Connected Vehicle Pilot Deployment Program Phase 2

Comprehensive Installation Plan – Tampa (THEA)

www.its.dot.gov/index.htm
Final Report — May 2018
Publication Number: FHWA-JPO-17- 463

U.S. Department of Transportation

Produced by Tampa Hillsborough Expressway Authority (THEA)
U.S. Department of Transportation
Intelligent Transportation Systems (ITS) Joint Program Office

Notice

Technical Report Documentation Page

1. Report No. **FHWA-JPO-17-463**	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Connected Vehicle Pilot Deployment Program, Comprehensive Installation Plan – Tampa (THEA)		**5. Report Date** May 2018 **6. Performing Organization Code**
7. Author(s) Tampa Hillsborough Expressway Authority		**8. Performing Organization Report No.**
9. Performing Organization Name And Address TAMPA HILLSBOROUGH EXPRESSWAY AUTHORITY 1104 E Twiggs St #300, Tampa, FL 33602		**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.** DTFH6116H00025
12. Sponsoring Agency Name and Address ITS-Joint Program Office 1200 New Jersey Avenue, S.E., Washington, DC 20590		**13. Type of Report and Period Covered** Draft Report **14. Sponsoring Agency Code** **HOIT-1**

15. Supplementary Notes
Work performed for:
Sarah Tarpgaard (AO), Govind Vadakpat (AOR), Kate Hartman (CV Pilots Program Manager, ITS JPO)

16. Abstract

The Tampa Hillsborough Expressway Authority (THEA) Connected Vehicle (CV) Pilot Deployment Program is intended to develop a suite of applications that utilize vehicle to infrastructure (V2I) and vehicle to vehicle (V2V) communication technology to reduce traffic congestion, improve safety, and decrease emissions using the authority provided by the United States Department of Transportation within the signed cooperative agreement (DTFH6116H00025). These CV applications support a flexible range of services from advisories, roadside alerts, transit mobility enhancements and pedestrian safety. The Pilot will be conducted in three Phases. Phase 2 includes the design, development, and testing phase.

This document presents the Comprehensive Installation Plan (CIP) which includes the Comprehensive Acquisition Plan (CAP) as Appendix A.

It provides a description of the THEA Team's approach to manage the technical specification, purchasing, installation and provisioning of equipment, devices, software and services comprising the connected vehicle system developed under Phase 1 and designed under Phase 2 of the THEA CV Pilot Deployment Program. The plan incorporates activities by multiple Pilot team members and vendors.

17. Key Words Connected Vehicle Technology, Purchasing, CAP, CIP, ORT, On Board Unit, OBU, Road Side Unit, RSU, Management Center, Applications, V2V, V2I, V2X, Installation, Supplier,	**18. Distribution Statement**		
19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No. of Pages** 82	**22. Price**

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Contents

List of Figures

List of Tables

1 Introduction

The Comprehensive Installation Plan (CIP) provides information on the policies, plans and processes to procure, manage and install the equipment, software and services to support the Tampa Hillsborough Express Authority (THEA) Connected Vehicle (CV) Pilot Deployment. In addition to documenting the procurement and installation plans, it will serve as a baseline management tool for process improvement, lessons learned and financial performance. While individual partner procurement and installation details may be sensitive, a blended reporting system is intended such that future CV deployments may benefit from their review.

As noted in the cooperative agreement general terms and conditions (paragraph C "Data Rights"), the Recipient need not submit annual property report using the form SF-428 – Tangible Personal Property Report.

However, THEA CV Pilot has utilized firm fixed pricing model for its system development and deployment, there is no equipment to be reported separately from those costs. The United States Department of Transportation (USDOT) has agreed that these forms will not be required of THEA CV Pilot under this set of procurement circumstances. But the THEA team will work cooperatively within the team and vendors to provide meaningful breakouts of costs that might be used to extrapolate future deployment budgetary insight.

1.1 Purpose of the Plan

This document describes acquisition and installation policies and procedures for the THEA CV Pilot. It serves as a resource to the THEA team for guidance and management of the procurement process. It is also intended as a resource for others interested in early deployment of CV technologies. Finally, it is intended to provide a documentation framework and validation tool for USDOT.

1.2 Organization of the Plan

The CIP is organized into the following sections:

- Section 1 This section provides the high-level overview of the installation
- Section 2 Acquisition Overview
- Section 3 Installation Overview
- Section 4 Vehicle/In-Vehicle Equipment
- Section 5 Infrastructure/Roadside Equipment
- Section 6 Management Center Equipment
- Section 7 Other Equipment
- Section 8 Bill of Materials
- Section 9 Glossary
- Section 10 References
- Section 11 Acronyms

2 Acquisition Overview

2.1 Infrastructure Acquisition Approach

The Siemens acquisition process is described in the Comprehensive Acquisition Plan (CAP), Appendix A. The key components and services requiring an acquisition plan are summarized as:

- Roadside Unit (RSU) Kits that include:
  - RSU
  - Dedicated Short Range Communications (DSRC) antennas
  - WiFi antennas
  - Bluetooth antennas
  - Global Positioning System (GPS) antennas
  - Mounting hardware
  - Cabling
  - Power over Ethernet (PoE) Injectors
- Radar detection for Wrong Way detection of unequipped vehicles on outbound REL
- Radar detection for queue lengths of inbound REL
- Video detection for unequipped vehicles approaching signalized intersections.
- Traditional pedestrian detection for movements of pedestrians and cyclists
- Master Server that includes:
  - Server hardware
  - Data storage
  - Communications equipment

The process in Section 2 of the CAP details the acquisition process used by Siemens in this project that includes the key steps of engineering design, supplier selection, sourcing and testing, and process improvement. Figure 1 of the CAP depicts the Infrastructure and Back Office equipment acquisition work flow.

2.2 Vehicle System Acquisition Approach

The Brandmotion acquisition process is described in the Section 3 of the CAP, the key components and services requiring an acquisition plan and described in this document can be summarized as:

- Human Machine Interface (HMI) components (cars, buses and streetcars)
- On-Board Units (OBUs) components (multiple suppliers)
- Wiring assembles/components (Brandmotion and supplier sourced)
- Antennas (multiple suppliers)
- Mounting hardware
- Installation Services

The process in Section 3 of the CAP details the acquisition process used by Brandmotion in this project that includes the key steps of engineering design, supplier selection, sourcing and testing and process improvement.

2.3 Personal System Acquisition Approach

The Siemens acquisition process for Personal Information Device (PID) and associated software applications:

- Participants agree to provide their own PID in the form of a smart phone
- Siemens provides a list of eligible PID for prospective participants
- PID using the Android operating system only.
    - Android is exclusively chosen as the only device supported by the MMITSS applications being tested
    - Android allows distribution of 3rd party software applications from the Master Server, opposed to required distribution through the store
    - Support of IOS devices is out of scope, but the resulting applications are available for port to IOS by other developers
- Chosen participants receive the object code and instructions to install the app on their PID as well as an installation key code texted separately

2.4 Infrastructure Acquisition Schedule

Section 2.2 of the CAP presents the acquisition schedule – component delivery dates and Application Development Schedule requirements.

2.5 Vendor Outreach Plan Acquisition Schedule

Section 3.8 of the CAP presents the acquisition schedule – component delivery dates and Application Development Schedule requirements. Note: Standard Green/Yellow/Red (GYR) risk assessment process is used: Green means no issues, yellow mean issues with high confidence mitigation plans, red means issue with no plans – high risk

2.6 Infrastructure Vendor Outreach Plan

As described in Section 2 of the CAP, Siemens open vendor outreach consists of the following process that began before this project with the publication of USDOT RSU specification version 4.0 plus requirement from Europe (EU) and the United Kingdom (UK):

1. USDOT issues the RSU Requirements Specification, version 4.0 (v4.0) based on lessons learned in the prior test beds.
2. United States of America (USA) RSU Requirements specification document based on v4.0, plus added requirements for THEA, including WiFi for pedestrian safety, cellular backhaul to collect data, Bluetooth reader for travel times, high-speed multiple core processor to run multiple applications, plus added memory to collect data and to store multiple MAP files.
3. RSU management and back office requirements from USA, Europe (EU) and United Kingdom (UK).
4. EU and UK RSU requirements
5. USA software requirements for RSU version using the DSRC WAVE communications extracted as a separate document.
6. USA hardware requirements extracted as a separate document, based on v4.0 plus WiFi, Bluetooth, cellular, processing speed and memory capacity.

7. EU and UK hardware requirements
8. EU and UK software requirements based on EU and UK wireless standards
9. Development of USA RSU software
10. Procurement document for common RSU hardware based on combined USA, EU and UK requirements issued to RSU manufacturers for competitive bid.
11. Development of EU/UK RSU software
12. Announcement at ITSA World Congress, Bordeaux of strategic partnership among Siemens, Cohda and NXP Live demonstration conducted using a Honda test vehicle, Cohda RSU and OBU, Cohda OBU applications and Siemens RSU applications. These existing applications were matched to the THEA Use Cases and Study Areas for the USDOT Pilot.
13. Cohda and NXP added to the Strategic Partnership entry of the Siemens Affiliated Test Bed informational slide
14. THEA vendor day in Tampa Florida. Multiple RSU and OBU manufacturers demonstrated their equipment. Based on the feature sets and verbal prices stated, decision to continue with the RSU designed to THEA requirements manufactured by Cohda instead of starting over with another RSU manufacturer.
15. USA RSU software completed for v4.0 plus the added THEA requirements.
16. Cohda delivers first article RSUs for integration test with the USA RSU software and EU/UK RSU software. Integration testing is completed for each.
17. EU/UK RSU software is completed.
18. USA RSU software is updated based on integration testing with first article RSU hardware.
19. Hardware design update completed based on integration and environmental testing
20. EU/UK RSU software is updated based on integration testing with RSU hardware
21. Final USA software is integrated with first production run of RSU hardware
22. RSU hardware first production run completed. (25) units delivered to THEA project for developers, testers, security scans and spares.
23. Final EU/UK software is integrated into first production run hardware
24. USDOT issues v4.1 RSU Requirements Specification that does not affect hardware, but requires software update and repeat of integration testing in the USA.
25. Requirements specification issued for pedestrian detection and vehicle detection equipment.
26. RSU Back Office and RSU Management development for USA, EU and UK requirements
27. USA RSU software update and repeat of integration testing to v4.1
28. Detection equipment cost quotes received and evaluated, including Lidar, radar and video.
29. Successful field test at Southwest Research Institute. Included controller unit sending signal countdown to RSU. RSU created SPaT, MAP and TIM messages to three OBU vendor vehicles. Vehicles send BSM to RSU over complete 780-meter track distance.
30. Detection equipment procurement for vehicles and pedestrians.
31. RSU Management and Back Office integration test and subsystem test with RSUs
32. USDOT Pilot installations in Tampa Florida
33. Second production run of RSUs, including 40 units for field installation in Tampa Florida
34. EU and UK RSU field installations, using EU/UK RSU software

