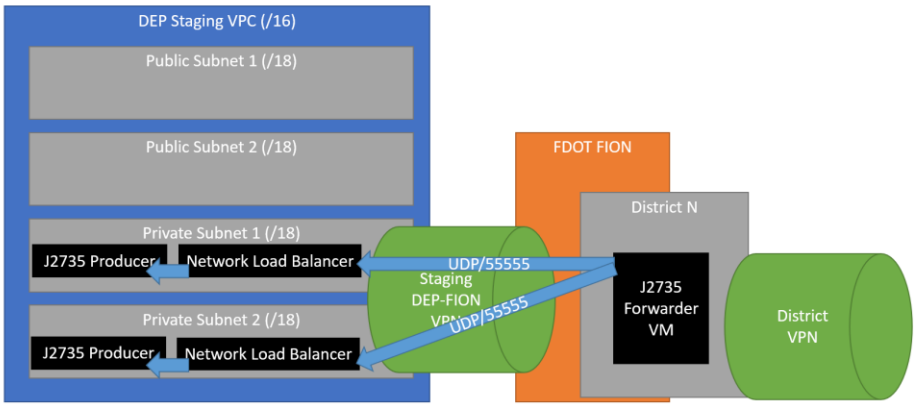



**Figure 4. CV-DEP networking**

### 4.3.2 Operational Environment and Characteristics

The DEP will be implemented within the AWS environment and composed of a variety of AWS services/products and custom implemented tools for ingesting, processing, and disseminating data. Security will be designed from the ground up such that the DEP will be highly resistant to bad actors. Network access will be granted on a whitelist basis except where requirements necessitate public access to a subset of DEP functionality. Cloud resources will be protected using firewalls for each network subnet and each component instance. Throughout the DEP architecture the principle of least privilege is applied, ensuring each component within the overall system only has network/credential access to what is necessary for that component to function within the DEP. The same approach of least privilege will apply to the data consumer interfaces. Its serverless architecture will leverage AWS-centralized Operating System (OS) security patching to ensure rapid resolution of identified vulnerabilities in the underlying compute infrastructure, and various intelligent log and network monitoring tools will be used to quickly identify anomalies. Services such as GuardDuty, CloudTrail, CloudWatch, and Config will be leveraged to provide insights into system use and automate detection of any anomalous interaction with the DEP. Existing FDOT firewalls outside the platform's implementation in AWS would be outside the purview of the DEP.

### 4.3.3 Relationships to Other Systems

The Team has developed a high-level systems architecture that provides a scalable, low latency, secure, highly available data exchange platform that can provide real time and predictive analytics both near term with data currently available and in the future as new data producers are identified. The DEP is implemented within the AWS environment with connections to both data producers and data consumers as illustrated in Figure 1.

The DEP is highly coupled with other systems in that it must ingest data from and make data available to third parties. The DEP does not generate any data itself. Nor is its goal to merely collect data. That said, it is designed to use standard formats where applicable, but is also capable of using custom formats when communicating and interacting with other systems.

### 4.3.4 High Level Data Flows with Inputs and Outputs

The following subsections describe data flows between data producers, the DEP, and consumers. Requirements for interfaces between these components may be found in Section 7.2.

#### 4.3.4.1 Data Producers

Data producers will provide data to the V2X DEP with configurations specific to each provider based on their existing capabilities, network topologies, and their flexibility to adapt to or implement other configurations. As there are several existing CV deployments, there are a variety of potential systems that are in place or being developed and implemented in parallel to the development of the V2X DEP. Some of these deployments are already operational, while others are in progress, and others are still in procurement phases. For each deployment, V2X DEP design and development will consider available APIs or interfaces. Lessons learned from current deployments will feed into future procurement requirements. Available interfaces may be provided or maintained by FDOT or local agencies themselves, or from a vendor that is involved in the project.

From a security and best practices perspective, any connections to outside systems should be through a VPN. Additionally, where possible and practical, direct connections to field devices, specifically CV Roadside Equipment (RSE) should be established and maintained by the local maintaining agency or entity. From that connection and management point, data should be routed to the V2X DEP. In many deployments, this intermediate aggregation point may not exist or be a viable option in the near term. For some deployments, the optimum solution may be to enable and configure a direct connection from the field equipment to the V2X DEP. One caveat to the use of the aggregation system is that certain metadata may be lost when passing through the aggregation component. For example, depending on the implementation, the source address where the data originated may be lost if the aggregation system only forwards the payload and not the complete network headers. This data would be unrecoverable as the DEP would have no knowledge of what the original data was since the aggregation occurred outside of the DEP. This potential data loss would ultimately impact certain use cases and functionality that may be desired.

The V2X DEP should be designed to support the range of connections described, allowing data to be provided from as many sources as possible without requiring substantial new work to be done to facilitate the data connection. The V2X DEP is being designed to be modular and allow for new/different ingestion interfaces to be added later without changing core functionality.

Configuration of end entity firewalls and networks is the responsibility of the respective entities. As experience is gained over the course of development, testing, and deployment, recommendations and other support will be provided by the V2X DEP development/deployment team to end entities to increase both the robustness and consistency of data flows. Similarly, recommendations and requirements can be further derived for use in future procurements to facilitate quick and reliable data connections to the V2X DEP.

##### *4.3.4.1.1 Data Ingestion*

Three of the primary methods that the V2X DEP is expected to support for data ingestion are establishing persistent connections, polling external systems, and allowing data to be pushed asynchronously. Persistent connections may be established by the V2X DEP to an external system or from the external system to the V2X DEP and are often over Transmission Control Protocol (TCP) (SunGuide is one example). Polled connections may be over TCP or User Datagram Protocol (UDP) and are configured to establish a new connection to an external system and request data at periodic intervals or based on other triggers. Pushed data is most often over a stateless connection that is established from the external system. A common example of this data flow is when CV RSEs receive BSMs from passing vehicles and are configured to forward the WAVE Short Message Protocol (WSMP) messages to a target UDP port on a backhaul. In this situation, the V2X DEP will establish a UDP socket on which it is accepting data (as per RSU specification). A variation on this data flow also applies to situations where several CV RSEs within an

agency's jurisdiction send the same data to a central aggregation point which then forwards the messages to the V2X DEP. From the DEP's standpoint, it looks like the same data flow and connection type. An example of a polled connection would be pulling Geographic Information System (GIS) data from the Transportation Data and Analytics File Transfer Protocol (FTP).

#### *4.3.4.1.2 Data Privacy*

A key consideration in the ingestion and integration of data sources is determining whether personally identifiable information (PII) is present in the data. Note that the definition of PII and its vehicular counterpart which is often included along with PII is evolving as of the date of this document revision. The stance of the DEP is that PII should not be collected nor made available. Depending on use cases and data usage agreements, vehicle identifying information may come to the DEP, and if it is useful, retained in an anonymized form (the algorithms for which are also evolving as of the date of this document revision). Any proper PII entering the DEP is discarded.

#### *4.3.4.1.3 Data Processing, Storage, and Analytics*

The Data Exchange Platform will be hosted in a secure AWS environment and will include data input and cleaning, storing data, and performing data processing, analytics, and queries on the stored data. Regardless of how data is sent to and received by the V2X DEP, similar data types will be processed and stored in a consistent format, enabling additional data connections to be added without requiring rework of the rest of the data analytics pipelines and processes. Data quality will be ensured by performing appropriate validations based on different data types and their sources.

The DEP will store data in different styles based on how it is intended to be used. These include at a minimum:

- Storage designed for long-term use and infrequent queries or access, known as cold storage. Examples include pulling historical data for research purposes and analyzing raw inputs to the V2X DEP for validation of data sources and consistency checks for verifying processed data.
- Storage designed for custom and on demand queries such as weekly or monthly reports, known as warm storage.
- Storage designed for real time analytics and processing, known as hot storage. This storage is for real time input streams of data, mostly utilized by the analytics pipeline.

As data ages, it will be moved to cold storage for archival. Data lifecycles will be defined per data source (and data type where necessary) and based on the utility of the data given targeted use cases and external requirements and policies defined for the input data.

#### *4.3.4.1.4 Real Time Analysis*

In the real time analysis pipeline, time-critical data analysis and notifications will be performed with a focus on minimizing latency from the time data is available within the cloud infrastructure to the time notifications exit the cloud infrastructure. Latency will be minimized by using Cloud-native pipelines that minimize impact on performance. Separate pipelines and access to performance-optimized cloud-native data storage will facilitate real time analysis of selected critical parameters and their relationships. The real time analysis results will be the generation of actionable notifications that will be dispatched to users through systems such as SunGuide. Refer to section 7.2.1 for specific performance-related information.

Sample real time analytics pipelines were built for the POC release. For traffic topics, these were configured to publish traveler information messages directly to FDOT SunGuide instances. Based on expressed desire from FDOT to have an operator in the loop instead of purely automated, these have been disabled.

For security and system analysis and real-time notifications, no targets are currently subscribed, and FDOT has indicated none are required for FDOT recipients as long as cybersecurity event communications to the InfoSec group are documented.

#### *4.3.4.1.5 Long-Term Storage*

The long-term storage pipeline is designed to optimize speed for regularly queried data and data needed for real time notifications while optimizing storage costs for infrequently queried data. External users such as researchers and external systems will have access to long-term storage as well as the more rapid access to real time data so that queries can be executed that correlate data from both sources to support longitudinal and other research needs. Refer to section 7.2.1 for specific performance-related information.

#### *4.3.4.1.6 Raw Data Store*

To ensure original raw data is available for reference and validation purposes, the DEP will archive the original unmodified data in parallel with processing and making the curated data available for the analytics pipelines. Raw data is not available for public access. Additionally, if the raw data may contain PII, the raw data archiving is disabled. For further discussion on PII, see the Security Plan. This storage will be optimized to reduce hosting costs.

