Project Systems Engineering Management Plan for:

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

FLORIDA DEPARTMENT OF TRANSPORTATION DISTRICT 6

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Table of Contents

List of Tables

List of Acronyms and Abbreviations

ARC-IT .... Architecture Reference for Cooperative and Intelligent Transportation
CEI .... Construction, Engineering, and Inspection
CFP .... Cost Feasible Plan
ConOps .... Concept of Operations
CPM .... Critical Path Method
D/B .... Design/Build
FDOT .... Florida Department of Transportation
HMI .... Human Machine Interface
ICD .... Interface Control Document
ICS .... Interface Control Specification
ITS .... Intelligent Transportation System
MOE .... Measure of Effectiveness
MOP .... Measure of Performance
MTR .... Minimum Technical Requirement
O&M .... Operations and Maintenance
ORR .... Operational Readiness Review
PERT .... Project Evaluation and Review Technique
PITSA .... Project Intelligent Transportation System (ITS) Architecture
PSEMP .... Project Systems Engineering Management Plan
QA .... Quality Assurance
QC .... Quality Control
QM .... Quality Management
RAD-IT .... Regional Architecture Development for Intelligent Transportation
RFP .... Request for Proposals
RITSA .... Regional Intelligent Transportation System (ITS) Architecture
RTMC .... Regional Traffic Management Center
RTVM .... Requirements Traceability Verification Matrix
SCMS .... Security Credentials Management System
SEMP .... (Florida's Statewide) Systems Engineering Management Plan
SEP .... Systems Engineering Process
SITSA .... Statewide Intelligent Transportation System (ITS) Architecture
TRR .... Test Readiness Review
TSM&O .... Transportation Systems Management and Operations
TSP .... Technical Special Provision

1. Introduction

1.1. Document Overview

This document is the Project Systems Engineering Management Plan (PSEMP) for the Connecting Overseas to Advance Safe Travel (Keys COAST) project.

A PSEMP is a plan that helps manage and control a project by using systems engineering processes (SEP). The PSEMP identifies what items are to be developed, delivered, integrated, installed, verified, and supported.
The rest of this document is organized as follows:

- Section 2 – Need for a PSEMP
- Section 3 – Applicable Documents
- Section 4 – Systems Engineering Processes
- Section 5 – Project Management and Control

2. Need for a Project Systems Engineering Management Plan

The Florida Department of Transportation (FDOT) requires high-risk intelligent transportation systems (ITS) projects using federal funds to use a SEP.[1] FDOT policy maintains that non-federal-aid ITS projects also follow a SEP for the project to be eligible for federal aid in the future. The PSEMP documents how systems engineering will be used for ITS project management.

Florida's Statewide Systems Engineering Management Plan (SEMP) was used as a reference guide in the creation of this PSEMP.

2.1. Project Identification

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

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

Federal Aid Project Number: [*Insert the federal aid project number, when it becomes available*].

2.2. Purpose and Scope

This document serves as the PSEMP for the District 6, Florida Keys, US 1 Connected Vehicle and Automated Traffic Signal Performance Measures (CV/ATSPM) Project.

[1] FDOT Procedure titled Systems Engineering and ITS Architecture (Topic No 750-040-003). Available online at http://www.dot.state.fl.us/proceduraldocuments/procedures.shtm.

It provides planning guidance for the technical management, procurement, installation, and acceptance of the project.

This project falls within the District 6 Regional Traffic Management Center's (RTMC) operations and within FDOT District 6 in Monroe County. It should be noted that District 6 Transportation Systems Management and Operations (TSM&O) will be expanding operations and maintenance in Monroe County to include State traffic signals in the City of Key West starting July 1, 2020 since the City has decided to opt out from the Traffic Signal Maintenance and Compensation Agreement (TSMCA). The FDOT plans to create a CV corridor consisting of 50 traffic control elements involving traffic signals (intersections; mid-block, emergency), pedestrian hybrid beacons (PHBs), one drawbridge signal; and a weigh station along 112.5 miles of US 1 from mile-marker (MM) 0.0. in Key West to MM 112.5 at Monroe County and the Miami Dade County line. Additionally, the project will deploy ATSPM software in the RTMC.

Further details of the project can be obtained by reviewing other documents, such as the project Concept of Operations (ConOps).