2.7 Vehicle Systems Vendor Outreach Plan

As described in Section 3 of the CAP, Brandmotion open outreach consisted of the following process:

1. Create Product Design Assumptions, completed Phase 1 by Brandmotion with THEA team input
2. Initiate Request for Proposal as needed, completed Phase 1 by Brandmotion with THEA team input

3. Required Request for Quotation to evaluate partners/suppliers, completed December 2016 by Brandmotion with THEA team input and review
4. Supplier Selection, completed January 2017 by Brandmotion with THEA team
5. Finalize Specifications, Statement of Work (SOW) with Program Timing, completed July 2017 by Brandmotion with THEA team input
6. Sourcing commitment, intent to source completed by Brandmotion with THEA team input
7. Program Purchase Orders, completion August 2017

3 Installation Overview

3.1 Infrastructure Supplier Base

The list of supplier base is described in Section 4 of the CAP and summarized as follows:

- RSU Supplier:
  - Cohda Wireless procured to Siemens requirements specification document
- Radar Vehicle Detection Supplier Candidates:
  - Wavetronics
  - Siemens
  - MsSedco
- Video Vehicle Detection Supplier Candidates:
  - Iteris
  - Econolite
  - Flir
  - Gridsmart
- Lidar Pedestrian Detection Supplier Candidates:
  - Metrotech
  - Quanergy
- Radar Pedestrian Detection Supplier Candidates
  - Siemens
- Video Pedestrian Detection Supplier Candidates
  - Iteris
- Master Server Supplier Candidates
  - Hewlett Packard
  - Dell Computer

3.2 Vehicle System Supplier Base

The list of supplier base is described in Section 3 of the CAP and summarized as follows:

- OBU Suppliers:
  - Savari
  - SiriusXM
  - Commsignia
- Antenna Supplier:
  - Harada

3.3 Infrastructure Procurement Method

The infrastructure procurement method flow is diagramed in Figure 1 of the CAP and described in Section 2.1.1. The procurement of the RSU began with publication of the RSU Requirements Specification version 4.0 and was awarded prior to this project. The RSU Requirements Specification issued to candidate suppliers includes updates to version 4.1 of the specification, plus additional features to meet the project requirements including WiFi for pedestrian safety and others.

Procurement of pedestrian detection equipment began with a Requirements Specification document submitted to manufacturers of video, radar and lidar pedestrian detection products shown in "Infrastructure Supplier Base" above. Lidar technology met the performance requirements, while radar and video technologies could not.

Procurement of vehicle detection equipment began with a Requirements Specification document submitted to manufacturers of video and radar vehicle detection products shown in "Infrastructure Supplier Base" above. Radar was selected as the most cost-effective solution for the varying weather and lighting conditions in Tampa.

Procurement of wrong-way detection equipment began with a Requirements Specification document submitted to manufacturers of video and radar vehicle detection products shown in "Infrastructure Supplier Base" above. The selection of radar was based on an existing and proven product already widely deployed in Florida for other wrong-way detection needs.

3.4 Vehicle Systems Procurement Method

The vehicle systems procurement method is described in section 3 of the CAP.

3.5 THEA System Inventory Management

Inventory management for the infrastructure and back office equipment is implemented using the Siemens SAP accounting and manufacturing software that includes:

- Material procurement
- Assignment of internal Siemens part numbers linked to vendor part numbers
- Incoming Receiving of material
- Inventory control with stocking locations
- Issuing material from stock to installers
- Return Material Authorizations (RMA) for repair and warranty material
- Inventory audits

The Inventory Management flow is as follows:

1. The RSU kit is assigned an internal Siemens part number shown in Section 4.1.3 of the CAP.
2. Internal Siemens part numbers are assigned stocking locations
3. Equipment vendors are set up as Siemens suppliers in SAP
4. Internal Siemens part numbers are linked to supplier part numbers in SAP
5. Part numbers and quantities are entered into the SAP procurement screen with delivery dates
6. Equipment is received and logged into SAP, then moved to the assigned stocking locations
7. Secured staging storage area is created at the THEA building in Tampa Florida with limited access by Siemens installation personnel.
8. Equipment received in the stocking location in Austin Texas is delivered to the staging storage at THEA on the installation schedule.
9. Inventory counts are adjusted in SAP as the material is shipped to the installer.
10. Installers obtain equipment from secure storage in Tampa as the installations proceed.
11. Any defective or damaged equipment is returned under RMA and replaced.
12. Inventory is audited by the Siemens commercial (accounting) staff in Austin Texas.

3.6 THEA System Configuration Management

The Configuration Management (CM) is part of the Work Breakdown Structure (WBS) described in section 3.5.1.1.2 of the Comprehensive Deployment Plan (CDP) consisting of five project Quality Gates at which CM is performed as follows:

- QG1: After investigation of all needed hardware and software objects to the Requirements
- QG2: After test and verification of each hardware and software object delivered to the project.
- QG3: After integration of software objects into hardware objects as subsystems
- QG4: After subsystems are integrated and tested with interfaces as a complete system
- QG5: After Field Testing

CM at Siemens follows the mature Siemens Product Evolution Process (PEP) that requires configuration and work product archives using the Perforce software system for archiving and revision control, as the Siemens Helpdesk issue tracking system with issue resolution archives

3.7 High-Level Equipment Inventory for Infrastructure

Table 1 is an inventory of the infrastructure equipment procured and installed.

Table 1 – High-Level Infrastructure Equipment Inventory

Equipment Type	# Procured	Total # Configured and Installed
RSU Kits	65	44
Pedestrian Detector	1	1
Vehicle Detector	1	1
Wrong Way Detector	1	1

3.8 High-Level Equipment Inventory for Vehicle Systems

Table 2 is an inventory of vehicle equipment procured and installed.

Table 2 – High-Level Vehicle System Equipment Inventory

Equipment Type	Total # Procured	Total # Configured & Installed
Vehicle OBU	~1610	1580
Streetcar/Bus OBUs	~25	20
Antennas (3 per vehicle)	~4850	4800

3.9 Infrastructure Installation Schedule

Table 3 is the milestone dates for infrastructure equipment installations.

Table 3 – High-Level Infrastructure Installation Schedule

Date	Task	Description
July 2017	Site Survey	Inspection of each RSU location Measure the conduit runs for cable Document location of each device installation location Create “as built” engineering drawings Test clearance of exiting conduit to accept additional cables
August 2017	Begin Installation	Installation of 44 RSUs Installation of 1 pedestrian detector Installation of 1 wrong way detector Installation of 1 vehicle detector
November 2017	Installation Completion	Final acceptance test of all equipment installed

3.10 Vehicle System Installation Schedule

The installation of competed systems consists of three vehicle system types, 1580 participant vehicles, 10 buses and 10 streetcars. Table 4 depicts the installation schedule for Hillsborough Community College (HCC) under Brandmotion supervision.

- OBU and other component delivery
- Friends of Pilot are THEA-owned vehicles and THEA employee private vehicles equipped as early adopters for testing ahead of the participant vehicle installation.
- Build days per week are the number of days the installers occupy the community college service bays each week.
- Weekly Build Target total are the number of participant vehicle installations per month on average

Table 4 – Vehicle System Installation Schedule

	Planned Component Deliveries to HCC				Installations by HCC/Brandmotion				
Month 2018	**Mirrors, Wiring, Antenna, etc.**	**Comm-signia OBU (250)**	**Sirius XM OBU (100)**	**Savari OBU (1250)**	**Vehicles installed for Partici-pants Target (cumula-tive)**	**Buses/ Streetcars**	**Build Days per week**	**Build Rate/ day (utilization)**	**Weekly Build Target**
March and prior	Delivery to HCC	Initial Delivery to HCC			Friends of the pilot builds and Launch	Initial Builds	1-3	TBD - establish process	TBD - establish process
April	Delivery to HCC	Initial Delivery to HCC	Initial Delivery to HCC	Initial Delivery to HCC	ramp up	Ongoing	4.5	7-10 vehicles (33%)	36
May	Delivery to HCC	NA	Final Delivery to HCC	Periodic Delivery	400	Completion	4.5	22 (90%)	99
June	Delivery to HCC	NA	NA	Periodic Delivery	800	NA	4.5	22 (90%)	99
July	Delivery to HCC	NA	NA	Periodic Delivery	1200	NA	4.5	22 (90%)	99
August	Delivery to HCC	Final Delivery to HCC	NA	Final Delivery to HCC	1600	NA	4.5	22 (90%)	99

Note: The chart assumes participants are available for installation and does not account for no shows and no builds

3.11 Infrastructure Plan

Site surveys are complete in July 2017. Site survey is conducted by a two-person crew that:

- Measures the intersection geometry and lane marking placement
- Determines the optimum RSU location by line of sight to vehicle approaches
- Locates the existing electrical conduit for routing the RSU cable
- Inspects the existing conduit by running an electrician's tape from the electrical cabinet to the RSU mounting pole to clear any debris and insects
- Records the controller type and software release number
- Records the communications media and adaptors
- Records the malfunction management unit type and software revision number

- Photographs the intersection and cabinet interior for use by the civil engineer to create “as built” engineering drawings.