#### *4.3.4.1.7 Data Lake*

To ensure fast, cost-effective queries, an optimized data lake will store transformed versions of the raw data received. This dataset will have duplicate and extraneous data removed. Once cleaned, the data will be converted to an open data format (Apache Parquet) to optimize data query speed and cost. The resulting data will be stored in AWS S3, providing highly available, highly durable storage for real time query operations.

#### *4.3.4.1.8 Data Consumers*

The primary data analytics engine results will be made available to a range of consumers, including SunGuide instances, local agencies, research institutions, vehicle OEMs, commercial fleets, and others. The analytics results will also be fed back into the Data Lake to augment future queries and processing. Visualization of the real time data and the analytics engine results will leverage AWS Redshift Data Warehouse and Data Lake. External commercial applications, such as ClearGuide (from Iteris) or Safety Insights (from Ford), can be utilized to demonstrate/visualize the DEP and provide real time route-level visualization and historical views of traffic data and events. The specifics of this type of visualization are not defined. Some level of custom development may be necessary for these external systems to be able to fully leverage these views for demonstration or operational purposes. Figure 5 provides an example of ClearGuide showing historical data over a month of heat maps for each day for the speeds along a specified route.

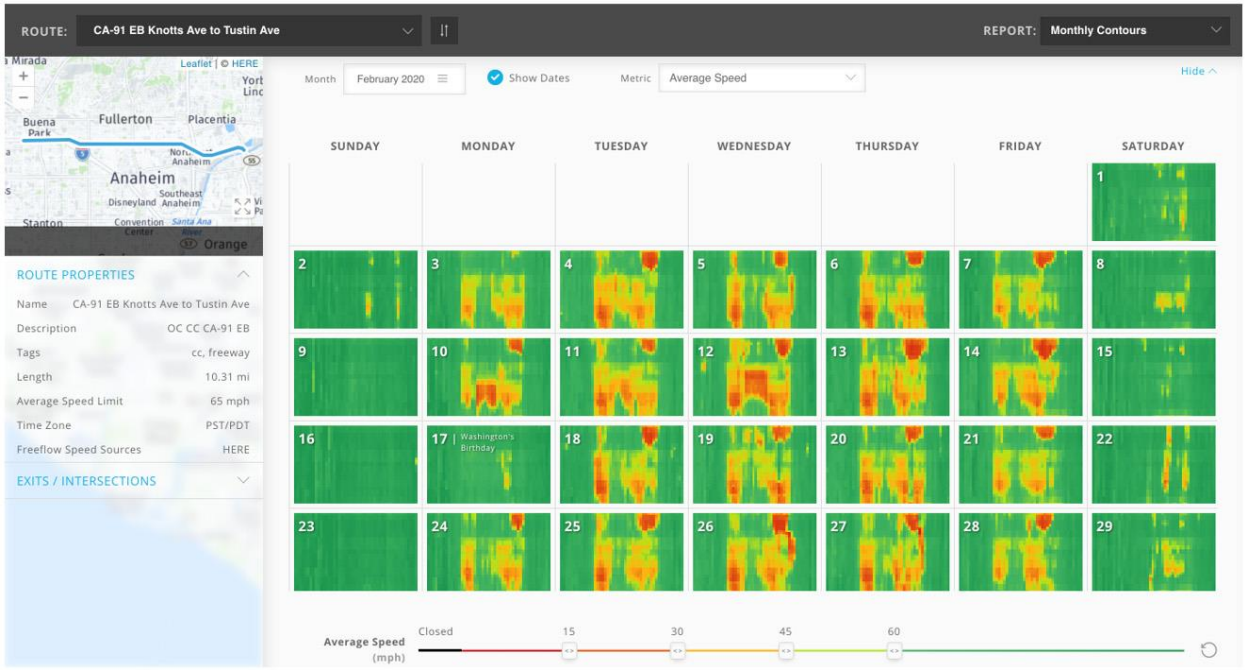



**Figure 5. Example ClearGuide Dashboard**

In addition to visualizations, the Team will work with Florida International University (FIU) to determine requirements for a secured point of access to be provided for university and research organizations to access certain data authorized by the FDOT over historical time ranges and real time data feeds. These research efforts will feed future opportunities for enhanced data analytics that can be applied to broaden the data exchange's capabilities.

### 4.3.5 Level of Automation

The platform will support authenticated users' access to data including real time displays as well as historical analysis as appropriate for the specific use cases being implemented, as noted in 3.2 User Needs. This access will be implemented using map-based dashboard tools in addition to API access as desired. More sophisticated access such as automated reports may be implemented in future releases.

### 4.3.6 Data Analytics

The data analytics functionality of the DEP has yet to be defined other than at a very high level.

## 4.4 Modes of Operation

The Phase 1 POC implementation included a standard mode of operation that includes the functionality required to support all targeted use cases, operational scenarios, and associated requirements associated with the release3.207. Additional modes of operation such as after hours, maintenance, diagnostic, emergency, training, fail-safe, and backup will be provided as needed to support use cases and requirements targeted for subsequent releases.

The Phase 2 Release 1 implementation will also include all targeted use cases, operational scenarios, and requirements associated with the release. This being the first production release, a dedicated support team will be activated to assist with issues, maintenance, and diagnostics in addition to maintaining the above level of service.

## 4.5 User Involvement and Interaction

User interaction with the V2X platform will take place through dashboard user interfaces, APIs, and alert notifications. Follow on releases will include additional means to interact with the DEP, such as allowing third-party data providers to request adding a new data feed.

For users to gain approval for access to the platform User Interface, FDOT's standard AARF mechanism is used for all users. Internal users (users with an FDOT email address) are provisioned by FDOT as part of FDOT's Active Directory. External users (users without an FDOT email address) are provisioned in the platform by the Developers as part of AWS Cognito as User Pool Users which are further organized into AWS Cognito User Pool Groups to grant permission sets. Tickets may be submitted to JIRA to request external users be added or removed after appropriate AARF approval. Details related to the user interface's operation may be found in the platform's Design document.

For users to utilize APIs, FDOT's standard AARF mechanism is also used to obtain an API key. API keys are managed by API Administrators using a specialized API that also requires an API key to authorize the request. As with external users, a ticket may be submitted to JIRA to request an API key with a particular set of permissions be created or deactivated.

### 4.5.1 User Class Profiles

The tables below describe roles for different types of V2X DEP users and their overall motivations for using the V2X platform. FDOT roles include full or part-time FDOT central office or regional staff, consultants, and contractors; all others are categorized as external roles. These roles have different detailed user needs and operational use scenarios described in the following sections.

During project implementation, limited access to specific features and data will be further subdivided through user groups based on regional boundaries, user needs, data use agreements, and other characteristics. However, the scope of this section is to define high-level roles to help engage the correct stakeholder groups to refine details during project development.

**Table 6. User Profile – FDOT Role**

| ID | FDOT Role | Description |
|---|---|---|
| **F1** | System Administrator/IT Support | Manages logins, permissions, and access keys for user interfaces and data; deploys, monitors, and supports IT infrastructure and applications |
| **F2** | System Developer | Uses programmatic access keys to develop and support V2X DEP data pipelines, interfaces, and applications |
| **F3** | Central Office/TSMO Staff | Performs statewide and regional reporting, analytics, planning, and program development |
| **F4** | District Executive | Performs district level reporting, analytics, planning, and program development |
| **F5** | District Traffic/Operations Engineer | Performs analysis and optimization of multi-modal traffic flow and safety for regional transportation networks |
| **F6** | District RTMC Staff | Monitors transportation networks, coordinates/implements responses to events that impact daily use |

| ID | FDOT Role | Description |
|---|---|---|
| **F7** | Maintenance/Construction Staff | Performs transportation network equipment installation, maintenance, upgrades; performs roadway construction; manages lane closures for worker and road user safety |
| **F8** | Planning Group | Plan future projects for this and related platforms/projects |

In addition to the above roles of individuals, the V2X DEP will collect and provide data to external entities. Refer to the V2x DEP External Entity Engagement Plan document for additional details. The table below is meant to help engage the correct stakeholder groups.

**Table 7. User Profile – External Role**

| ID | External Role | Description |
|---|---|---|
| **E1** | Transit Agency | Provides public access to transportation by bus, light rail, and other mobility services |
| **E2** | Toll/Expressway Agency | Manages operation of roadways for which fees are charged per use |
| **E3** | City/Municipal Agency | Ensures equitable access to transportation, employment, healthcare, and education across a region; manages use of transportation networks, event centers, and other resources during planned regional events |
| **E4** | Traveling public | Vehicular and vulnerable road users, including pedestrians and bicyclists |
| **E5** | Transportation Network Companies (TNC)/Mobility Operator | Manages on-demand services such as ride sharing, bike/scooters, etc. |
| **E6** | Navigation/Route Provider | Provides maps, traffic information, and routing advice to road users, e.g., Google/Waze |
| **E7** | Emergency Responder | Manages safety, first aid, lane closures and other roadside services during traffic incident and evacuation scenarios |
| **E8** | Fleet Operator | Manages operation of vehicles that transport supplies, goods, and services to and throughout a region |
| **E9** | OEM | Provides services and technology directly integrated into vehicles through on-board applications, e.g., Ford |
| **E10** | Research & Analytics | University and other public and private organizations performing transportation related research and development |

## 4.6 Assumptions and Constraints

The following are some assumptions and constraints currently identified for the V2X DEP development project.

The V2X DEP is not intended to provide real time safety alerts that can only be accomplished by direct device-to-device communication in the field (i.e., in-vehicle forward collision alerts, red light violation warnings, and other applications that require very low latency and are typically derived by applications running locally on an in-vehicle device).

CV data will be provided via standard backhaul interfaces as defined in RSU specification; e.g., BSM, Personal Safety Message (PSM), and Probe Vehicle Data (PVD).