2.3. Technical Project Summary Schedule

The project's proposed schedule is shown in Table 1:

Table 1: Proposed Project Schedule

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

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

This schedule is an overview of the major events to provide a general timeline for the project. The detailed schedule will be available once the project evaluation and review technique (PERT) or critical path method (CPM) chart is prepared, as described in *Section 5.2. Managing the Schedule with the Project Evaluation and Review Technique and the Critical Path Method.*

2.4. Relationship to Other Plans

2.4.1. Relationship to Florida's Ten-Year ITS Cost Feasible Plan

The project is not related to the District's Ten-Year ITS Cost Feasible Plan (CFP). It is funded as a standalone project.

2.4.2. Relationship to Florida's Statewide ITS Architecture

The project will need to add several service packages for CVs to the Regional ITS Architecture (RITSA) as described in *Section 4.1. Developing the Project Intelligent Transportation System Architecture* and in the ConOps. This will be done through the FDOT Central Office's RITSA consultant.

2.4.3. Relationship to Other "On-project" Plans

Other plans in development include the ConOps, Requirements Traceability Verification Matrix (RTVM), System Verification and Validation Plan, and Request for Proposals (RFP). A Systems Validation Plan may need to be developed to evaluate the system's success in meeting user needs defined in the ConOps.

There are no conflicts with ongoing projects in the Florida Keys or in the RTMC, though there are several ongoing construction and maintenance projects.

3. Applicable Documents

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

Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE). (Accessed June 2017). *Guide to the Systems Engineering Body of Knowledge (SEBOK).* http://sebokwiki.org/wiki/Guide_to_the_Systems_Engineering_Body_of_Knowledge_(SEBoK).

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

FHWA. (January 2007). *Systems Engineering for Intelligent Transportation Systems.* http://ops.fhwa.dot.gov/publications/seitsguide/.

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

4. Systems Engineering Processes

The SEP to be followed will be derived from the completed ConOps and PSEMP. Once these documents are developed, the Minimum Technical Requirements (MTR) and RFP will be developed. This will ensure that the stakeholders and all their user needs are documented and accounted for in the project.

The following SEP tasks will be undertaken:

- ConOps

- PSEMP
- RTVM
- Verification and Validation Plan
- RFP
  - Advertisement
  - Letting / Notice to Proceed
- System Design and Installation
  - RSU vendor selection
  - RSU software development for service packages
  - RSU deployment
  - OBU vendor selection
  - OBU software development
  - OBU deployment
  - TRR and ORR plan development
  - SCMS purchase and deployment
  - ATSPM Installation in RTMC
- System Verification
  - RSU-OBU Testing
  - TRR and ORR
    - CV Unit/Subsystem Tests
    - CV System Acceptance Tests
  - ATSPM Testing
  - ATSPM Acceptance Test
- System Validation
- Final Acceptance

4.1. Developing the Project Intelligent Transportation System Architecture

The CV system will operate based on the service packages in the National ITS Architecture, which is the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) 8.1. The service packages will include:

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

These service packages are new to the District 6 RITSA. The generic service packages are detailed in ARC-IT and have been presented in the ConOps in Appendix A. The District 6 RITSA has not yet been converted to ARC-IT format. The conversion will be done with the Regional Architecture Development for Intelligent Transportation (RAD-IT) tool, since the Turbo Tool has been superseded and is no longer available. The customized project service packages, which are under development, will be delineated with the RAD-IT tool and be included in an Appendix.

FDOT D6, through the Central Office RITSA consultant, will need to add these eight service packages to the Regional ITS Architecture (RITSA), and possibly SU08 for SCMS.

4.2. Creating High-Level Functional Requirements

The ConOps document described user needs which are the basis of high-level project requirements taken from stakeholder or customer perspectives. The user needs table is presented below in Table 2.

FDOT D6 is the primary stakeholder and user in this deployment. FDOT D6 RTMC operators will oversee the CV system's effects on the traffic stream and use the ATSPM to evaluate and tune signal timings. Initially, FDOT drivers will be the only CV users. Ultimately, the general driving public, pedestrians, emergency vehicles, transit operators, and freight operators will use the system, so their needs are considered in this project as well. User needs are treated in Table 2. The User Need Identification Number (ID), UNxxx, will be used in the Requirements Traceability Verification Matrix (RTVM) for backward tracing of the user need. User needs will help to identify requirements that will follow in the RTVM and performance criteria that will be used to evaluate the project's success in the System Validation Plan.