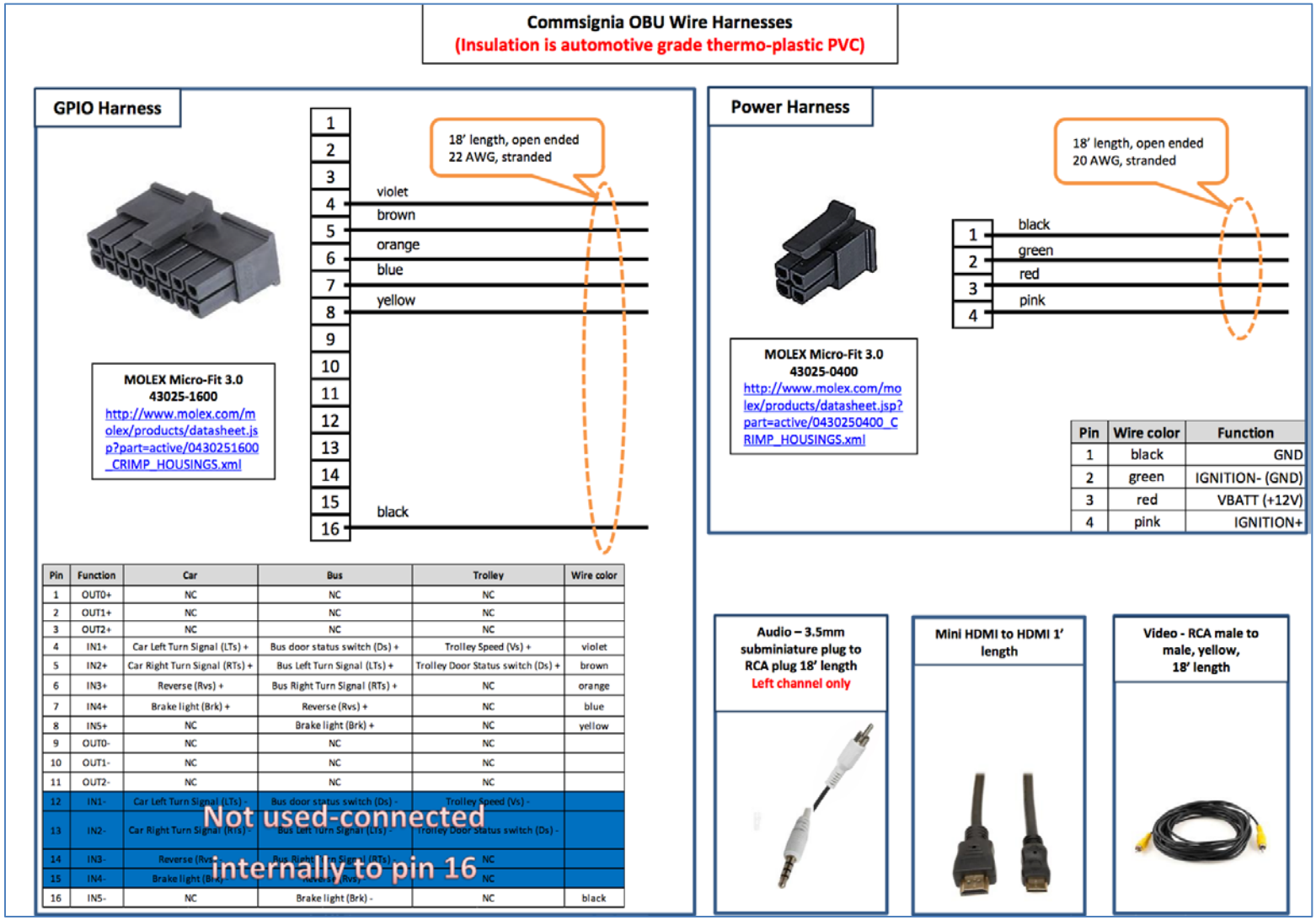
Elevation plans, electrical diagrams, hardware mounting details, communications network diagrams are created based on the site survey to be delivered per the project schedule. Installation and acceptance tests are completed per the project schedule.

3.12 Installation Plan

We have acquired wiring diagrams from all OBU suppliers and are working with wiring harness suppliers for procurement. Figure 1 is an example of one of the wiring diagrams. The color code column refers to standardized color codes of the physical wire. No standardized SAE wire colors are used in the automotive industry. RED is typically +12V and BLACK is typically 0V. Differing colors are used to identify wires routed through the vehicle.

We have completed antenna testing for best placement and performance of antennas on vehicles. HMI component has been tested and procurement plans were established. Installation and acceptance test to be completed per the project schedule.

Figure 1 – OBU Wiring Diagram



Pin	Function	Car	Bus	Trolley	Wire color
1	OUT0+	NC	NC	NC	
2	OUT1+	NC	NC	NC	
3	OUT2+	NC	NC	NC	
4	IN1+	Car Left Turn Signal (LTs) +	Bus door status switch (Ds) +	Trolley Speed (Vs) +	violet
5	IN2+	Car Right Turn Signal (RTs) +	Bus Left Turn Signal (LTs) +	Trolley Door Status switch (Ds) +	brown
6	IN3+	Reverse (Rvs) +	Bus Right Turn Signal (RTs) +	NC	orange
7	IN4+	Brake light (Brk) +	Reverse (Rvs) +	NC	blue
8	IN5+	NC	Brake light (Brk) +	NC	yellow
9	OUT0-	NC	NC	NC	
10	OUT1-	NC	NC	NC	
11	OUT2-	NC	NC	NC	
12	IN1-	Car Left Turn Signal (LTs) -	Bus door status switch (Ds) -	Trolley Speed (Vs) -	
13	IN2-	Car Right Turn Signal (RTs) -	Bus Left Turn Signal (LTs) -	Trolley Door Status switch (Ds) -	
14	IN3-	Reverse (Rvs) -	Bus Right Turn Signal (RTs) -	NC	
15	IN4-	Brake light (Brk) -	Reverse (Rvs) -	NC	
16	IN5-	NC	Brake light (Brk) -	NC	black

Pin	Wire color	Function
1	black	GND
2	green	IGNITION- (GND)
3	red	VBATT (+12V)
4	pink	IGNITION+

4 Vehicle / In-Vehicle Equipment

The Brandmotion Acquisition Schedule, as described in Section 3.7 of the CAP, is a matrix that details the following:

- Brandmotion part number
- Industry part number, several of the parts are COTS
- Specification and release engineer
- Contract and Purchase Order status
- Delivery and Purchase responsibility (buyer)
- Application Development Schedule requirement

4.1 Vehicle/In-Vehicle Item OBU Acquisition Information

Brandmotion as described in Section 3 of the CAP procures the Onboard Units under contract and Service Level Agreement from Commsignia, SiriusXM and Savari.

4.1.1 Technical Description/Specification

Brandmotion communicates OBU technical information to the suppliers through a document, VEHICLE SYSTEMS - OBU COMPONENT SPECIFICATION, OBU_COMPSPEC_BM_THEA v2.2 which incorporates the requirements from the System Architecture Document (SAD) and the System Design Document (SDD).

4.1.2 Ancillary Equipment

As described in Section 3 of the CAP and in the Acquisition Schedule matrix and in section 4.1.7, the antennas are purchased from Harada, wiring, video adapters and display components from Brandmotion.

4.1.3 Part Numbers and Quantities

The Acquisition Schedule matrix shown in Table 5 below provides the description and part numbers, quantities, and source of all components.

4.1.4 Associated Software

The application software of the OBU for the THEA applications as listed in the SAD are part of the OBU purchase. A license for use of the software for the THEA pilot is addressed in the OBU purchasing contract.

4.1.5 Acquisition Method

Reference Section 3 of the CAP

4.1.6 Potential Vendors

Reference Section 3 of the CAP

4.1.7 Acquisition Schedule

The Acquisition Schedule Matrix is detailed in Table 5 below. Note: This is a working and dynamic document that is periodically updated by Brandmotion.

Table 5 – Acquisition Schedule

Brandmotion Part Numbe	Industry Part Number		Description	Design and Relea Engr.	Purchasing	Test Engr.	Design Status		Acquisition Status		Production Delivery			Memo: Vehi Launch	Risks
							Design Release	ADS Requirement	Acquisition Status	ADS Requirement	Production Site	Production Units	ADS Requirement		
OBUC-0001	TBD		Commsignia On Board Un Cars	Rafal L.	Kirthi D.	Bob K.	Specification	08/18/17	Contract Draft Sent	10/13/17	Hillsborough Commun College	250	10/13/17	11/02/17	None
OBUC-0002	TBD		SiriusXM On Board Units Cars	Rafal L.		Bob K.	Specification	08/18/17	Contract Draft Sent		Hillsborough Commun College	80	10/13/17	11/02/17	
OBUC-0003	TBD		Savari On Board Units - Cars	Rafal L.		Bob K.	Specification	08/18/17	Contract Signed		Hillsborough Commun College	1250	12/15/17	01/12/18	
OBUB-0001	TBD		Savari On Board Units - Buses	Rafal L.		Bob K.	Specification	08/18/17	Contract Signed		Hillsborough Commun College	10	12/15/17	01/12/18	
OBUB-0002	TBD		Savari On Board Units - Streetcars	Rafal L.		Bob K.	Specification	08/18/17	Contract Signed		Hillsborough Commun College	10	12/15/17	01/12/18	
91 FLTW-7693 FLTW-7695 FL	N/A		Rear-View Mirror with integrated display and	John K.		Bob K.	Specification	08/18/17	Sample Testing		Hillsborough Commun College	1500	10/13/17	11/02/17	
ODVD- 0001	TBD		On Dash Video Displays Buses/Streetcars	John K.		Bob K.	Specification	08/18/17	Contract Draft	10/13/17	Hillsborough Commun College	20	10/13/17	11/02/17	
TBD (custom-made)	N/A		Wiring Harnesses	Bob. K.		James Mc	Design Assumptions/ND	08/18/17	Internal Sourced	10/13/17	Brandmotion	1500	09/22/17	11/02/17	
Sedans				Bob. K.		Bob K.	Design Assumptions/ND	08/18/17	PO Placed, expected arriva 10/13/17	10/13/17	Hillsborough Commun College	1520	10/13/17	11/02/17	None
Harada	Primary DEN-HA-001-GEN2	Secondary DEN-HA-00 002-GEN2	Antenna DSRC												
Harada	DEN-GN-001-002-GEN2		Antenna GNSS												
SUV/Van															
Harada	Primary DEN-HA-001-GEN2	Secondary DEN-HA-00 002-GEN2	Antenna DSRC												
Harada	COM-HA-001-002-GEN2		Antenna GNSS												
ADAP-0001	TBD		HDMI/NTSC Converters	Rafal L.		Bob K.	Validation Prototyp approved	08/18/17	Sample Testing	10/13/17	Hillsborough Commun College	1600	10/13/17	11/02/17	None
Multiple Part numbers based vehicle type	NA		Mounting hardware/brackets	James Mc		Bob K.	Design Assumptions/ND	08/18/17	Sourcing Letter/SOW	10/13/17	Hillsborough Commun College	1600	10/13/17	11/02/17	