Connections needed to provide data from district and PSM external entities to the DEP will be configured and maintained by the appropriate FDOT and/or other personnel.

Currently it is assumed connections to the DEP will be via a combination of districts aggregating entity connections and providing data to the central office where it will then be aggregated and sent to the DEP, as well as through direct connections from districts and entities to the DEP when desired or deemed beneficial by all parties.

Any Traveler Information Message (TIM) or other outbound CV messages are expected to be provided to an operator for approval prior to distribution to vehicles or other end users.

- PII will not be actively collected, stored, nor disseminated by the V2X DEP.

## 4.7 Risks

Refer to the V2X DEP Project Management Plan which will in turn refer to the project's risk registry. The risk registry is the document through which risks are captured and analyzed. In addition, it contains decisions regarding how the risk is handled. The risk registry is reviewed periodically by the project's project management (PM) team during standing PM meetings. New risks and opportunities are expected to emerge as the project progresses.

## 4.8 Support Environment

Prior to project completion, FDOT will be responsible for contacting and creating an account with AWS administrator rights to access needed AWS resources. FDOT will need to know (at least):

- How to use the AWS web console to validate system configurations and operations
- How Cloud Development Kit (CDK) and Cloud Formation (CF) work to deploy and configure system resources rather than making manual changes via the console
- How to monitor and scale resources
- How to use CloudWatch logs to identify/debug issues

Details will be formalized prior to project completion.

## 4.9 Phased Development

The V2X DEP uses a multi-phased agile development process, which adds data, functions, and features to the platform at each phase of the development process. A high-level roadmap (as of 3/27/23) is shown in Figure 6 below. This roadmap will be updated on a routine basis as stakeholder feedback is obtained, priorities are shifted, and at a minimum, reviewed prior to the beginning of the development for each release.

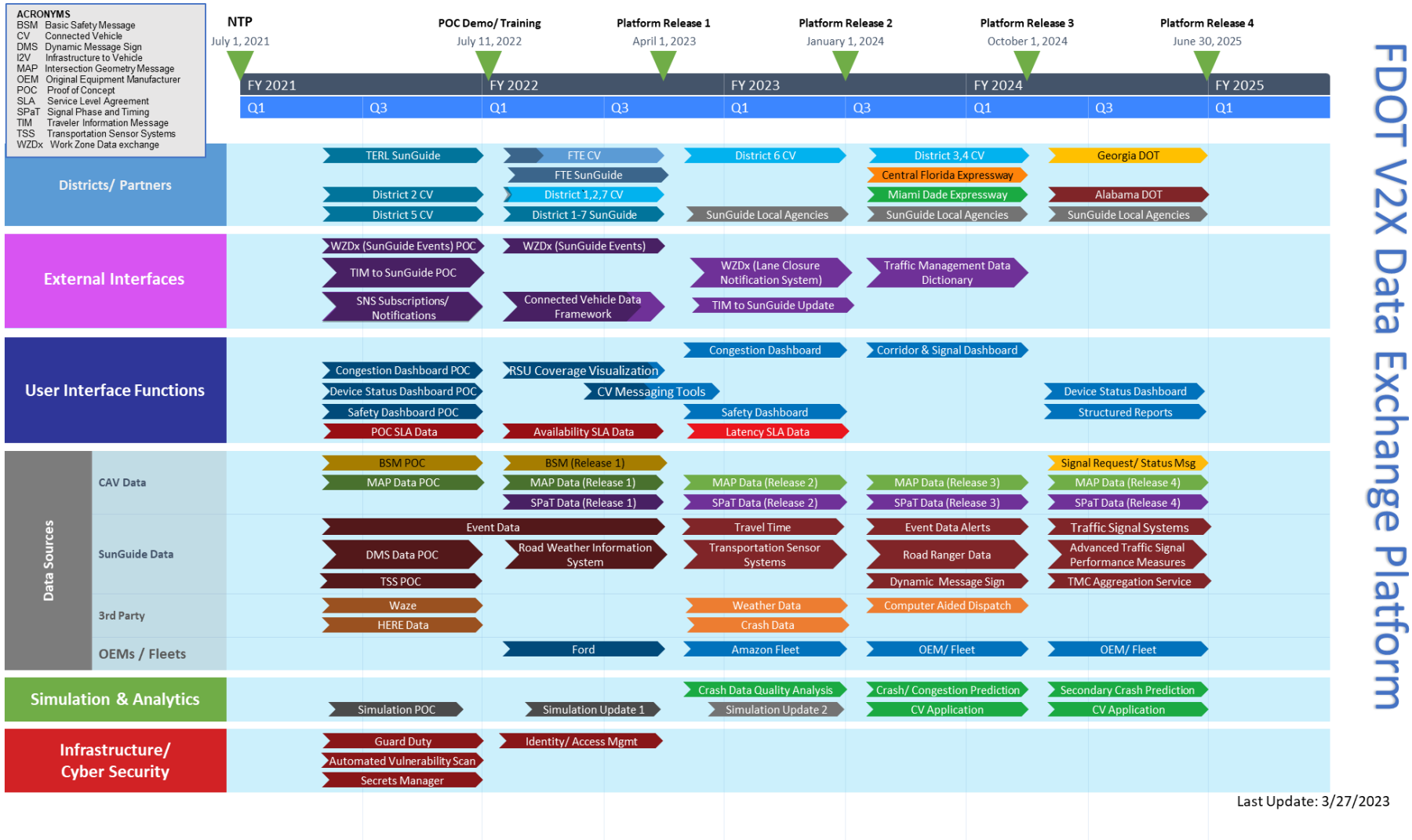



**Figure 6. V2X DEP Roadmap (as on 3/27/2023)**

# 5. Operational Scenarios

The narratives below describe how the proposed system will operate to perform the identified use cases.

## 5.1 Documentation

In the spirit of following a more agile systems/software development process, operational scenarios are captured within the user stories referenced in 3.2 User Needs, and in use cases in the project's Use Cases/User Stories Jira Repository. Other referenced documents may be found in 1.6 Referenced Documentation. At this time, this section describes categories of messaging/alerts and data that will come into play under various operational modes and conditions.

## 5.2 Normal Operations Scenario(s)

The following subsections describe categories of messaging/alerts and data relevant to normal operational scenarios for the V2X DEP.

### 5.2.1 Traffic Conditions

The V2X DEP collects traffic data such as speed, volume, occupancy, travel times, and derived congestion metrics from multiple sources. Data sources include traffic sensor data collection systems, third party traffic data feeds, and information derived from BSMs and other messages transmitted from vehicles to roadside devices.

Current and historical data/information is used by FDOT to generate alerts to drivers, operators, and other decision makers for queues and other notable conditions. University researchers and third parties use this data to develop automated detection of safety issues and incident hot spots and to predict unsafe conditions that put road users at risk.

Derived aggregated information, such as average speed, travel times, delay, and risk predictions are shared with downstream operational, OEM, freight/fleet, and mobile apps for both commercial and personal multi-modal routing and trip planning.

Regional Transportation Management Center (RTMC) operators monitor the current traffic conditions to assess safety risks and manage interventions that reduce congestion, clear incidents, and improve safety and reliability. A historical data interface is used by traffic engineers to analyze the impact before and after changes to traffic management infrastructure and by district secretaries to report traffic network performance measures for evaluation and planning purposes and to respond to complaints by citizens.

### 5.2.2 Safety Conditions

The V2X DEP collects data/information about crash incidents and lane closures, both planned and unplanned, from multiple sources such as SunGuide and Waze. Future releases may include additional data sources such as N-MISS[2] detections of near-miss avoided crashes and extracted data from CV BSMs, such as incidents of hard braking or acceleration and sudden swerves.

Real time data is used by the V2X platform to generate alerts which are transmitted to oncoming vehicles through roadside infrastructure and users of third-party navigation and route planning applications through real time notifications and APIs. Navigation and fleet management applications may use this information to reroute travelers around impacted areas. Law enforcement officers may subscribe to alerts to facilitate on-scene assessment and response.

[2] https://www.fdot.gov/traffic/teo-divisions.shtm/cav-ml-stamp/cv/maplocations/n-miss

Aggregated historical data is fused with other data sources, such as weather and daylight information, to find high risk areas and/or conditions and prioritize planning for potential interventions.

#### 5.2.3 Traveler Information

Congestion develops on a state highway and an RTMC operator directs SunGuide to issue a new message warning travelers approaching the queue via DMS. The V2X platform is used to provide an equivalent message to CVs. For the initial POC implementation, TIM and other outbound CV messages are expected to be provided to an operator for approval prior to distribution to vehicles or other end users.

The V2X DEP subscribes to SunGuide DMS updates from all available systems. Information is curated, consolidated, and shared via an API for use by operational, OEM, freight/fleet, and mobile application developers. The platform may also monitor specific message types from other/non-SunGuide sources and generate alerts for FDOT, external users, and applications. For example, alternate/diversion route related messages may generate high priority alerts to commercial fleet vehicles known to travel to/within the affected region.

#### 5.2.4 DEP Performance

Service level agreement (SLA) performance requirements are defined in Section 7.2.1. Ultimately, V2X DEP components will use contextual logging to store data used to track identified performance metrics, such as system availability and data processing latency. Metrics will be aggregated and used to generate alerts when performance falls outside allowable ranges, and reports will be generated to visualize overall system status and to highlight and prioritize potential issues. For POC, performance data/information were provided manually to initiate the alert and report process. Alert notifications will be sent to indicate outages between the DEP and external data sources so that DEP support teams can quickly rectify them.

### 5.3 Maintenance Scenario(s)

Maintenance scenarios from the perspective of the various user types have not been defined at this point.

### 5.4 Failure Scenario(s)

Failure scenarios resulting from failed or degraded operations have not been defined at this point. Performance-related situations are mentioned in section 5.2.4 DEP Performance; more are expected to be defined.