Systems engineering procedures specify a validation method to determine whether each user need is met, by means of a performance measure.

Though not strictly part of the RITSA, the Security Credentials Management System (SCMS) is an important element of the system and fulfills a user need for CV data security. The use of the SCMS is described further in the ConOps.

Table 2: High-Level User Needs

User Need ID	User	Need
UN001	System Owner	Improve mobility of fleet vehicles/reduce delay
UN002	System Owner	Improve safety of driving population
UN003	System Owner	Fast response to incidents
UN004	System Owner	Ensure CV system data security (SCMS or equivalent)
UN005	System Owner	Reliable and low-latency CV system communications
UN006	System Operators	Evaluate system effectiveness - number of arrivals on green/red and other performance measures of signal control
UN007	System Operators	Data warehousing to support system evaluation
UN008	System Maintainers	Maintain RSUs, OBUs, communications
UN009	System Operators	Signal timing optimization/improvement (ATSPM)
UN010	System Operators	Notification of CV equipment or communications failure
UN011	System Operators	Notification of safety alerts
UN012	System Operators	Notification of incidents and bridge closings
UN013	Drivers	Trip time optimization/improvement, fewer stops on red
UN014	Drivers	Fewer crashes/safer transportation system

User Need ID	User	Need
UN015	Drivers	V2V safety alerts
UN016	Drivers	V2I messaging for signal timing
UN017	Drivers	Data and privacy security
UN018	Drivers	User-friendly Human Machine Interface (HMI)
UN019	Drivers	Maintenance on OBU
UN020	Drivers	Upstream information on bridge closings
UN021	Pedestrians & Cyclists	Fewer incidents with vehicles
UN022	Transit	Better on-time performance
UN023	Transit	Increased ridership
UN024	Freight	Better on-time performance and travel time
UN025	Freight	Vehicle violation notification

4.3. Creating Detailed Requirements

The ConOps created for this project lists the basic requirements based on stakeholder and customer needs. The detailed requirements to be listed in the RTVM will expand on the needs listed in the ConOps and *Section 4.1* of this PSEMP and the requirements listed in this section.

The system has operational requirements necessary for equipment to meet. The CV system will require RSUs and aftermarket OBUs that meet SAE J2735 standards for DSRC message sets and for cellular communications between signal controllers and the RTMC. The ATSPM has a requirement, common with the CV portion, that all traffic signal controllers will collect the data and transmit via cellular to the RTMC. Vehicle detection at the traffic signal cabinet, connected by channel (one detector per channel), will make the high-resolution data collected by the controller more useful to the ATSPM software. Lane-by-lane detection will support the accurate counting of vehicles as well as the display and processing of actuated coordination and arrival information. The pedestrian smartphone application will transmit and receive an appropriate DSRC message set to meet the functions set forth in the ConOps.

The CV system has security requirements that SCMS is expected to meet.

FDOT has chosen to implement the various CV service packages and ATSPM software as follows:

- Design, construction, integration and testing will be advertised and delivered as a Design/Build (D/B) contract. The District will serve as the contract manager.
    - The present signal controllers, as detailed in the ConOps (*Section 3.3.1*) are McCain brand (except for two emergency signals and two drawbridge signals) and require a compatible interface to the RSUs.
    - Any new signal controllers will be compatible with the RSUs selected, as above, for the McCain controllers.
    - All signal controllers, including intersection and emergency, will connect via cellular to the RTMC.

  - The flashing beacon assembly's RSU at the drawbridge northbound and southbound approaches will utilize cellular to the RTMC.
  - The weigh-in-motion screening station RSU will utilize cellular to the RTMC.
  - The mid-block and intersection RSUs will communicate with smartphones using an appropriate DSRC message set.
  - The project, while initially to be for FDOT District 6 fleet vehicles, will be extended to emergency, freight and transit vehicles and pedestrians/cyclists per the ConOps.
  - The system will operate security with SCMS.
- The Central Office will develop any necessary CV modules for SunGuide under its extant contract with Southwest Research Institute (SwRI).
- The Central Office will develop any necessary ATSPM modules for SunGuide under its extant contract with SwRI.
- The District will work with Central Office on installing the ATSPM.

In each case, FDOT District 6 will maintain oversight and coordination of the design and construction.