Legend: Green indicates task complete

Yellow indicates task to be completed, minor issues

Red indicates task not complete and major issues need to be resolved`

4.2 Vehicle System Installation Information

4.2.1 Supplier(s)

As described in Section 3 of the CAP, Hillsborough Community College is under contract to Brandmotion to provide installation services.

4.2.2 Inventory Control Method

Brandmotion shall develop and establish the Inventory Control Method (ICM). Detailed inventory of each item ordered, received and shipped shall be recorded in the Brandmotion-THEA Standard Inventory file system.

HCC shall record via the approved Brandmotion and HCC ICM. Detailed inventory of each item ordered, received and installed shall be recorded in the Brandmotion-HCC Inventory file system located at HCC. The ICM will include date ordered, date received, date installed, any discrepancies or defects in parts received during incoming inspection or installation. HCC shall maintain the ICM file electronically on a shared drive with Brandmotion. The ICM will be updated on a daily basis by HCC. Brandmotion shall review the ICM on a regular basis and upon any special request to review inventories.

4.2.3 Configuration(s)

There will be multiple antenna configurations exercised during installation depending on vehicle type. Below in Figure 2 is an example of one. Also, depending on the OBU and vehicle type, the OBU could be mounted in different locations. Below in Figure 2 is an example position of the mounted OBU.

Figure 2 – Example Position of OBU Mounting

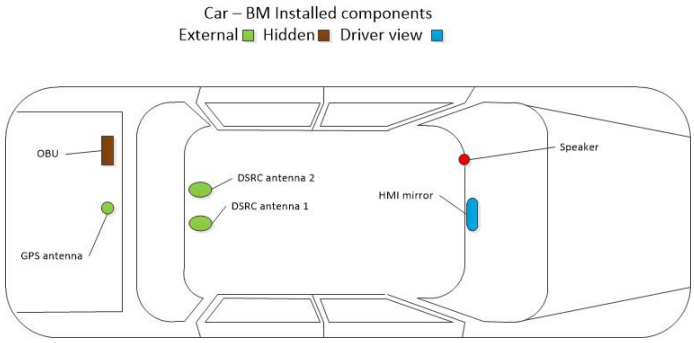
4.2.4 Installation Diagrams

This section provides the detailed installation diagram(s).

4.2.4.1 In-vehicle mechanical installation diagram

Figure 3 depicts the installation locations of each hardware device in the private vehicles. Each vehicle will have two DSRC antennas installed, one will be used solely for safety channel and one for control channel. Each car will also have a separate GPS antenna for accurate positioning. The OBUs will be hidden and installed in the trunk of the car and mirror with a speaker up front for the interface with the driver.

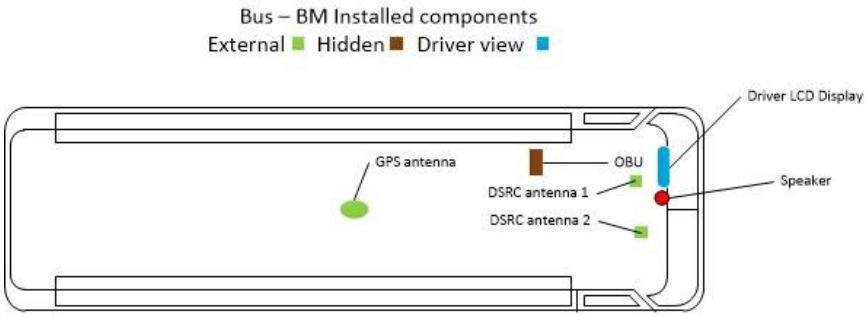
Figure 3 – In vehicle Mechanical Installation Diagram



4.2.4.2 Bus mechanical installation diagram

Figure 4 depicts the installation locations of each hardware device in HART buses. Each bus will also have two DSRC antennas installed, one will be used solely for safety channel and one for control channel. Each bus will also have a separate GPS antenna for accurate positioning. The OBUs will be hidden and installed inside a cabinet onboard the bus and display with a speaker up front for the interface with the driver.

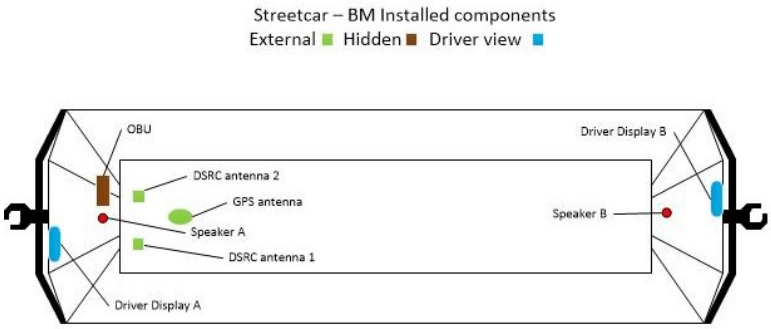
Figure 4 – Bus Mechanical Installation Diagram



4.2.4.3 Streetcar installation diagram

Figure 5 depicts the installation locations of each hardware device in TECO streetcars. Each streetcar will also have two DSRC antennas installed, one will be used solely for safety channel and one for control channel. Each streetcar will also have a separate GPS antenna for accurate positioning. The OBUs will be hidden and installed inside a cabinet onboard the streetcar and display with a speaker up front for the interface with the driver. There will be a second set of display and speaker installed in a the second onboard cabinert for when the streetcar reverses the direction of travel and the driver moves to the other side.

Figure 5 – Streetcar Installation Diagram



4.2.5 Installation Procedures

The sections below illustrate the intended timing and procedural outlook for the two-hour appointment block required for the installation of antennas, on-board units, and rear-view mirrors to the participant's approved vehicle. The participant will, at the time of their appointment, be trained on the usage and intended reactions regarding the equipment and safety messages they will receive. They will also receive and sign an informed consent document regarding their participation in this human use study.

Responsibilities and authorities:

Reception, Booking, Training	Global-5 Communication
Installation, Testing	HCC
Equipment, Support	Brandmotion

4.2.5.1 Pre-Installation Procedures/Checklist

Reception of the Participant
The participant(s) will be greeted at the entrance of the HCC Ybor Campus Training Center by the trainer on duty at the time of their appointment. Signage will be posted to direct participants to drive to the appropriate entrance, where an HCC technician will receive their vehicle, instructing the driver of any needs for access that may be affected by the interior condition of the vehicle. The technician will then drive the participant's vehicle to the appropriate bay, where the custom kit and supplies will be ready for installation prior to the arrival of the vehicle based on the weekly appointment schedule provided to HCC from Global-5.

Vehicle Inspection and Preparations
HCC technicians will inspect the vehicle once in the bay to assure the proper make, model, and trim has been reported by the participant from the application process. Technicians document if any additional features not previously reported via the application process are present on the rear-view mirror, or within the car's programming, specifically if any collision avoidance system is found. The technician brings these items to the attention of the trainer immediately. Participants at that time will be asked if they wish to continue with the CV Pilot in the case of features not being retained by the newly installed rear-view mirror. A document regarding feature loss is also presented and signed by the participant at that time. Collision warning systems will not be accepted, and participants whose vehicles are found during the inspection process to have such a system will not be allowed to continue with the CV pilot.

Informed Consent
Following the inspection, the participant will be shown a brief video regarding their consent as a human-use case study during the duration of the CV pilot, in accordance with NIH regulations. An informed consent document must be signed by the participant prior to the installation process beginning in the bay, and the training courses being given. Once signed, the technicians may begin the installation, and the trainer may begin the coursework with the participant. This informed consent document may be a digital document, stored via tablet. The tablet used will be secured, and locked every night in a secure location at the HCC Ybor Campus Training Center.

Bus and Streetcar installations
For the bus and streetcar installations, HART and Global-5 will provide training to their drivers separately and the informed consent form will be from HART, not individual bus/streetcar drivers like it is for participant vehicles.

4.2.5.1.1 OEM Vehicle Pre-Installation Procedures/Checklist

1. Verify and annotate vehicle make, model year, model version and all unique add-ons not installed by OEM.
2. Identify Rear View Mirror features and annotate.
3. Acquire from HCC stock inventory all matching required vehicle installation components, to include: OBU, wire harnesses, antennas, cables, brackets, antenna location decals, etc.
4. Annotate any vehicle discrepancies, windows and surface marks, and blemishes, scratches, missing OEM equipment, burn marks, general under hood (engine) and any broken interior and exterior items.
5. Start and operate vehicle to annotate all electrical functions operate. To include:
    a. Radio, rear view mirror functions, any vehicle or engine tell-tale lights, fault indicators, wipers, door locks, windows, seats, lights, lighting etc.