## 6. Summary of Impacts

Potential operational impacts will be described as they are identified. Through coordination and meetings with FDOT up to this point, there are a few impacts with respect to operating agencies and what they would need to address to integrate local systems with the V2X DEP. To have locally generated CV data (for instance BSMs from OBUs that are received by RSUs) sent to the DEP, the RSUs will need to be configured to forward the data to the DEP. Alternatively, the RSUs may forward to a single backhaul process that then forwards the data to multiple destinations if needed. Currently active deployments will likely need to be handled individually with close coordination with the V2X DEP development team to determine the best process for their respective situations. Future deployments may opt to include requirements in procurement documents to ensure this data flow is available and integrated from the start. For a local agency to integrate a SunGuide instance with the V2X DEP, login information will need to be created in SunGuide for the DEP and optionally (but recommended) and a VPN tunnel will need to be established between the endpoints.

These impacts are described in more detail in the V2X DEP System Design Document.

# 7. Requirements

This section describes system requirements for V2X DEP, and the format includes sections that have been inserted into this joint ConOps and Requirements document from FDOT's standard requirements document template. In combination with the ConOps standard format, some sections are redundant and at times irrelevant, at least for the V2X DEP project. Except as otherwise noted, the subsections have been included from the standard and marked as not applicable (N/A) when appropriate.

## 7.1 System Definition

According to the Systems Requirement template, this section is intended to provide an overview of the V2X DEP system and describe operational assumptions and system interface requirements; however, an overview has been provided within the ConOps portion of this document under section 0

Concepts for the Proposed System, and has not been repeated here.

### 7.1.1 Operational Assumptions

V2X DEP operational assumptions may be found in 0

Assumptions and Constraints.

### 7.1.2 System Interface Requirements

The following subsections describe V2X DEP external and internal system interface requirements.

7.1.2.1 System External Interfaces

This section describes the high-level external system interfaces and APIs required to implement the V2X DEP.

*7.1.2.1.1 Data Ingestion Dependencies*

Items listed here are dependencies that the V2X platform relies on but is not directly responsible for deploying or supporting. The interfaces listed in Table 8, below, are required to ingest data from external data producers as shown in **Error! Reference source not found.** such as FDOT, external systems, and third p arties into the V2X DEP. This table will be updated to reflect information relevant to phased releases as they are identified.

**Table 8. Data ingestion dependencies**

| ID | Release | Existing Interface |
|---|---|---|
| **ING-1** | POC, P2R1 | SunGuide DataBus "pub/sub" API for DMS config/status, CV config/status, lane closures, crash incidents:<br>D1 TMC (SUNGUIDE)<br>D2 TMC CV, SUNGUIDE)<br>D5 TMC (CV, SUNGUIDE)<br>D7 TMC (SUNGUIDE)<br>TERL (CV, SUNGUIDE)<br>FTE (SUNGUIDE) |
| **ING-2** | POC | Waze REST API for crash incidents statewide<br>https://www.waze.com/partnerhub-api/waze-feed-access-token/<ACCESS-TOKEN> |

| ID | Release | Existing Interface |
|---|---|---|
| | | Note that <*ACCESS-TOKEN*> above refers to a private token that is not publicly available |
| **ING-3** | POC | UDP forward CV BSM from D2: direct from roadside units to DEP |
| **ING-4** | POC | UDP forward CV BSM from D5: indirect from roadside units to TMC to DEP |
| **ING-5** | POC | HERE REST API for traffic conditions statewide *https://trafficanalytics.here.com* |
| **ING-6** | POC | TDA-GIS website FTP *https://www.fdot.gov/statistics/gis/default.shtm* |
| **ING-7** | P2R1 | Ford Mobility https://fleetaccount.ford.com/ |

*7.1.2.1.2 Data Dissemination Methods*

General interface patterns, listed below in

Table 9 will be developed within the V2X DEP to disseminate data and alerts for use by FDOT systems, external systems, and third parties. These interfaces allow retrieval of current, historical, and live/streaming data.

**Table 9. General interface patterns**

| ID | Release | New Interfaces |
|---|---|---|
| **DIS-1** | POC | REST API to query and filter current data sets |
| **DIS-2** | POC | REST API to query and filter historical data sets |
| **DIS-3** | POC | Publish TIMs to SunGuide |
| **DIS-4** | TBD | Streaming API to receive and filter web socket-based or other live data feeds |
| **DIS-5** | POC | Dashboards |
| **DIS-6** | P2R1 | Work Zone Data Exchange Feed (URL: TBD) |

*7.1.2.1.3 Two-way Data Communications*

New applications developed for the V2X platform that require synchronous two-way communication with external systems will be listed here. There are none as of this version of this document.

7.1.2.2 System Internal Interface

Currently, no internal system interfaces are expected as V2X DEP is planned as a single system without subsystems.

## 7.2 System Requirements

The System/Subsystem Requirements Specification establishes the functional, performance, design, development, and verification requirements for this project. This section contains requirements gathered from the contractual elements typically consisting of the contract document, scope of work, concept of operations, request for proposals, etc. The System/Subsystem Requirements Specification defines the set of requirements to be verified as part of the acceptance of the project. Please refer to the V2X DEP System Test Plan for additional details.

### 7.2.1 Performance

Table 10, below, identifies service level agreement (SLA) categories, measures, and consequences of unmet goals.

As of the time of the latest update to this document, no known real time nor historical datasets exceed the thresholds described below (refer to the V2X DEP System Design Document for details on dataset analysis). However, as the DEP build-out continues, new datasets are ingested and curated in new ways. Discrepancies will be noted here should they occur.

**Table 10. Performance Requirements**

| SLA Category | High-Level Approach | Definition of SLA |
|---|---|---|
| Schedule | The SwRI Team will deliver the required scope as defined during the ideation preceding each project phase. | There are 5 total releases planned in the iterative development cycle of the program:<br>Phase 1<br>POC<br>Phase 2<br>Release 1<br>Release 2<br>Release 3<br>Release 4<br>Penalties will be incurred if core functionality for each release is not delivered according to schedule. |
| System Availability | The SwRI Team will balance system availability with the rapid innovation required to provide FDOT maximum value.<br>In Phase 1, the 90% system availability is proposed, starting from when the DEP is first made available to FDOT for evaluation.<br>In each subsequent ideation session, SwRI will work with FDOT to define reasonable system availability requirements.<br>By the final phase, the DEP will meet or exceed 99.9% availability. | System availability will be defined as major functionality of the data exchange to ingest data from identified data sources and make the data available to distribute to consumers.<br>In the iterations prior to the final release, there may be periods of the DEP not being operational or down to facilitate development, testing, and other activities. These periods will not count against availability. Planned downtime for system maintenance after the final release will not count against availability.<br>Target availability of each phase/release:<br>Phase 1<br>POC 90%<br>Phase 2<br>Release 1 – 95%<br>Release 2 – 98%<br>Release 3 – 99%<br>Release 4 – 99.9% |

| SLA Category | High-Level Approach | Definition of SLA |
|---|---|---|
| Latency | For the purposes of this project, latency will be defined as the time that data is ingested into the DEP to the time that analytics are complete and real time or historical analytics can be delivered. This excludes network and other latencies into or out of the data exchange.<br>In early phases, the SwRI Team will balance minimizing latency with rapid innovation to maximize FDOT value.<br>By the final phase, the DEP will provide ~5s latency for real time analytics and ~30s latency for historical analytics.<br>Note that specific analytics may not be conducive to these latencies and the SwRI Team will note these limitations during the ideation process as applicable. | By Phase 2, Release 4, the DEP will achieve the following latency:<br>Real time data latency — The DEP will provide < 5 second latency on average for all data types measured from the time the Date Exchange receives the data at the cloud host and makes the analyzed and fused data available for distribution.<br>Historical data availability latency — The DEP will archive the new data available for historical analytics < 30 seconds from when it is received at the cloud host.<br>There will be some real time and historical data outputs that will not be able to be completed within the desired latency from receipt of new data due to complexity in analysis and data queries. SwRI will advise FDOT during the design about the anticipated latency of complex analysis, reports and queries that could exceed the target latency. |
| Data Completeness | The SwRI Team will make every effort to ensure all relevant data based on project ideation sessions is made available.<br>If 3rd-party data outside of our control changes or becomes unavailable, SwRI will notify FDOT and work to identify an acceptable alternative data source. | Target data sources will be identified during the ideation phases and assigned to a targeted phase and release.<br>Availability of the data source in the release will be dependent on data providers providing data interface specifications, test data feeds, and integration support to successfully integrate the data source.<br>During the execution of the project, SwRI will provide a monthly summary of the status of each data source including a target date for when the interface specification, test interface, and integration testing must be completed to make the source available. In the event the data provider does not meet any of the identified target dates, the data source may be moved to a subsequent release with no penalty to SwRI. |

### 7.2.2 Data Retention

Note that this section was not included in the standard template but has been added here to describe V2X DEP data retention requirements. The DEP will implement data lifecycle management to automatically transition older data to more cost-effective data storage and eventually expire data past a certain age. Furthermore, data lifecycle policies may vary for data ingestion from external sources into the DEP depending on the terms and conditions of use for that data source, which may further vary by type. The ***proposed*** lifecycle will retain three years of data in the Data Lake for general use, followed by seven years of cold storage where data can be retrieved if needed, but with higher latency.

More detail may be found in the V2X DEP Security Plan, Section 6.4 Record Retention

### 7.2.3 Physical Characteristics

This section is not applicable to V2X DEP.

### 7.2.4 Reliability

Reliability is a factor of performance; these requirements may be found in 7.2.1 Performance Requirements above.

### 7.2.5 Maintainability

Requirements for maintainability have not yet been defined.