Detailed requirements will trace back to user needs as discussed in *Section 4.2*. Detailed requirements will trace forward to test procedures as discussed in *Section 4.7*. Detailed requirements shall be developed prior to the RFP as part of the RTVM.

Most detailed requirements are addressed in FDOT standard specifications, plan preparation manuals, and standard design indices. Modified Technical Requirements, Technical Special Provisions, and developmental specifications may be required. CV requirements may not currently be fully addressed in FDOT standards and specifications. An interface control document (ICD) will be drawn up as determined necessary and to be done by the D/B firm in the design phase. The system will require the interface to be based on a well-defined open architecture.

4.4. Performing Tradeoff Studies, Gap Analyses, or Technology Assessments

Given that there have been similar projects around the state, there are no Trade-off or Gap Analyses required for this project. While it is not planned to have additional technology assessments, beyond the operational proofs underway and completed in the SPaT Challenge in Tallahassee and the THEA CV Pilot, a TRR and ORR will be performed per *Section 4.5* (below).

The traffic signal controllers and RSUs to be used will be already listed on the FDOT Approved Products List (APL) or will need to obtain FDOT Transportation Engineering Research Laboratory (TERL) approval before addition to the APL. RSUs and OBUs are required to support SAE J2735 DSRC communications message sets for the CV portion of the project.

If FDOT decides to add additional detection to the traffic signals to accomplish one detector per channel for ATSPM, the method of detection will be made in accordance with FDOT requirements. Video or microwave detection devices are listed on the APL, not requiring assessment.

The cellular communications currently used for signal transfer to the RTMC may need to be evaluated for latency issues, though it is expected that cellular modems will support the communications sufficiently. This method of communications has already been established and is reliable.

RTMC communications to the traffic signal controller is required for ATSPM. The controller will need to be polled at certain intervals to collect the data the ATSPM system needs for analysis.

In the event cellular communications of CV data to the RTMC is not tenable, investigation of use of the existing FDOT microwave radio system to the RTMC may be undertaken. This option may require some technology assessment to interface with the microwave system. At this time, the use of the FDOT microwave system is considered a last resort and would require the approval of FDOT Central Office Transportation Systems Management and Operations (TSM&O). Cellular transmission of signal data to the RTMC for use with ATSPM is not considered a problem.

4.5. Performing Technical Reviews

The project will use an Interface Control Specification (ICS) to specify all interfaces among subsystems (e.g., signal controller to RSU, RSU to OBU). The contractor designing and integrating the system will typically write the ICS. When the interfaces have proven themselves to work as specified in the ICS and the system is accepted, the ICS will become the ICD. (FDOT SEMP *Section 4.3.1.7.2*).

Since the project has several subsystems new to FDOT District 6, project technical reviews will be an important task to reduce risk. Under the Florida SEMP, *Section 4.6.1*, Monitoring and Control, technical reviews can occur at various phases in the project. The project will need reviews of system field functionality, at a minimum, to include a TRR and ORR (other reviews, such as those in FDOT SEMP *Section 4.6.1* for requirements and hardware and software design may also be considered necessary). As this will be a D/B project, the contractor will perform these tests, so the test coverage will be detailed in the RFP (see *Section 4.6.1.1.7* and *Section 4.6.1.1.9* in the FDOT SEMP for appropriate typical items to cover) and will include each of the operations subsystems in the deployment:

- SCMS
- RSU interface with signal controller
- Signal controller to RTMC communications
- RSU DSRC message set (BSM, TIM, etc.)
    - By mode: fleet vehicle, emergency, truck and transit vehicle message verification
- Aftermarket OBU (V2V and V2I) DSRC message set (BSM, TIM, etc.)
- All aftermarket OBU equipment installed in 100 FDOT fleet vehicles
- OBU HMI installations and utility testing
- CV alert transmissions to RTMC
- Pedestrian application functionality
- Pedestrian to RSU Message set
- Pedestrian warning to OBU communications
- Drawbridge RSU operations and communication to OBU
- Weigh Station RSU operations and communication to OBU

- ATSPM software and communications to signal controllers
- SunGuide/SWRI interfaces to CV and ATSPM modules

SunGuide is under contract with SWRI, though the D/B firm will install the ATSPM software and integrate it with the SunGuide system. All other system integrations with SunGuide will be done by the D/B firm with the cooperation of SWRI.