4.2.5.1.2 Bus Pre-Installation Procedures/Checklist

1. Verify Bus is in good safe operating condition from HART and is an approved model year version as agreed upon between Brandmotion and HART.
2. Check for any special equipment installed that may impair installation of Brandmotion (BM) Connected Vehicle Pilot (CVP) equipment.
3. Acquire from HART stock inventory all matching required Bus installation components, to include: OBU, wire harnesses, antennas, cables, brackets, and antenna location decals etc.
4. Start and operate vehicle to annotate all electrical functions operate. To include:
    a. Radios, fare collection equipment, any vehicle or engine telltale lights, fault indicators, wipers, lights, lighting etc.
    b. Ensure there is adequate mounting space inside the electronic components box.

4.2.5.1.3 Streetcar Pre-Installation Procedures/Checklist

1. Work with HART Streetcar technician to ensure and verify Streetcar is in good safe operating condition from HART.
2. Check for any special equipment installed that may impair installation of BM CVP equipment.
3. Acquire from HART stock inventory all matching required Streetcar installation components, to include: OBU, wire harnesses, antennas, cables, brackets, antenna location decals etc.
4. Start and operate vehicle to annotate all electrical functions operate. To include:
    a. Radios, fare collection equipment, any vehicle or engine tell-tale lights, fault indicators, wipers, doors, lights, lighting etc.
    b. Ensure there is adequate mounting space inside the recommended OBU location area.

4.2.5.2 Installation Procedures

Once informed consent is given, the installation process may begin in the bay. The technician(s) will remove the existing rear-view mirror, placing the stock part in a container to be returned to the participant. The custom kit, provided by Brandmotion, will then be installed, including the OBU in the trunk or under dash of the vehicle, antenna(s) on the roof of the vehicle, wiring along the frame of the vehicle, and the rear-view mirror with video display along the windshield or ceiling of the vehicle. Following installation, the technician(s) will test the connection between the OBU and a stationary RSU located in the bay, or outside for clear sky reception. The technician will make certain data is received by the RSU, and that safety messages are received by the OBU, and transmitted to the screen in the newly installed rear-view mirror.

Once installation has begun, the participant will be trained in the use cases, warning system, and intended reactions. A series of videos will be shown to the participant, along with visuals for each individual safety message that will be displayed. The participant will also be informed of the control and treatment groupings, but will not be informed as to which set they will placed in during the test phase of the pilot.

The Center for Urban Transportation Research (CUTR) has set up the initial survey online. At the installation appointment, after the participant has signed the Informed Consent Document, the participant is asked to go online and take the survey. Once the survey is complete, training would proceed. The Participant IDs will be linked to the survey.

4.2.5.2.1 Vehicle CVP Equipment Installation Procedures

1. Acquire all necessary CVP equipment from HCC CVP inventory.
2. Verify which OBU system you will be installing (Commsignia, Savari or SiriusXM) and follow the included installation instructions contained in the OBU specific install kit.
3. Vehicle ignition power is off.
4. Install OBU with mounting bracket into trunk or under dash area as necessary for vehicle type. Nuts, bolts included in parts bag supplied. ***Note:*** In some applications Velcro may be utilized.
5. Install the video converter box to the OBU using the supplied cable.
6. Connect OBU wire harnesses to OBU. ***Note:*** All wire leads will cut to length after determining the routing and lengths necessary. Recommend adding extra 20% or more length to allow for future movement if required.
7. Connect all GPIO wires to locations specified in the verified OBU manufacturer Vehicle Interface Wiring Diagram (IWD).
    i. Use supplied splices, tape and connectors supplied in parts bag.
    ii. Wires must be routed and secured to prevent movement and chafing. Allow extra length to prevent any stress on wires or connectors.
8. Route the RCA video cable to the Rear-View Mirror.
9. Mount the Rear-View Mirror into the recommended location using hardware supplied in parts bag.
10. Connect the RCA cable to the Rear-View Mirror. Secure cable. Make sure it is not loose or in view of the operator.
11. Route the audio cable to the Speaker. Be careful not to locate the audio cable next to radio electrical radio wires to prevent electrical audio interference.
12. Mount the Speaker into the recommended location using hardware supplied in parts bag.
13. Connect the audio cable to the Speaker. Secure cable.
14. Connect all power and ground wires onto locations specified in the Vehicle IWD.
15. Locate and apply the 2 DSRC antenna location decals per the locations specified in the “Vehicle DSRC antenna location guide.”
16. Install the two magnets mounted or adhesive mounted DSRC antennas onto the roof covering the locating decals.
    a. Route the DSRC antenna coaxes into the vehicle trunk (or other location for the OBU).
    b. Create a coax “drip loop” just before or in the trunk seal gap (see Figure 6 and Figure 7).

i. ***Note:*** Check for no water leakage with trunk closed.

c. Connect the DRSC antenna coaxes into the appropriate connectors on the OBU.

17. Install the GNSS antenna onto the location specified on the "Vehicle GNSS antenna location guide." Typically, this will be the center top of trunk lid.
    a. Route the GNSS antenna coax as necessary to OBU.
    b. Create a coax "drip loop" just before or in the trunk seal gap (see Figure 6 and Figure 7).
        i. ***Note:*** Check for no water leakage with trunk closed.
    c. Connect the GNSS antenna coax into the appropriate connector on the OBU.
18. Proceed to the Vehicle final checkout procedures.

Figure 6 – Drip Loop in Vehicle

Figure 7 – Drip Loop Example

4.2.5.2.2 Bus CVP Equipment Installation Procedures

1. Acquire all necessary CVP Bus equipment from HART CVP inventory.
2. IMPORTANT: Coordinate with the HART Bus Technician all wire, power, wire routing, bulkheads, feed-throughs etc.
3. Bus ignition power is off.
4. Install OBU with mounting bracket into "equipment box." Nuts, bolts included in parts bag supplied.
5. Connect OBU wire harnesses to OBU. ***Note:*** All wire leads will cut to length after determining the routing and lengths necessary. Recommend adding extra 20% or more length to allow for future movement if required.
6. Connect all GPIO wires to locations specified in the Bus IWD.
    a. Use supplied splices, tape and connectors supplied in parts bag.
    b. Wires must be routed and secured to prevent movement and chafing. Allow extra length to prevent any stress on wires or connectors.
7. Route the HDMI video cable to the LCD display. Be careful not to have any severe bends in the HDMI cable.

8. Mount the HDMI display into the recommended location using hardware supplied in parts bag.
9. Connect the HDMI cable to the display box. Secure cable. Make sure it is not loose or in view of the operator.
10. Route the audio cable to the Speaker. Be careful not to locate the audio cable next to radio electrical radio wires to prevent electrical audio interference.
11. Mount the Speaker into the recommended location using hardware supplied in parts bag.
12. Connect the audio cable to the Speaker. Secure cable.
13. Connect all power and ground wires to locations specified in the Bus IWD.
14. Install the two (2) DSRC antennas onto the locations specified on the "Bus DSRC antenna location guide."
    a. ***Note:*** The HART technician will drill all holes into roof as necessary.
    b. ***Note:*** The HART technician will seal the roof mounted antenna and coax as necessary to prevent water leakage.
    c. Route the DSRC antenna coaxes as necessary avoiding severe bends.
    d. Connect the DRSC antenna coaxes into the appropriate connectors on the OBU.
15. Install the GNSS antenna onto the location specified on the "Bus DSRC antenna location guide."
    a. ***Note:*** The HART technician will drill all holes into roof as necessary.
    b. ***Note:*** The HART technician will seal the roof mounted antenna and coax as necessary to prevent water leakage.
    c. Route the GNSS antenna coax as necessary avoiding severe bends.
    d. Connect the GNSS antenna coax into the appropriate connectors on the OBU.
16. Proceed to the Bus final checkout procedures.

4.2.5.2.3 Streetcar CVP Equipment Installation Procedures

1. Acquire all necessary CVP Streetcar equipment from HART CVP inventory.
2. IMPORTANT**:** Coordinate with the HART Streetcar Technician for wire, power, wire routing, bulkheads, feed-throughs etc.
3. Streetcar ignition power is off.
4. Install OBU with mounting bracket into recommended OBU location (upper right top panel); *Note: The intended primary installation end is the "A" end.* Nuts, bolts included in parts bag supplied.
5. Connect OBU wire harnesses to OBU. ***Note:*** All wire leads will cut to length after determining the routing and lengths necessary. Recommend adding extra 20% or more length to allow for future movement if required.
6. Connect all GPIO wires to locations specified in the Streetcar IWD.
    a. Use supplied splices, tape and connectors supplied in parts bag.
    b. Wires must be routed and secured to prevent movement and chafing. Allow extra length to prevent any stress on wires or connectors.
7. Route the HDMI video cable to the HDMI video splitter.
8. Route the SIDE "A" cable to the Side "A" Streetcar LCD display. Be careful not to have any severe bends in the HDMI cable.
9. Route the second HDMI output cable to side "B" or opposite end of the Streetcar, HDMI Display.
10. Mount the HDMI display into the recommended location using hardware supplied in parts bag.
11. Connect the HDMI cable to the display box. Secure cable. Make sure it is not loose or in view of the operator.
12. Route the audio cable to the Speaker. Be careful not to locate the audio cable next to radio electrical radio wires to prevent electrical audio interference.
13. Mount the Speaker into the recommended location using hardware supplied in parts bag.
14. Connect the audio cable to the Speaker. Secure cable.
15. Repeat 12-14 for opposite end, except speaker cable must be routed from trolley end "A" to end "B.".
16. Connect all power and ground wires to locations specified in the Streetcar IWD.
17. Install the two (2) DSRC antennas onto the locations specified on the "Streetcar DSRC antenna location guide."
    a. ***Note:*** The HART technician will drill all holes into roof as necessary.

b. ***Note:*** The HART technician will seal the roof mounted antenna and coax as necessary to prevent water leakage.
c. Route the DSRC antenna coaxes as necessary avoiding severe bends.
d. Connect the DRSC antenna coaxes into the appropriate connectors on the OBU.