### 7.2.6 Environment Requirements

The DEP is designed and developed for the AWS cloud environment. All necessary services which are part of the cloud are listed in this document and their configuration is prescribed by the Infrastructure as Code in the source code bundle delivered to FDOT.

For the development environment used to develop the DEP, please refer to the V2X DEP System Design Document.

## 7.3 Design and Construction

Design and construction requirements specific to the architecture, design, and data standards will be described herein or in other related sections as is appropriate, as they are defined. Additional details concerning planned data volumes are detailed in the V2X DEP System Design Document.

### 7.3.1 Electromagnetic Radiation

This section is not applicable to V2X DEP.

### 7.3.2 Workmanship

This project does not contractually fall under the FDOT OIT standards (https://www.fdot.gov/it/appdevstandards). However, it does follow many of them. Workmanship will be assured through adherence to software and systems engineering best practices followed by review and acceptance by FDOT personnel of contractual deliverables. Refer to the V2X DEP Project Management Plan for details of the delivery/acceptance procedures.

### 7.3.3 Interoperability

Interoperability requirements will be described herein or in other related sections (such as 7.1.2 System Interface Requirements) as appropriate, as they are defined.

### 7.3.4 Safety Requirements

Safety requirements pertaining to personnel, property, and the physical environment are not applicable to V2X DEP.

### 7.3.5 Security Requirements

Security details may be found in the V2X DEP Security Plan.

## 7.4 Human Factor Requirements

There are no human factor requirements for V2X DEP currently.

## 7.5 Personnel and Training

V2X DEP system training will be provided near project completion and is described in the V2X DEP Project Management Plan; requirements will be included here as needed and appropriate.

Additionally, system training is also conducted during quarterly demos for recently implemented features. Training session materials such as PowerPoint slides and recorded videos have been provided. For reference to past materials see Section 6.9.2.

## 7.6 Subsystem Requirements

V2X DEP is a system which utilizes the Infrastructure as Code (IaC) methodology to repeatably manage the provisioning of infrastructure through code, instead of doing so manually. The V2X DEP accomplishes this with the AWS CDK. CDK encourages the usage of separate smaller deployment units called Stacks, which can be thought of as “Subsystems” to the platform. Requirements for each of these “Subsystems” are not available.

## 7.7 Precedence

There is no order of precedence established at this time for DEP system requirements. Development will proceed in sprints, each of which will address a subset of requirements as determined at the start of each sprint.

## 7.8 Quality Assurance Provisions

System quality will be assured through testing of system requirements as described in the V2X DEP System Test Plan and other relevant documents as appropriate.

## 7.9 General

This section is listed here as it is included in the FDOT Systems Requirement standard template; however, it is unclear what its purpose is.

### 7.9.1 Responsibility for Tests

As noted above, tests will be conducted according to the V2X DEP System Test Plan.

### 7.9.2 Special Tests and Examinations

This section is not applicable to V2X DEP.

## 7.10 Quality Conformance Inspections

Quality conformance will be determined through system tests which may include inspection, analysis, and/or demonstration.

### 7.10.1 Inspection

The DEP will undergo internal code review by the DEP development team and inspection by the Office of Information Systems for conformance to the FDOT Application Development standards

### 7.10.2 Analysis

The platform reports on conformance to contractual SLAs in CloudWatch dashboards. These will be documented in the V2X DEP System Test Plan.

### 7.10.3 Demonstration

The stakeholder receives demonstrations quarterly with key demonstrations aligning with release milestones.

### 7.10.4 Testing

These will be documented in the V2X DEP System Test Plan.

## 7.11 Software Quality Assurance

As noted above, system quality will be assured through testing of system requirements as described in the V2X DEP System Test Plan and other relevant documents as appropriate.

## 7.12 Requirements Traceability Matrix (RTVM)

***Note:*** As of P2R2, the team has created a standalone Requirements Traceability Verification Test Matrix (RTVM), located with the other systems engineering documents and kept current on a per-release basis (in the RTVM folder). This section (particularly the tables) is kept for posterity. The remainder of this section that describes the development process remains current and accurate.

The RTVM maps the requirements to test cases such that, if/when test cases pass, the tests will satisfy that the requirements have been met. Every requirement and test case are represented in this document and the table below ensures complete coverage of the requirement set. This allows for forward and backward traceability, ensuring that all requirements have test cases, and all test cases satisfy requirements.

The following subsections currently include the latest lists of Jira issues (all entities in Jira are called issues, i.e., epics, user stories, and requirements) as of the date listed in the subheadings. These are tied together in the final subsection within the V2X DEP Requirements Traceability Matrix.) at all times during the course of this project, and the final version of this document will contain the final set of issues as they exist upon delivery of the final software version.

For clarification, user needs to be met by the V2X platform are described as epics in Jira; these are linked to associated Jira user stories describing individual use cases. Functionality included here is from an end-user perspective, focused mainly on interfaces for viewing, analyzing, and retrieving data managed within the DEP. Detailed functional system requirements to meet user needs are defined in Jira as requirements and are associated with their respective stories and epics. This is depicted in the image below; note that there are multiple epics (even though only one is shown).

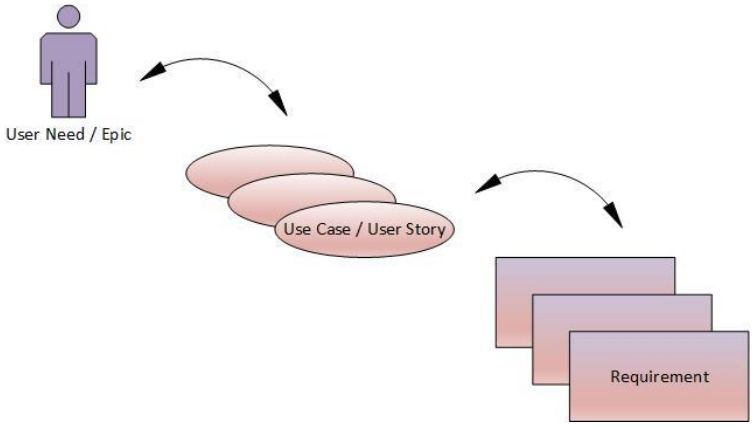



**Figure 7. Traceability from User to Requirement**

As user stories are worked by the development team, they transition through several states as defined by the development process. The following table maps development states to the states visible in the FDOT Jira project. Note that some development states have been omitted for clarity.

**Table 11. User Story States**

| ID | Initial | → | → | Final |
|---|---|---|---|---|
| DEV State | TO DO | IN PROGRESS | various states | DONE |
| FDOT State | TO DO | IN PROGRESS | IN PROGRESS | DONE |

Epics effectively follow the flow in the table above, with the caveat that as soon as one subordinate story moves to the in-progress state, the epic does. Likewise, it will not move to the done state until all stories are complete.

On the development side, all state changes are made manually. Corresponding FDOT states are updated automatically in accordance with the DEV state. The developer(s) working the story will move it into the in-progress state once development work begins. Once the work is completed (reviewed, tested, etc. as per the development process) and reviewed/accepted by the SwRI PM, it is moved into the done state, i.e. ready for FDOT review.

### 7.12.1 List of Epics/User Needs

The following tables are obtained from Jira, the agile development tool being used to manage the development iterations on this project. Each was obtained on the date noted and is subject to change as stakeholders and developers adjust to emerging project needs.

The epics identify high-level functionality of the DEP and are further elaborated by user stories as presented in the following section.

#### 7.12.1.1 POC Release (FL P1R1) as of 8/17/2021

Status of Epics/User Needs is updated in Jira as a living document. Following are the current Epics/User Needs for the POC release.

**Table 12. FDOT V2X DEP Epics / User Needs (POC Release)**

| ID | Summary |
|---|---|
| FDOTV2XUC-19785 | District staff want to share Workzone Data Exchange data |
| FDOTV2XUC-19561 | District staff want to share device status data |
| FDOTV2XUC-19445 | FDOT users need to monitor DEP performance metrics |
| FDOTV2XUC-17836 | Simulation System Release 1 |
| FDOTV2XUC-15524 | District staff want to share CV data |
| FDOTV2XUC-13824 | FDOT users need to monitor traffic (congestion) conditions |
| FDOTV2XUC-12593 | DEP team needs cloud infrastructure to support baseline DX functionality. |
| FDOTV2XUC-10596 | FDOT users need to monitor traffic safety (crash, lane closure) conditions |

#### 7.12.1.2 Phase 2 Release 1 (P2R1) as of 3/27/2023

Status of Epics/User Needs is updated in Jira as a living document. Following are the current Epics/User Needs for Phase 2, Release 1.

**Table 13. FDOT V2X DEP Epics / User Needs (Phase 2 Release 1)**

| ID | Summary |
|---|---|
| FDOTV2XUC-19830 | Build-out Availability SLA Data Including Retention Processing |
| FDOTV2XUC-19727 | On-board Districts/Partners (SunGuide and CV Projects) |
| FDOTV2XUC-19684 | Collect MAP Data |
| FDOTV2XUC-19472 | Provide Identity/Access Management |
| FDOTV2XUC-18853 | Collect SunGuide Event Data |
| FDOTV2XUC-17385 | Differentiate (and potentially process differently) BSMs |
| FDOTV2XUC-16163 | Collect Road Weather Information System (RWIS) |
| FDOTV2XUC-15482 | Collect Ford OEM fleet data |
| FDOTV2XUC-15271 | Ingest and Produce Work Zone Information Based on SunGuide Events |
| FDOTV2XUC-15008 | RSU Coverage Visualization |
| FDOTV2XUC-14257 | Collect SPAT Information |
| FDOTV2XUC-12898 | Simulation System Release 2 (MAP & SPaT) |
| FDOTV2XUC-12878 | Fortify/Enhance the Architecture as Opportunities Arise |
| FDOTV2XUC-11495 | Documents, Presentations, etc. |
| FDOTV2XUC-10036 | Collect Basic Safety Message (CV) Data |

#### 7.12.1.3 Phase 2 Release 2 (P2R2) and Subsequent Releases

Epics/User Needs for P2R2 are located in the RTVM.