4.6. Identifying, Assessing and Mitigating Risk

Project risks are listed in Table 3 with a risk rating (low-medium-high). While all the risks are considered solvable, the risk rating indicates the likelihood and costliness of running into a delay in addressing the issue.

Table 3: Project Risks and Rating (Low-Medium-High)

Project Risk	Rating	Mitigation
Federal Communications Commission (FCC) licensing at each location	Low	Early application on FCC website. FDOT SICN is responsible and on track for filing the application.
Vehicle detectors sufficient for ATSPM accuracy	Low	Additional infrastructure including new pull boxes and bored conduit in anticipation of defective or absence of loops
SunGuide software integration of ATSPM	Low	Selecting qualified D/B contractor
SunGuide software integration of CV alert modules	Medium	Applying lessons learned from previous CV projects in Tampa and Tallahassee
Cellular communications may present latency or reliability problems	Medium	Measuring cellular signal strength and DSRC interference at intersections
OBU delivery per specifications and fully compatible with RSU module	Medium	Allowing sufficient time in the schedule for a vendor to develop/procure the OBU
OBU DSRC message set compatible for service packages	Medium	Selecting OBU vendor carefully and with well-written specifications
OBU HMI is sufficient and successful for human user	Medium	Selecting OBU vendor carefully and with well-written specifications
DSRC 802.11p versus C-V2X Release 16	Medium	Track the advancement of both technologies. Flexibility is needed to choose one technology over the other.

Project Risk	Rating	Mitigation
Schedule for design and construction as OBU design, development, installation, training and testing may be the critical path	High	Allowing sufficient time for the development and implementation of the OBU technology. Include time for the PID application testing, Test Readiness Review (TRR) and the Operational Readiness Review (ORR)
TRR and ORR of OBU, RSU and Personal Information Device (PID) DSRC messaging, SCMS, controller cellular transmissions, etc.	High	The products of the TRR will need to be submitted and approved prior to any testing. The development of the products will need to be included in the project schedule. The items relating to the ORR will also be shown in the schedule.
PID application development	High	The high-level user needs are to be traced to detailed requirements in the Requirements Traceability Verification Matrix (RTVM). Detailed requirements will trace forward to performance tests.
SCMS deployment (requires specialist treatment)	High	Allowing sufficient time for first-instance failed operations tests of CV equipment and SCMS

Mitigation measures include:

- Selecting qualified D/B contractor
- Allowing sufficient time in schedule for a vendor to develop/procure the OBU
- Selecting OBU vendor well-defined selection process and with well-written specifications
- Allowing sufficient time for development and implementation of each new technology:
    - Personal Identification Device (PID) application
    - Installations of OBUs into vehicles (250 planned for project)
- TRR and ORR
- Allowing sufficient time for first-instance failed operations tests of CV equipment and SCMS
- Applying lessons learned from previous CV projects in Tampa and Tallahassee.
- Measuring cellular signal strength and DSRC interference at intersections.
- Track the advancement of both DRSC 802.11p and C-V2X technologies. Flexibility is needed to choose one technology over the other.

The Department is also aware that the project deployment limits are within an environmentally sensitive area. The technology and the proposed construction does not require any additional right of way, clearing and grubbing activities and as such, there are neither anticipated ROW acquisition nor environmental impacts, and therefore it qualifies for National Environmental Policy Act (NEPA) Categorical Exclusion (CE) Type 1. Since the approval has an expiry date of one-year for construction to start, the paperwork for approval from NEPA is developed in advance and will be submitted upon the announcement of the Infrastructure for Rebuilding America (INFRA) grant results. The process of filing the paperwork and receiving approval is automated through the FDOT Efficient Transportation Decision Making (ETDM) process.

4.7. Creating the Requirements Traceability Verification Matrix

The high-level user needs in *Section 4.2* are to be traced to detailed requirements in the District RTVM. Detailed requirements will trace forward to performance tests.

The D/B Firm will use the RTVM Template to track each high-level user need along to associated detailed technical requirements through final design, installation, integration, testing and acceptance. The RTVM shall identify at least one detailed technical requirement for each high-level user need. The RTVM will identify at least one integration-and-testing requirement for each detailed technical requirement.

Testing requirements may range from visual observation to a detailed test plan as required to demonstrate detailed requirements were met prior to final acceptance.

4.8. Creating Performance Measure Metrics

Performance measures can be for system verification, termed measures of performance (MOP), or for system validation, termed measures of effectiveness (MOE).