18. Install the GNSS antenna onto the location specified on the "Streetcar DSRC antenna location guide."
    a. ***Note:*** The HART technician will drill all holes into roof as necessary.
    b. ***Note:*** The HART technician will seal the roof mounted antenna and coax as necessary to prevent water leakage.
    c. Route the GNSS antenna coax as necessary avoiding severe bends.
    d. Connect the GNSS antenna coax into the appropriate connectors on the OBU.
19. Proceed to the Streetcar final checkout procedures.

4.2.5.3 Post-Installation Procedures/Checklist/Testing

Following the installation and training session, the participant will be escorted out to the bay, where the technician(s) will assist in the presentation of the safety messages in the participant's vehicle, using the stationary road side unit located in the bay or outside. This testing will act as the final element of the training session for the participant, providing the participant with a real-world view of the safety messages. Once finished, the technician will drive the participant's vehicle back to the entrance of the HCC Ybor Campus Training Center, and the participant may leave.

4.2.5.3.1 Vehicle CVP Equipment Post-Installation Procedures.

1. Turn ignition key on.
2. After 5 seconds observe in the Rear-View Mirror, lower left-hand corner, that you see the green "heart beat" light blinking.
3. Drive vehicle to the HCC back parking lot.
4. Observe that you see the TBD-XXX warning or message displayed in the Rear-View Mirror.
5. Annotate successful completion of vehicle test in HCC Vehicle Installation Log Book.
6. HCC and Brandmotion approved sign-off person must inspect physical work completed and sign "Post Installation" Completed in Log Book
7. Test Complete. Return vehicle to customer.

4.2.5.3.2. Bus CVP Equipment Post-Installation Procedures.

1. Turn ignition key on.
2. After 5 seconds observe in the LCD Display, lower left-hand corner, that you see the green "heart beat" light blinking.
3. Drive Bus to the HART back parking lot.
4. Observe that you see the TBD-XXX warning or message displayed in the LCD Display.
5. Annotate successful completion of vehicle test in HART Bus Installation Log Book.
6. HART and Brandmotion approved sign-off person must inspect physical work completed and sign "Post Installation" Completed in Log Book.
7. Test Complete. Return Bus to service.

4.2.5.3.3 Streetcar CVP Equipment Post-Installation Procedures.

1. ***Note:*** This test must be repeated twice in order to test both Streetcar directions "A" and "B."
2. Turn Trolley ignition power on.
3. After 5 seconds observe in the LCD Display, lower left-hand corner, that you see the green "heart beat" light blinking.
4. If possible, drive Streetcar outside where a test vehicle will be cooperating by transmitting a V2V test signal.
5. Observe that you see the TBD-XXX warning or message displayed in the LCD Display.
6. Annotate successful completion of vehicle test in HART Bus Installation Log Book.
7. HART and Brandmotion approved sign-off person must inspect physical work inspect physical work completed and sign "Post Installation" Completed in Log Book
8. Test Complete. Return Streetcar to service.

4.2.6 Quality Assurance/Quality Control Process

In addition to the tests and installation procedures mentioned in section 4.2.5 of this document, the quality assurance and control process tests are mentioned in section 6 of the OBU COMPSPEC v2.2 document. The equipment suppliers must provide their QA/QCP process to Brandmotion.

4.2.7 Installation Schedule

The schedule in Table 6 below is the installation schedule for participant vehicles, buses, and streetcars.

Table 6 – Installation Schedule

	Planned Component Deliveries to HCC				Installations by HCC/Brandmotion				
Month 2018	**Mirrors, Wiring, Antenna, etc.**	**Comm-signia OBU (250)**	**Sirius XM OBU (100)**	**Savari OBU (1250)**	**Vehicles installed for Partici-pants Target (cumula-tive)**	**Buses/ Streetcars**	**Build Days per week**	**Build Rate/ day (utilization)**	**Weekly Build Target**
March and prior	Delivery to HCC	Initial Delivery to HCC			Friends of the pilot builds and Launch	Initial Builds	1-3	TBD - establish process	TBD - establish process
April	Delivery to HCC	Initial Delivery to HCC	Initial Delivery to HCC	Initial Delivery to HCC	ramp up	Ongoing	4.5	7-10 vehicles (33%)	36
May	Delivery to HCC	NA	Final Delivery to HCC	Periodic Delivery	400	Completion	4.5	22 (90%)	99
June	Delivery to HCC	NA	NA	Periodic Delivery	800	NA	4.5	22 (90%)	99
July	Delivery to HCC	NA	NA	Periodic Delivery	1200	NA	4.5	22 (90%)	99
Aug	Delivery to HCC	Final Delivery to HCC	NA	Final Delivery to HCC	1600	NA	4.5	22 (90%)	99

Note: The chart assumes participants are available for installation and does not account for no shows and no builds

4.2.8 HW and SW Configuration Control Process

The OBUs will come pre-configured from the vendor for the vehicle type they will be installed on. The hardware from the OBU vendors will then be joined with wiring harnesses that match the vehicle type. Final software configuration will be done by the installer with the instructions provided by each OBU supplier. Includes

4.2.9 Sparing Strategy, Warranty and Contingency Plan

Sparing strategy keeps a stock of all parts for timely service. Brandmotion has warranty agreements in place with the OBU suppliers that include Service Level Agreements (SLA), which provide technical support over the life of the pilot. The warrant agreement requires replacement parts for all defects. The contingency plan is for the OBU suppliers to provide onsite technical support if and when needed. The SLA has performance measurement requirements to ensure timely response to problems.

5 Infrastructure/Roadside Equipment

5.1 Roadside Equipment RSU Acquisition Information

5.1.1 Technical Description/Specification

The procured RSU complies with the USDOT RSU Requirements Specification version 4.1, plus the following added features to fulfill the System Requirements:

- Added WiFi hot spot connected to Personal Information Devices for pedestrian and cyclist safety applications
- Two independent radio modules
- Service Console
- Communications to RSU management central software
- Added Bluetooth reader
- Added cellular backhaul for central monitoring and control as well as collection of data, such as vehicle counts and speeds
- High speed, multi-core microprocessor to support multiple V2I applications
- Added non-volatile memory for storage of collected data and map files

5.1.2 Ancillary Equipment

Each RSU is installed with the following ancillary equipment:

- Power over Ethernet Injector
- Two DSRC antennas
- Two LTE antennas
- One WiFi antenna
- One GPS antenna
- One Bluetooth antenna
- Ethernet CAT 6 cable, outdoor rated
- Mounting hardware

5.1.3 Part Numbers and Quantities

This section lists the specific model numbers of the RSUs being acquired, as well as quantities and manufacturer's serial numbers if available for both the main item and ancillary equipment.

Table 7 – RSU Part Numbers and Quantities

Qty	Description	Vendor	Part Number
65	RSU Kit, including: RSU Antennas Cables Mounting hardware RSU software	Siemens	L24707-E100-A7
65	RP100 PoE Injector	Siemens	6GK6010-0A901-1AA0

RSU Usage:
(21) Development staff, testing staff, cyber security penetration testing and replacement spares
(44) Deployment in Tampa

5.1.4 Associated Software

RSU custom built software is included in the RSU Kit:

- DSRC wireless stack including USDOT RSU Spec v4.1 software features (e.g. SNMP)
- Communications to back office
- V2I applications: Infrastructure software objects
    - ERDW
    - WWE
    - MMITSS v1.1
    - PED-SIG
    - PED-X

5.1.5 Acquisition Method

Working back from the required installation date of November 2017, plus considering development and production lead times of 12 to 20 weeks, the acquisition process began in March 2015. The acquisition method is described in Section 2.1.

5.1.6 Potential Vendors

As described in Section 2.1, the RSU procurement process evaluated multiple RSU manufacturers with manufacturing experience both with the USA DSRC standards as well as the EU / UK standards. The evaluation also included advice from manufacturers of the electronic components used in the RSU. A competitive bid resulted in the selection of NXP and Cohda as announced at ITSA World Congress in Bordeaux. That strategic partnership was included in the Siemens USDOT Test Bed Affiliates information sheet.

5.1.7 Acquisition Schedule

The key dates are shown in Figure 1 of the CAP and in section 4.1.7

5.2 Installation Information

5.2.1 Supplier(s)

RSU supplier is Siemens Industry Inc., manufactured by Cohda Wireless.

5.2.2 Inventory Control Method

Inventory control method is described in Section 3.5 above. Procurement and inventory control is accomplished using the Siemens SAP accounting, inventory and manufacturing software used for order entry, material procurement, manufacturing, inventory, shipping and return authorizations of all other Siemens products, such as traffic signal controllers.

5.2.3 Configuration(s)

Baseline RSU configuration:

- Two independent DSRC radio modules with antennas conforming to RSU specification 4.1
- Two WiFi channels with antennas for pedestrians
- One Bluetooth Personal Area Network with antennas
- One GPS receiver with antenna
- One cellular radio with antenna, without SIM card

Cellular Backhaul Configuration:

- Baseline configuration
- Addition of cellular SIM card for the selected service provider

5.2.4 Installation Diagram(s)

The Installation diagrams can be found in the following documentation:

- ESCoS Roadside Unit – WAVE User Manual. Installation Procedures
- ESCoS Roadside Unit – WAVE User Manual. Pre-Installation Procedures/Checklist
- ESCoS Roadside Unit – WAVE User Manual. Installation Procedures
- ESCoS Roadside Unit – WAVE User Manual. Post-Installation Procedures/Checklist
- ESCoS Roadside Unit – WAVE User Manual. Quality Assurance/Quality Control Process