### 7.12.2 List of User Stories/Elaboration of User Needs

The following tables are obtained from Jira, the agile development tool being used to manage the development iterations on this project. Each was obtained on the date noted in the subtitle and is subject to change as stakeholders and developers adjust to emerging project needs.

User stories help explain how software features will provide value to customers so that the development team better understands what they are building and why. They provide context to developers as they produce complex functionality iteratively.

#### 7.12.2.1 POC Release (FL P1R1) as of 8/17/2021

The status of user stories is updated in Jira as a living document. Following are the current statuses of Epics/User Needs as of POC release.

**Table 14. FDOT V2X DEP User Stories (POC Release)**

| ID | Summary |
|---|---|
| FDOTV2XUC-19846 | DEP needs to implement data retention policies |
| FDOTV2XUC-19845 | Implement HereProducer |
| FDOTV2XUC-19841 | Implement Traffic Congestion Dashboard |
| FDOTV2XUC-19839 | Implement CV SPaT ingestion |
| FDOTV2XUC-19837 | Implement WazeProducer |
| FDOTV2XUC-19836 | Test FIU simulated BSMs with ActiveDX |
| FDOTV2XUC-19835 | DEP needs CV MAP ingestion |
| FDOTV2XUC-19833 | Implement SunGuide DMS Ingestion |
| FDOTV2XUC-19832 | Prototype real time architectural components |
| FDOTV2XUC-19828 | DEP needs to send basic TIMs to SunGuide |
| FDOTV2XUC-19076 | Districts need to collect and share crash event information |
| FDOTV2XUC-18042 | DEP needs to store BSM data as Parquet |
| FDOTV2XUC-17839 | District staff need to provide MAP messages to the DEP |
| FDOTV2XUC-17085 | FDOT staff needs to view device status |
| FDOTV2XUC-17084 | DEP needs to store SunGuide device configuration and status data as Parquet |
| FDOTV2XUC-17010 | DEP needs to store MAP data as Parquet |
| FDOTV2XUC-16563 | District staff need to provide SunGuide TSS data to DEP |
| FDOTV2XUC-16064 | DEP needs AWS Network Stack |
| FDOTV2XUC-15390 | FIU needs integration with BSM encoding |
| FDOTV2XUC-14670 | District staff needs to provide SunGuide configuration and status data to DEP |
| FDOTV2XUC-14605 | DEP needs AWS Producer Stack |
| FDOTV2XUC-14446 | DEP needs to transform MAP messages into Avro representations |
| FDOTV2XUC-14250 | DEP needs to store SunGuide event (crash, lane closure) data as Parquet |
| FDOTV2XUC-14040 | DEP needs automated scanning of Docker images |
| FDOTV2XUC-13679 | DEP needs to store HERE data as Parquet |
| FDOTV2XUC-13588 | District staff needs to provide SunGuide device monitoring data |
| FDOTV2XUC-13326 | Provide work zone data exchange (WZDX) integration |
| FDOTV2XUC-13270 | DEP needs to store SunGuide TSS data as Parquet |
| FDOTV2XUC-12770 | SunGuide End-to-End (Trivial) Proof of Concept |
| FDOTV2XUC-12670 | District staff need to provide BSMs to the DEP |
| FDOTV2XUC-12334 | District staff need to provide SPaT messages to the DEP |
| FDOTV2XUC-12163 | DEP needs to transform BSMs into Avro representations |
| FDOTV2XUC-11132 | DEP needs to transform SunGuide device configuration and status data into Avro representation |

| ID | Summary |
|---|---|
| FDOTV2XUC-10588 | FDOT staff need to view traffic safety conditions |
| FDOTV2XUC-10143 | FDOT staff needs to provide HERE data to DEP |

#### 7.12.2.2 Phase 2 Release 1 (FL P2R1) as of 3/27/2023

Status of user stories is updated in Jira as a living document. Following are the stories for Phase 2, Release 1.

The links for the user stories are expected to be available on 8/31/2022.

**Table 15. FDOT V2X DEP User Stories (Phase 2 Release 1)**

| ID | Summary |
|---|---|
| FDOTV2XUC-19869 | Update client documents for Sprint 25 outputs |
| FDOTV2XUC-19868 | Update client documents for Sprint 24 outputs |
| FDOTV2XUC-19867 | Prepare P2R1 leadership presentation materials |
| FDOTV2XUC-19866 | Deploy Sprint 24 to Staging |
| FDOTV2XUC-19864 | SG/DEP provide 3 lane statuses (including unknown) which do not map to the standard feed |
| FDOTV2XUC-19863 | Store all available MAP fields |
| FDOTV2XUC-19861 | Establish Staging Account |
| FDOTV2XUC-19852 | Implement Connected Vehicle Data Framework (CVDF) External API |
| FDOTV2XUC-19851 | Make UI prototype |
| FDOTV2XUC-19850 | Provide DEP access to FDOT SMEs II |
| FDOTV2XUC-19848 | Implement SunGuide CVS Ingestion |
| FDOTV2XUC-19843 | Implement HERE unique road segment identifier generation |
| FDOTV2XUC-19834 | Implement S3 event-driven ingestion of manually uploaded MAP zip |
| FDOTV2XUC-19830 | Build-out Availability SLA Data Including Retention Processing |
| FDOTV2XUC-19727 | On-board Districts/Partners (SunGuide and CV Projects) |
| FDOTV2XUC-19684 | Collect MAP Data |
| FDOTV2XUC-19588 | Remove hard-coded IP address in NetworkStack.cs |
| FDOTV2XUC-19543 | Document process for adding and removing Cognito Users in Security Document |
| FDOTV2XUC-19472 | Provide Identity/Access Management |
| FDOTV2XUC-19294 | Make Waze data available to development accounts |
| FDOTV2XUC-19278 | The V2X DEP shall load relational data for currently available Waze crash incidents. |
| FDOTV2XUC-18958 | Prepare slides for 10/24 training |
| FDOTV2XUC-18871 | FDOT Azure AD account access prerequisites |

| ID | Summary |
|---|---|
| FDOTV2XUC-18853 | Collect SunGuide Event Data |
| FDOTV2XUC-18814 | Collect Ford OEM fleet Data from Ford Demo Feed |
| FDOTV2XUC-18746 | The V2X DEP shall load relational data for currently available SunGuide crash incidents |
| FDOTV2XUC-18705 | Add CDK Context variable which denotes environment |
| FDOTV2XUC-18591 | Resolve R1 Comments |
| FDOTV2XUC-18537 | Make HERE data available to development accounts |
| FDOTV2XUC-18431 | Add copyright header to code |
| FDOTV2XUC-18330 | Generate DEP Component Diagram for Design Document |
| FDOTV2XUC-18292 | Establish VPN Connection to FION in Staging Account |
| FDOTV2XUC-18241 | Refine Permissions for WZDx Lambda Policy |
| FDOTV2XUC-18189 | The V2X DEP shall load relational data into a distributed data warehouse. |
| FDOTV2XUC-18177 | DEP needs to generate and/or log DEP metrics for SLAs |
| FDOTV2XUC-18131 | Update usage of Time Zone data |
| FDOTV2XUC-18006 | Deliver simulation system R2 (due 12/29/2022) |
| FDOTV2XUC-17967 | The V2X DEP API shall support query of HERE congestion data averaged on time intervals such as 5min, 15min |
| FDOTV2XUC-17415 | Make each Producer optional in CDK Context with required fields |
| FDOTV2XUC-17385 | Differentiate (and potentially process differently) BSMs |
| FDOTV2XUC-17324 | Ingest remaining SunGuide event data |
| FDOTV2XUC-17312 | Remove account reference from lambda test code |
| FDOTV2XUC-17072 | Present 10/24 mid-release demonstration and training |
| FDOTV2XUC-16756 | The V2X DEP shall version data stream message formats |
| FDOTV2XUC-16626 | The V2X DEP shall calculate and store derived values from data |
| FDOTV2XUC-16555 | Prepare simulation demonstration materials |
| FDOTV2XUC-16163 | Collect Road Weather Information System (RWIS) |
| FDOTV2XUC-15874 | Address POC code review feedback |
| FDOTV2XUC-15844 | Configurable Redshift Cluster Sizing Using CDK Settings |
| FDOTV2XUC-15730 | Collect SPAT information from J2735 |
| FDOTV2XUC-15482 | Collect Ford OEM fleet data |
| FDOTV2XUC-15377 | Clean up POC account |
| FDOTV2XUC-15271 | Ingest and Produce Work Zone Information Based on SunGuide Events |
| FDOTV2XUC-15245 | Update ActiveDX to use latest SunGuide .NET Standard variant |
| FDOTV2XUC-15047 | Pass Tables from DataCatalog to Datasets |