MOPs will be determined in the RTVM to test each detailed requirement. MOEs will be used to evaluate if the built project satisfied user needs as defined in the ConOps and in *Section 4.2* of this PSEMP. MOPs listed in the ConOps are shown in Table 4 below. The ATSPM suite of performance measures will be available, once it is installed and tested, to capture traffic performance of the CVs probes.

Table 4: User Needs and Performance Measures

User Need ID	Need	Performance Measure
UN001	Improve mobility of fleet vehicles/reduce delay	Number of stops on red
UN002	Improve safety of driving and pedestrian population	Number of crashes
UN003	Fast response to incidents	Time to respond
UN004	Ensure CV system data security (SCMS or equivalent)	Number of privacy breaches

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

4.9. Conducting System Testing, Integration, Verification, Validation, and Acceptance Planning

The construction consultant/contractor will provide the test plan and procedures to be approved to complete testing listed in the RTVM for system verification. The Construction, Engineering and Inspection (CEI) engineer will use the RTVM and follow the test plan to determine if a test should be accepted or rejected based on results.

System validation will be conducted using before data and after data with respect to system operation and acceptance testing. The construction consultant and contractor will provide the test plan to determine if user needs were met. User needs and performance measures are shown in *Section 4.8*.

System verification tests and system validation tests will include:

- Test approach/procedures
- Test schedules
- Test tools
- Test facility
- In-process test plans
- System integration test plan
- System acceptance criteria
- Integration and testing organizational responsibilities

The Construction Consultant will provide the test plan for approval. The Construction, Engineering, and Inspection (CEI) Consultant will witness the tests to make sure test procedures were followed and use the RTVM and validation test plan to determine if a test should be accepted or rejected based on results.

5. Project Management and Control

The ITS Management Team responsibility begins with the project kickoff and ends with operations and maintenance.

The following areas will be covered in the paragraphs below:

- Organization Structure
- Managing the Schedule with PERT or CPM
- Procurement Management
- Risk Management
- Subcontractor Management
- Engineering Specialty Integration
- Monthly Project Status Reviews
- Change Management
- Quality Management (QM)
- Systems Acceptance
- Operations and Maintenance/ Upgrade/Retirement
- Lessons Learned

5.1. Organization Structure

Specific roles and responsibilities for the project include:

- FDOT Project Management: to be determined.
- ConOps development: HNTB
- Draft PSEMP: HNTB
- Final PSEMP: D/B Firm
- Final Plans: D/B Firm
- Draft RTVM: HNTB
- Final RTVM: D/B Firm
- RFP Scope development: HNTB
- RFP/Procurement: FDOT District
- TRR and ORR plan and test: D/B firm
- SCMS: D/B firm
- Integration and testing: D/B Firm and District
- Environmental permits: D/B Firm
- Utility coordination: D/B Firm
- SunGuide Software CV and ATSPM modules: Derek Vollmer, FDOT Central Office and SwRI
- Construction Inspection and Oversight (CEI): District TSM&O CEI consultants (this may change as the project progresses)
- System verification: D/B firm
- System validation: HNTB
- Operations and Maintenance (O&M) Plan: D/B firm
- Technical support during design, testing and construction: HNTB

The FDOT Districts will operate and maintain the RTMCs' components once the project is deployed.

5.2. Managing the Schedule with the Project Evaluation and Review Technique and the Critical Path Method

The proposed project schedule indicating major milestones is presented in *Section 2.3*. This project involves multiple disciplines for that various field, RTMC and in-vehicle equipment that needs to be deployed. The high-level schedule presented in *Section 2.3* will be broken down further using project evaluation and review technique (PERT) or critical path method (CPM) method to identify all aspects of the project schedule including but not limited to procurement, design, software and application development, construction, installation, testing and integration and final acceptance. A draft CPM schedule may be developed and discussed internally with the Department during the procurement process of the D/B Firm to identify required lead time for project elements such elements such as RSU/OBU equipment and software application readiness and other anticipated project deliverable long lead items.

The D/B Firm will be required to coordinate with other design consultants and contractors under contract with the Department that are performing work within the project limits (e.g. push-button contracts). All activities involving designers and contractors performing work within the project limits specifically involving the traffic control elements in this project need to be monitored closely.