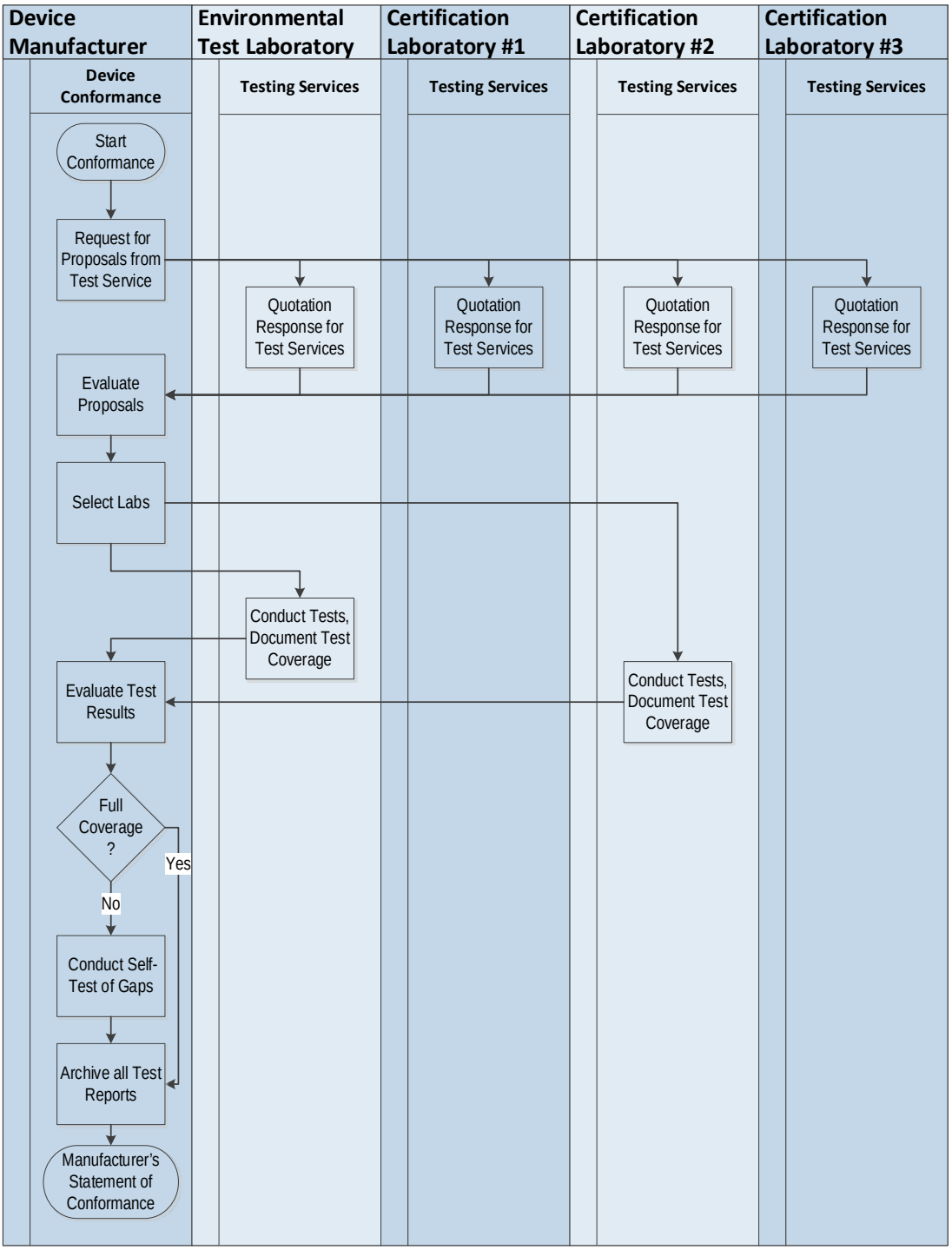
Note: These documents are still under development. The final version number will be updated in the references section.

Quality Assurance Process is depicted in Figure 8 to ensure product conformance.

The Pre-Commercial Phase of 2016 and 2017 is managed by the Certification Operating Council (COC). The COC defines test specifications which have to be met by RSUs. The COC also selected three test labs which offer test certification based on the test specification. As these labs ramp up their certification service during the pre-commercial phase, full test coverage of the COC test specifications may not yet be available. Instead of allowing complete self-certification by manufacturers, this Declaration of Conformity prescribes:

- Environmental certification test by any capable independent laboratory.
- Independent certification by one of the three accredited laboratories to the extent of test coverage available. At this writing the three laboratories are 7-Layers, Danlaw and Southwest Research Institute.
- Self-certification by the manufacturers of any gaps in the test coverage missing from the three accredited laboratories.
- Declaration of Conformity published by the device manufacturers serves in lieu of Certificate of Certification until the commercial accredited laboratories achieve full test coverage.

Figure 8 – Conformance Workflow



Quality Control is managed by Cohda Wireless manufacturing processes.

5.2.5 Installation Schedule

Key schedule dates from Figure 1 of the CAP:

- April 2015: First procurement
- March 2016: First article testing
- October 2016: First production run of 25 units for development, testing and spares
- July 2017: Site surveys for installation
- August 2017: Second production run of 44 units for deployments received
- August 2017: Installation begins
- October 2017: Installation completed

5.2.6 HW and SW Configuration Control Process

- Hardware and software configuration management is described in 3.6 above. Hardware configuration is managed via Engineering Change Orders (ECO)
- Software is developed in Austin Texas using the Siemens CM processes
    - Perforce software archiving
    - Product Evolution Process (PEP)

5.2.7 Sparing Strategy, Warranty and Contingency Plan

Sparing Strategy: A total of 65 RSUs are procured:

- 21 distributed to developers, testers and OBU vendors and retained as spares
- 44 deployed on the within the Pilot area.

Warranty: Throughout project Phase 2 and Phase 3

Contingency:

- RSU software is developed and maintained by Siemens staff in Austin Texas.
- RSU hardware is used on prior CV projects

6 Management Center Equipment

6.1 Master Sever Acquisition Information

6.1.1 Technical Description/Specification

Master server consists of a module installed in a 19" instrument rack that also houses the Transit server and the CUTR server. Master server supports Concert area maps, collection of agency data, collection of OBU BSMs, alerts and warnings, as well as supports the NextConnect communications layer to the various devices

6.1.2 Ancillary Equipment

Ancillary equipment includes hard drive for mass storage and a network switch implementing a VLAN with security firewall.

6.1.3 Part Numbers and Quantities

Siemens has volume procurement contracts in place with multiple suppliers for similar Traffic Management Center equipment. Specific part numbers and quantities will be determined once the data storage requirements are finalized.

6.1.4 Associated Software

Master Server software consists of the Siemens Concert ™ Advanced Transportation Management System, which includes an RSU management module developed and deployed on prior Connected Vehicle projects.

6.1.5 Acquisition Method

Please refer to the CAP for a description of the acquisition method. Included in RSU Management and Back Office Software

6.1.6 Potential Vendors

No vendor can supply a COTS RSU management system that includes area maps, ability to download RSU software updates and aggregate BSMs into vehicle counts and speeds. Siemens is reusing the COTS Concert system developed for EU and UK connected vehicle projects.

6.1.7 Acquisition Schedule

August 2017: Acquisition procurement; Request for Quotes
September 2017: Received by Siemens and shipped to THEA for installation.

6.2 Master Server Installation Information

6.2.1 Supplier(s)

Suppliers will be selected from a list of approved vendors already used in ongoing Siemens ITS central traffic management center projects.

6.2.2 Inventory Control Method

Servers and communications equipment will be procured and shipped directly to THEA for installation per the schedule.

6.2.3 Configuration(s)

Configuration is under design in collaboration with THEA and City of Tampa IT departments and will be added when completed.

6.2.4 Installation Diagram(s)

Installation diagrams are under design in collaboration with THEA and City of Tampa IT departments.

6.2.5 Installation Procedures

6.2.5.1 Pre-Installation Procedures/Checklist

Installation checklists are under design in collaboration with THEA and City of Tampa IT departments and will be added when completed.

6.2.5.2 Installation Procedures

Installation procedures are under design in collaboration with THEA and City of Tampa IT departments and will be added when completed.

6.2.5.3 Post-Installation Procedures/Checklist

Post-installation Procedures/Checklists are under design in collaboration with THEA and City of Tampa IT departments and will be added when completed.

6.2.6 Quality Assurance/Quality Control Process

Quality Assurance/Quality Control Process is under design in collaboration with THEA and City of Tampa IT departments and will be added when completed.

6.2.7 Installation Schedule

September 2017: Begin installation
October 2017: Completion of installation

6.2.8 HW and SW Configuration Control Process

- Hardware and software configuration management is described in 3.6 above. Hardware configuration is managed via ECO
- Software is developed in Austin Texas using the Siemens CM processes
    - Perforce software archiving
    - PEP

6.2.9 Sparing Strategy, Warranty and Contingency Plan

Sparing Strategy: Siemens agreements with IT equipment suppliers for repair and maintenance
Warranty: Throughout project Phase 2 and Phase 3
Contingency Plan: Help desk and existing Siemens agreements with IT equipment suppliers for emergency repair and replacement.

7 Other Equipment

7.1 Pedestrian Detection

Each item that is being acquired, and its' associated components required for full installation and operation, has its' own section with the following sub-sections.

7.1.1 Technical Description/Specification

The procured pedestrian detection system is used to precisely locate pedestrians within and nearby a non-signalized midblock crosswalk. The equipment then converts the location, direction and speed of each pedestrian into an SAE J2735 Personal Safety Message (PSM) which is then sent to a nearby RSU via WiFi. The RSU translates the received PSM through DSRC to approaching vehicles.

7.1.2 Ancillary Equipment

The Pedestrian Detection System includes the following ancillary equipment:

- Two mounting poles
- Outdoor electrical cabinet for VAS Server
- Conduits and power service entrance

7.1.3 Part Numbers and Quantities

Table 8 – Pedestrian Detection Part Numbers and Quantities

Qty	Description	Vendor	Part Number
1	VAS Sever	Metrotech	Unassigned
2	PTZ cameras with routers	Metrotech	Unassigned
2	Mark 5 LiDAR sensors, including Power supply and cables Quanergy Processing Unit (QPN) Linux Ubuntu environment M8 drivers Q-Guard security software Q-View sensor management tool Installation and sensor configuration Q-Guard plug-in visualizer Object list processing	Quanergy	Unassigned

Source – Siemens

7.1.4 Associated Software

COTS software provided by Metrotech is included in the pedestrian detector.