| ID | Summary |
|---|---|
| FDOTV2XUC-15008 | RSU Coverage Visualization |
| FDOTV2XUC-14936 | Switch dotnet/Csharp test framework to Nunit |
| FDOTV2XUC-14831 | Dry run of 10/24 demo |
| FDOTV2XUC-14789 | The V2X DEP API shall support query of filtered/curated details for Waze crash incidents. |
| FDOTV2XUC-14746 | Prepare slides for 10/24 demonstration |
| FDOTV2XUC-14453 | Encrypt J2735 data to DEP in transit |
| FDOTV2XUC-14329 | Test candidate repo tools |
| FDOTV2XUC-14257 | Collect SPAT Information |
| FDOTV2XUC-14197 | Move AWS helper scripts to tools repo |
| FDOTV2XUC-14024 | Cognito users must authenticate with MFA |
| FDOTV2XUC-13743 | The V2X DEP ETL jobs shall batch ingest data from external sources. |
| FDOTV2XUC-13272 | Add support for SunGuide 8.1HF4 |
| FDOTV2XUC-13156 | Update Build/CI/CD documentation |
| FDOTV2XUC-13126 | Identify overlap between ford data and standard data (e.g. SAE J2735 BSM) |
| FDOTV2XUC-12997 | Create health status dashboard |
| FDOTV2XUC-12983 | J2735Producer KinesisApi should use SSL |
| FDOTV2XUC-12898 | Simulation System Release 2 (MAP & SPaT) |
| FDOTV2XUC-12878 | Fortify/Enhance the Architecture as Opportunities Arise |
| FDOTV2XUC-12875 | Visualize RSU coverage and gaps |
| FDOTV2XUC-12650 | As a DEV, I want to automate deployment to cloud so that I may spend more time developing |
| FDOTV2XUC-12558 | Load dedicated Redshift tables for dashboard datasets |
| FDOTV2XUC-12338 | Provide DEP access to FDOT SMEs |
| FDOTV2XUC-12043 | Ensure that WZDx only originated from SunGuide |
| FDOTV2XUC-11938 | The V2X DEP shall load relational data into a distributed data warehouse. |
| FDOTV2XUC-11912 | Prototype DEP access using User Pools and Identity Pools |
| FDOTV2XUC-11830 | The V2X DEP shall calculate jam factor (JF) from HERE traffic data. |
| FDOTV2XUC-11714 | The V2X DEP shall calculate and store 5-min, 15-min average values for ingested multi-source traffic data |
| FDOTV2XUC-11596 | Optimize Lambdas by not using containerized runtime |
| FDOTV2XUC-11559 | The V2X DEP shall enrich, fuse, and aggregate data. |
| FDOTV2XUC-11495 | Documents, Presentations, etc. |
| FDOTV2XUC-11461 | Improve Query Response Times for Dashboards |

| ID | Summary |
|---|---|
| FDOTV2XUC-11012 | Spike: Review Ford data and documentation |
| FDOTV2XUC-11010 | P2R1 Demonstration Data Stats |
| FDOTV2XUC-10619 | Amend Design Document for new data sources |
| FDOTV2XUC-10441 | Implement Initial RWIS Ingestion via Sun Guide |
| FDOTV2XUC-10255 | External users should follow FDOT's password requirements - AWS Settings |
| FDOTV2XUC-10036 | Collect Basic Safety Message (CV) Data |
| FDOTV2XUC-10025 | Integrate and run SonarQube |
| FDOTV2XUC-10024 | J2735 Producer Firehose and Kinesis APIs should use SSL |

7.12.2.3 Phase 2 Release 2 (P2R2) and Subsequent Releases

The above tables provide a link to the project management tracking system along with a summary. This is also available in the RTVM. The reader is directed to that document for P2R2 information.

### 7.12.3 List of Requirements

The following table was obtained from Jira, the agile development tool being used to manage the development iterations on this project. It was obtained on the date noted above and is subject to change as stakeholders and developers adjust to emerging project needs.

These system requirements map to software features described in user stories (see Section 7.12.3.2).

7.12.3.1 POC Release (FL P1R1) as of 8/17/2022

Status of user stories is updated in Jira as a living document. Following are the current statuses of Epics/User Needs as of POC Release 1.

**Table 16. FDOT V2X DEP Requirements (POC Release)**

| ID | Summary |
|---|---|
| FDOTV2XUC-19764 | V2X DEP Producers shall continuously ingest SunGuide crash incidents |
| FDOTV2XUC-19591 | V2X DEP Producers shall continuously ingest and make available relevant SunGuide CVS roadside device rseConfig & status elements |
| FDOTV2XUC-19452 | The V2X DEP shall load relational data for currently available current Waze crash incidents |
| FDOTV2XUC-18454 | V2X DEP shall generate distributed and replicated data streams |
| FDOTV2XUC-18050 | The V2X DEP shall collect and store data in a distributed and replicated data lake. |
| FDOTV2XUC-17246 | The V2X DEP shall load relational data for currently available traffic conditions |
| FDOTV2XUC-17182 | The V2X DEP UI shall display a device status dashboard |
| FDOTV2XUC-16875 | The V2X DEP ETL jobs shall batch ingest data from external sources |
| FDOTV2XUC-16205 | V2X DEP Producers shall continuously and make available relevant SunGuide DMS device dmsConfig & status elements |

| ID | Summary |
|---|---|
| FDOTV2XUC-16172 | V2X DEP Producers shall continuously ingest HERE traffic conditions |
| FDOTV2XUC-15840 | The traffic conditions dashboard shall display current traffic and congestion information |
| FDOTV2XUC-15648 | The V2X DEP shall load relational data for currently available current SunGuide crash incidents |
| FDOTV2XUC-15415 | The device status dashboard shall display current infrastructure device information |
| FDOTV2XUC-15022 | The safety conditions dashboard shall display current road safety information |
| FDOTV2XUC-14562 | The V2X DEP shall implement the USDOT-defined WZDx protocol |
| FDOTV2XUC-14323 | The V2X DEP UI shall display a safety conditions dashboard |
| FDOTV2XUC-13807 | The V2X DEP shall catalog all data generated in the Data Lake |
| FDOTV2XUC-13134 | V2X DEP Producers shall continuously ingest data from external sources |
| FDOTV2XUC-12012 | V2X DEP Producers shall continuously ingest CV BSMs (subset of devices from D2, D5) |
| FDOTV2XUC-11950 | The V2X DEP UI shall display a traffic conditions dashboard |
| FDOTV2XUC-11944 | V2X DEP Producers shall continuously ingest Waze crash incidents |
| FDOTV2XUC-11650 | V2X DEP Producers shall continuously ingest HERE traffic conditions. |
| FDOTV2XUC-11350 | The V2X DEP shall apply lifecycle policies defined (Section 6.4 in the Security Plan) |

#### 7.12.3.2 Phase 2 Release 1 (FL P2R1) and Subsequent Releases

The development team ceased using standalone requirement entities beginning with this release. The rationale is that in Scrum, the individual stories contain the requirements to which the team develops.

### 7.12.4 Mapping of Requirements to Stories to Epics

The following table was obtained from Jira, the agile development tool being used to manage the development iterations on this project. It was obtained on the date noted above and is subject to change as stakeholders and developers adjust to emerging project needs.

This table shows the mapping between the three types of issues (per Jira nomenclature) from the tables above. In general, it is expected that all requirements will be mapped to one or more user stories and user stories can be mapped to one epic. However, note the paragraph above that the stakeholders are progressively elaborating the DEP. Note that requirements are yet to be developed for some of the listed user stories.

#### 7.12.4.1 POC Release (FL P1R1) as of 8/17/2022

Following are the current statues of Epics/User Needs as of POC release 1.

**Table 17. FDOT V2X DEP Requirements Traceability (POC)**

| Epic ID | Story ID | Requirement ID | Requirement Summary |
|---|---|---|---|
| FDOTV2XUC-19785 | FDOTV2XUC-13326 | FDOTV2XUC-14562 | The V2X DEP shall implement the USDOT-defined WZDx protocol |
| FDOTV2XUC-19561 | FDOTV2XUC-17084 | FDOTV2XUC-16205 | V2X DEP Producers shall continuously and make available relevant SunGuide DMS device dmsConfig & status elements |
| | | FDOTV2XUC-19591 | V2X DEP Producers shall continuously ingest and make available relevant SunGuide CVS roadside device rseConfig & status elements |
| | FDOTV2XUC-11132 | FDOTV2XUC-16205 | V2X DEP Producers shall continuously and make available relevant SunGuide DMS device dmsConfig & status elements |
| | | FDOTV2XUC-19591 | V2X DEP Producers shall continuously ingest and make available relevant SunGuide CVS roadside device rseConfig & status elements |
| FDOTV2XUC-15524 | FDOTV2XUC-18042 | FDOTV2XUC-13807 | The V2X DEP shall catalog all data generated in the data lake. |
| | | FDOTV2XUC-18050 | The V2X DEP shall collect and store data in a distributed and replicated data lake. |
| | FDOTV2XUC-17839 | FDOTV2XUC-13134 | V2X DEP Producers shall continuously ingest data from external sources. |
| | FDOTV2XUC-17010 | FDOTV2XUC-16875 | The V2X DEP ETL jobs shall batch ingest data from external sources. |
| | | FDOTV2XUC-13807 | The V2X DEP shall catalog all data generated in the data lake. |
| | | FDOTV2XUC-18050 | The V2X DEP shall collect and store data in a distributed and replicated data lake. |
| | FDOTV2XUC-14446 | FDOTV2XUC-13134 | V2X DEP Producers shall continuously ingest data from external sources. |

| Epic ID | Story ID | Requirement ID | Requirement Summary |
|---|---|---|---|
| | FDOTV2XUC-12670 | FDOTV2XUC-12012 | V2X DEP Producers shall continuously ingest CV BSMs (subset of devices from D2, D5). |
| | | FDOTV2XUC-13134 | V2X DEP Producers shall continuously ingest data from external sources. |
| | FDOTV2XUC-12334 | FDOTV2XUC-13134 | V2X DEP Producers shall continuously ingest data from external sources. |
| | FDOTV2XUC-12163 | FDOTV2XUC-12012 | V2X DEP Producers shall continuously ingest CV BSMs (subset of devices from D2, D5). |
| | | FDOTV2XUC-13134 | V2X DEP Producers shall continuously ingest data from external sources. |
| FDOTV2XUC-12593 | FDOTV2XUC-19846 | FDOTV2XUC-11350 | The V2X DEP shall apply lifecycle policies defined (Section 6.4 in the Security Plan) |
| FDOTV2XUC-10596 | FDOTV2XUC-19076 | FDOTV2XUC-15648 | The V2X DEP shall load relational data for currently available current SunGuide crash incidents. |
| | | FDOTV2XUC-11944 | V2X DEP Producers shall continuously ingest Waze crash incidents. |
| | | FDOTV2XUC-15022 | The safety conditions dashboard shall display current road safety information. |
| | | FDOTV2XUC-14323 | The V2X DEP UI shall display a safety conditions dashboard. |
| | | FDOTV2XUC-19452 | The V2X DEP shall load relational data for currently available current Waze crash incidents. |
| | | FDOTV2XUC-19764 | V2X DEP Producers shall continuously ingest SunGuide crash incidents. |

#### 7.12.4.2 POC Release (FL P2R1) and Subsequent Releases

In this release, the development team moved to better align with best agile practices where stories embody the system requirement, proper. To those ends, stories were written with requirements embedded in them.