Similarly, the D/B Firms will be required to develop, maintain and provide a CPM schedule for the project based on their proposed solution to meet the project requirements. The D/B Firm will be responsible for updating the CPM schedule and development of a recovery plan as needed for any project delays. The Project Manager and the CEI will use the schedule to monitor and evaluate the design and construction progress throughout the project.

5.3. Procurement Management

The construction contractor shall procure the civil work infrastructure, field devices (RSU modules and OBUs), communication infrastructure, and head-end equipment system items to comply with the construction criteria package and the high-level technical requirements it contains.

5.4. Risk Management

Besides the risks identified in *Section 4.6*, the selected design and construction providers will provide a risk management plan to the FDOT for review and approval.

5.5. Subcontractor Management

The design and construction providers will be responsible for managing any subcontractor that may be needed for the project. The design and construction providers will provide a subcontractor plan to the FDOT for review.

5.6. Engineering Specialty Integration

CV technology with its new service packages and the ATSPM are new to District 6, so the project will require oversight by qualified persons.

5.7. Integrated Logistics Support and Maintenance Engineering

The following engineering specialties will provide input through the life-cycle of the project:

- Operability and Human Engineering: OBU design and specifications
- Security Engineering: SCMS deployment with the CV system
- Systems Architect: Operational Data Exchange architect and API design
- ITS Engineer: Final Plans and Specifications
- Electrical Engineer: electrical design
- ITS construction technician: installation, integration; site and subsystem testing
- ITS Maintenance Technician: trouble-shooting, repair, and replacement
- IT Technician: CV and ATSPM integration and SunGuide configuration
- RTMC Operators: CV and ATSPM use and operation

5.8. Monthly Project Status Reviews

The FDOT will schedule monthly project status reviews with the selected design firm and construction contractor throughout the contract duration. At the review meetings, items such as project schedule, cost, action items, etc., will be discussed in detail and documented.

5.9. Change Management

The selected D/B firm will address changes in schedule and cost to the FDOT for review and approval. The CEI consultant will work with FDOT and the D/B firm to evaluate the effects of the project change.

5.10. Quality Management

The selected D/B Firm will provide a Quality Assurance Plan to the FDOT for review and approval. The Construction Engineering and Inspection (CEI) consultant will work with the FDOT and selected construction contractor to evaluate the quality of the project deployment.

5.11. Systems Acceptance

The selected design firm is responsible for providing a system acceptance test plan to the FDOT for review and approval. The procurement document will describe in detail the contents of the system acceptance test plan.

The D/B firm will develop and implement ICS, TRR and ORR plans for a thorough test of all subsystems and interfaces (RSU, OBU, PID, signal controller, ATSPM, etc.), all modes (Installation/Testing/Maintenance, Normal Operations, Equipment or Communications Failure, Emergency Operations per *Section 5.4* and *Section 6* and Appendix B of the ConOps), and vehicle types (fleet vehicle, emergency vehicle, freight, and transit). Test and acceptance activities will be performed at TERL and on-site in District 6, as needed.

After the D/B firm has performed the acceptance tests witnessed by the CEI, the final inspection of the system will be performed by FDOT in the presence of an authorized construction contractor representative.

The FDOT will prepare a final acceptance test report based on the results of the system acceptance test and final system inspection. Once the construction contractor has addressed all comments and deficiencies noted in the final acceptance test report to the satisfaction of the FDOT project manager, the FDOT will issue a formal notification of system acceptance. At this point, the FDOT will assume system ownership, and the construction contractor will become responsible for hardware and software warranty and maintenance.

5.12. Operations and Maintenance, Upgrade, and Retirement

The selected D/B Firm will prepare an Operations and Maintenance (O&M) Plan that will be reviewed and approved by FDOT prior to system implementation. The O&M Plan, which will include all relevant policies and procedures, will address all scheduled and unscheduled maintenance responses for all hardware and software, communications links and networks, power supplies, and processing systems. The plan should also detail any upgrade or retirement activities that may be required during the contractual period.

The Districts will need to update RTMC standard operating procedures (SOP) and performance measures for RTMC operations.

The Districts will need to update ITS maintenance SOP and performance measures for ITS maintenance contractors.

5.13. Lessons Learned

As the design progresses, key comments and subsequent action items from each design review meeting will be tracked and documented. Through the system engineering process, project owners will evaluate project performance and track all pertinent issues that arise during the project to ensure that all project requirements are met.

6. User Definitions

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