# 8. Analysis of the Proposed System

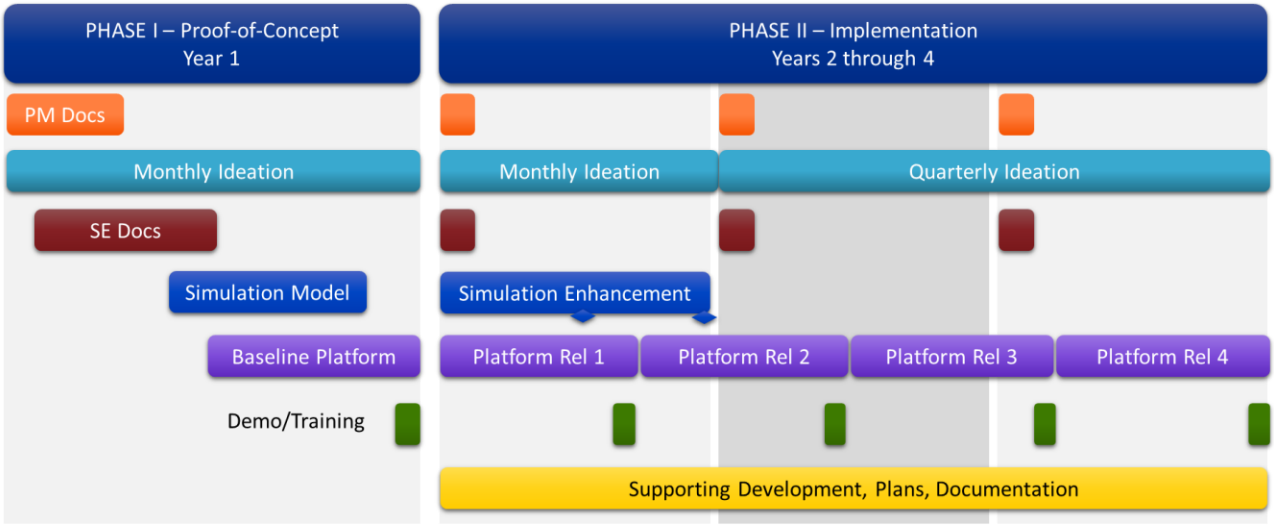
This section describes where project management information such cost and schedule, systems engineering plan, and performance measurement information may be found.

## 8.1 Alternatives

This section is not applicable to this project.

## 8.2 Cost and Schedule

The project was contracted for a 4-year period of performance beginning with the Notice to Proceed (NTP) on June 29, 2021. The period of performance was further divided into two major phases: Phase 1 was a proof-of-concept with delivery 12 months after NTP, and Phase 2, the implementation phase, was comprised of major platform releases every 9 months thereafter. The schedule can be depicted as follows.




Expected costs of AWS services have been estimated in the table below based on historical usage, but costs can change dramatically based on spikes of data, new or updated feature implementations, and other factors. Ford data source costs are paid as part of the platform costs and was originally for 250 vehicles. Project costs, schedule, and procurement management plans may be found in V2X DEP Project Management PlanV2X DEP Project Management Plan.

To support development of a cloud-based, serverless, CDK/IaC-deployed platform, multiple AWS accounts are used and are described as follows.

| Account type | Management | Audit | Log archive | Development | Staging | Production |
|---|---|---|---|---|---|---|
| Users/usage | Administrators for billing and account management purposes | Administrators for account compliance audit information | Administrators for account log information | Developers only for routine development | Client PM staff and key stakeholders for exploration/verification/feedback | All end users |

| Account type | Management | Audit | Log archive | Development | Staging | Production |
|---|---|---|---|---|---|---|
| Deployment frequency | One-time | One-time | One-time | Anytime as needed by developer | Every sprint (every 3 weeks) and/or as desired | Every release and/or as approved by client |
| Contents | AWS ControlTower components to manage other account types | AWS ControlTower components to audit other account types | AWS ControlTower components to log other accounts | Select components with work-in-progress software changes | All components with developer-verified enhancements | All components with client-approved enhancements |
| Persistence | N/A | | | Down when not in use to save on costs | Up 24/7 | Same as Staging |
| Estimated cost per account (costs evolve rapidly based on many factors; last updated Aug. 2023) | ~2K/month | <$100/month | <$100/month | ~$500-2K/month depending on developer activity | ~$5-8K/month depending on data volumes | Same as Staging |
| Number of accounts required | 1 | 1 | 1 | 5 | 1 | 1 |

**8.3 Management, Audit, and Log archive account types are part of a multi account Control Tower Organization (https://docs.aws.amazon.com/controltower/latest/userguide/accounts.html#special-accounts). These enable a single account to govern and monitor all the AWS accounts that are part of supporting the platform. The Developers each have access to a Developer account to deploy and test work-in-progress components based on the cloud provider's proposed best practices (https://docs.aws.amazon.com/cdk/v2/guide/best-practices.html#best-practices-organization). The Staging and Production accounts**

**contain the entire platform deployment for verification and end users, respectively. Systems Engineering Plan**

The V2X DEP ConOps (portion of this document) will be used to further develop user stories and systems requirements (also within this document and/or Jira issues), that will in turn be used to develop test plans, training materials, and other relevant documentation.

The DEP will be implemented in a phased approach to scale up from early prototype implementations, where data and computing needs may be limited, to full deployment where data is being consumed from all SunGuide instances statewide, multiple vehicle OEMs, numerous data sources throughout the state, and even potential data streams from Georgia and Alabama to support regional events near the border and accurate traveler information.

In the iterations prior to the final release, there may be periods where the DEP is not operational or is down to facilitate development, testing, and other activities. SWRI will work with FDOT to schedule times that the DEP will not be available.

## 8.4 Performance Measurement for System Validation

Performance measures as stated in contractual SLAs copied to 7.2.1 Performance Requirements of this document will be incorporated into test plans for system validation prior to project completion.

# 9. Acronyms and Abbreviations

**Table 18. Acronyms**

| Acronym | Definition |
|---|---|
| AARF | Automated Access Request Form |
| API | Application Programming Interface |
| ARBM | All Roads Base Map |
| AWS | Amazon Web Services |
| BSM | Basic Safety Message |
| CAV | Connected and Autonomous Vehicle |
| CDK | Cloud Development Kit |
| CF | Cloud Formation |
| CO | Central Office |
| ConOps | Concept of Operations |
| CV | Connected Vehicle |
| CV2X | Cellular Vehicle to Everything |
| DEP | Data Exchange Platform |
| DIVAS | Data Integration and Video Aggregation System |
| DMS | Dynamic Message Sign |
| ETL | Extract, Transform, Load |
| EVP | Emergency Vehicle Priority |
| FAT | Factory Acceptance Testing |
| FDOT | Florida Department of Transportation |
| FIU | Florida International University |
| FTP | File Transfer Protocol |
| GIS | Geographic Information System |
| HERE | HERE Technologies (not an acronym) |
| IC | Integration Case |
| JF | Jam Factor, i.e., speed and congestion information |
| ITN | Invitation To Negotiate |
| ITS | Intelligent Transportation Systems |
| MHz | Megahertz |
| N-MISS | Iteris Near Miss real time alert system |
| NTP | Notice to Proceed |
| OEM | Original Equipment Manufacturer |
| OS | Operating System |
| P1R1 | Phase 1 Release 1 |
| P2R1 | Phase 2 Release 1 |
| P2R2 | Phase 2 Release 2 |
| P2R3 | Phase 2 Release 3 |

| Acronym | Definition |
|---|---|
| P2R4 | Phase 2 Release 4 |
| PII | Personally Identifiable Information |
| PMP | Project Management Plan |
| POC | Proof-of-concept |
| PSM | Personal Safety Message |
| Pub/Sub | Publish/Subscribe |
| PVD | Probe Vehicle Data |
| RFP | Request for Proposal |
| R-ICMS | Regional Integrated Corridor Management System |
| RITIS | Regional Integrated Transportation Information System |
| RSE | Roadside Equipment |
| RSU | Roadside Unit |
| RTMC | Regional Transportation Management Center |
| SAE | Society of Automotive Engineers |
| SLA | Service Level Agreement |
| SME | Subject Matter Expert |
| SNMP | Simple Network Management Protocol |
| SPaT | Signal Phase and Timing |
| SwRI | Southwest Research Institute |
| TAM | Traveler Advisory Message |
| TC | Test Case |
| TCP | Transmission Control Protocol |
| TDA | Transportation Data and Analytics, an FDOT statewide office |
| TSP | Transit Signal Priority |
| TIM | Traveler Information Message |
| TSMO / TSM&O | Transportation Systems Management and Operations |
| UDP | User Datagram Protocol |
| UF | University of Florida |
| V2X | Vehicle to Everything |
| VPN | Virtual Private Network |
| WAVE | Wireless Access for Vehicular Environment |
| WSMP | WAVE Short Message Protocol |
| WZDX | Work Zone Data Exchange |