7.1.5 Acquisition Method

Acquisition method is described in Section 2.1 and preceded as follows:

- Requirements specification document provided to potential vendors
- One vendor responded with a proposal without exceptions to the requirements
- All other vendors responded with “no bids” as unable to meet requirements
- Two separate Requirements Reviews were conducted with successful bidder
- Purchase order issued for equipment and software

7.1.6 Potential Vendors

Potential vendors of pedestrian equipment considered:

- Radar:
  - Wavetronics
  - Siemens
- Video:
  - Iteris
  - Econolite
  - Flir
  - Gridsmart
- Lidar:
  - Metrotech
  - Quanergy

7.1.7 Acquisition Schedule

Key procurement milestones:

- October 2016: Request for Proposals
- December 2016: Requirements review with affirmative responder
- June 2017: Second requirements review with successful vendor after project Quality Gate 1
- July 2017: Purchase order to successful vendor

7.1.8 Installation Schedule

Key installation milestones:

- August 2017: WWE radar detector at Twiggs / Meridian
- March 2018: ERDW queue radar detector on REL
- May 2018: PCW lidar pedestrian detector at Hillsborough County Courthouse

8 Bill of Materials (BOM)

8.1 Infrastructure BOM

Table 9 – Infrastructure Bill of Materials

QTY	PN	Vendor	Description
Vehicle Detection:			
1	CLK-201	Wavetronix	Click 201, 1 amp AC to DC Power Converter
1	CLK-200	Wavetronix	Click 200 Surge Protector
1	100-0064	Wavetronix	Misc Mech, hardware, steel, 9" DIN Rail
1	101-0414	Wavetronix	SmartSensor HD Retrofit
1	SS-WARR-3	Wavetronix	SmartSensor 3 year extended warranty
1	SS-611	Wavetronix	SmartSensor Mount
1	SS-708-060	Wavetronix	8 Conductor Cable, 26 pin Connector 60'
Pedestrian Detection:			
1		Metrotech	VAS Server
2		Metrotech	PTZ cameras w routers
2		Quanergy	Mark 8 LiDAR Sensors, including:
			Power supply and cables
			Quanergy Processing Unit (QPU)
			Linux Ubuntu environment
			M8 Drivers
			Q-Guard Security Software
			Q-View Sensor Management Tool
			Installation and Sensor Configuration
			Q-Guard Plug-In Visualizer
			Object List Processing
Wrong Way Vehicle Detection Equipment:			
1	TC-CK1-SBC	MsSedco	Detector
2	TCIB 4.1	MsSedco	4 Channel Card
1	SS-SBC120	MsSedco	SkyBracket Sedco Mounting Bracket
Connected Vehicle Roadside Equipment:			
65	L22707-E100-A7	Siemens	RSU Kit
65	RP100	Siemens	PoE Injector
Management Center Equipment:			
1	TBD	TBD	Server
1	TBD	TBD	Communications Equipment

8.2 Vehicle Systems BOM

Table 10 – In Vehicle Systems Bill of Materials

Brandmotion Part Number	Industry Part Number	Supplier	Description	Design and Release Engr.	Purchasing	Test Engr.	Design Status		Acquisition Status		Production Delivery			Memo: Vehicle Launch	PO #	Accural Date	Payment Week (Date)
							Design Release	ADS Requirement	Acquisition Status	ADS Requirement	Production Site	Production Units	ADS Requirement				
OBUC-0001	TBD	Comm-signia	Comm-signia On-Board Units - Cars	Rafa l l.	Kirthi D.	Bob K.	Specification	08/19/21	PO sent and approved	10/14/21	Hillsborough Community College	250	10/14/21	10/24/21	reissue by 2/15/18	TBD	5 (2/2/2018)
OBUC-0002	TBD	Sirius XM	SiriusXM On Board Units - Cars	Rafa l l.		Bob K.	Specification	08/19/21	PO sent and approved, need contract		Hillsborough Community College	80	10/14/21	11/03/21	reissue by 2/15/18	10/24/2021	5 (2/2/2018)
OBUC-0003	TBD	Savari	Savari On Board Units - Cars	Rafa l l.		Bob K.	Specification	08/19/21	Contract Signed, PO sent		Hillsborough Community College	1250	12/16/2021	01/13/22	Draft issued 8/11, final to be issued by 9/12	12/20/2021	5 (2/2/2018)
OBUB-0001	TBD	Savari	Savari On Board Units - Buses	Rafa l l.		Bob K.	Specification	08/19/21	Contract Signed		Hillsborough Community College	10	12/16/2021	01/13/22	reissue by 2/15/18	1/9/2022	5 (2/2/2018)
OBUB-0002	TBD	Savari	Savari On Board Units - Streetcars	Rafa l l.		Bob K.	Specification	08/19/21	Contract Signed		Hillsborough Commu	10	12/16/2021	01/13/22	reissue by	1/9/2022	5 (2/2/2018)

Brandmotion Part Number	Industry Part Number		Supplier	Description	Design and Release Engr.	Purchasing	Test Engr.	Design Status		Acquisition Status		Production Delivery			Memo: Vehicle Launch	PO #	Accural Date	Payment Week (Date)
								Design Release	ADS Requirement	Acquisition Status	ADS Requirement	Production Site	Production Units	ADS Requirement				
												nity College				2/15/18		
Service Contract	TBD		Hillsborough Community College	Hillsborough Community College	Dave Mc.		Bob K.	SOW	08/19/21	Contract signed		Hillsborough Community College	1580	10/14/2021	10/24/21	reissue by 2/15/18	10/24/2021	43 (11/23/2017)
FLTW-7690 FLTW-7691 FLTW-7693 FLTW-7695 FLTW-7696 FLTW-7720 FLTW-7730	N/A		Germidaka Global Media	Rear-View Mirror with integrated display and speaker - Cars	Rafal I.		Bob K.	Specification	08/19/21	Payment sent. First two mirrors in production, awaiting samples of last two.		Hillsborough Community College	1500	10/14/21	11/03/21	reissue by 2/15/18	10/24/2021	5 (2/2/2018)
ODVD-0001	TBD		Evervoix	On Dash Video Displays - Buses/Streetcars	Kirthi		Bob K.	Specification	08/19/21	Jimmy placed order	10/14/21	Hillsborough Community College	20	10/14/21	11/03/21	reissue by 2/15/18	10/24/2021	5 (2/2/2018)
TBD (custom-made)	N/A		Newtech 3	Wiring Harnesses	Bob. K.		James Mc	Design Assumptions/NDA	08/19/21	PO sent and acknowledged.	10/14/21	Brandmotion	1500	09/23/21	11/03/21	reissue by 2/15/18	10/24/2021	5 (2/2/2018)
Sedans																		
Harada	*Primary:* DEN-HA-	*Secondary:* DEN-HA-	Harada	Antenna DSRC	Bob. K.		Bob K.	Design Assumptions/NDA	08/19/21	Antennas are delivered on a rolling basis.	10/14/21	Hillsborough Community College	1520	10/14/21	11/03/21	RVMH-D845N	10/24/2021	5 (2/2/2018)

Brandmotion Part Number	Industry Part Number		Supplier	Description	Design and Release Engr.	Purchasing	Test Engr.	Design Status		Acquisition Status		Production Delivery			Memo: Vehicle Launch	PO #	Accural Date	Payment Week (Date)
								Design Release	ADS Requirement	Acquisition Status	ADS Requirement	Production Site	Production Units	ADS Requirement				
	001-002-GEN2	003-002-GEN2																
Harada	DEN-GN-001-002-GEN2		Harada	Antenna GNSS														
SUV/Van																		
Harada	*Primary:* DEN-HA-001-002-GEN2	*Secondary:* DEN-HA-003-002-GEN2	Harada	Antenna DSRC														
Harada	COM-HA-001-002-GEN2		Harada	Antenna GNSS														
ADAP-0001	TBD		Dhgate	HDMI/NTSC Converters	Kirthi		Bob K.	Specification	08/19/21	Arrived at HCC.	10/14/21	Hillsborough Community College	1600	10/14/21	11/03/21	reissue by 2/15/18	10/16/2021	44 (11/30/2017)
Brandmotion Part Number			Internal (Brandmotion)	Kit costs (instructions, shipping, etc.)														
Multiple Part numbers based on vehicle type	N/A		American Terminal Supply	Mounting hardware/ brackets	James Mc		Bob K.	Design Assumptions/NDA	08/19/21	Screws/tape/decal has arrived.	10/14/21	Hillsborough Community College	1600	10/14/21	11/03/21	reissue by 2/15/18	10/11/2021	43 (11/23/2017)
			Realjoy							Cable is in production						reissue by		43 (11/23/2017)

Brandmotion Part Number	Industry Part Number		Supplier	Description	Design and Release Engr.	Purchasing	Test Engr.	Design Status		Acquisition Status		Production Delivery			Memo: Vehicle Launch	PO #	Accural Date	Payment Week (Date)
								Design Release	ADS Requirement	Acquisition Status	ADS Requirement	Production Site	Production Units	ADS Requirement				
																2/15/18		
CANDEC-0001	N/A		Automotive Technical Solutions	CAN Decoder	Rafal I.		Rafal I.	Design Assumptions/NDA	08/19/21	PO Placed, expected arrival: 10/15/2017	10/16/2021	Hillsborough Community College	250	10/16/2021	11/3/2021	RVMH-D957N	10/16/2021	42 (11/15/2017)

Legend: Green indicates task complete

Yellow indicates task to be completed, minor issues

Red indicates task not complete and major issues need to be resolved`

9 Glossary

Term	Definition
Agreement Officer (AO)	The FHWA representative responsible for administering the agreement under which the grant funding is/was provided
Agreement Officer Representative (AOR)	The Agreement Officer's representative who provides the ongoing oversight of the Pilot ensuring both technical excellence and administrative compliance
COTS	Commercial-Off-the-Shelf
CUTR	Center for Urban Transportation Research - University of South Florida
HART	Hillsborough Area Regional Transit Authority
HMI	Human Machine Interface or User Interface
Onboard Unit (OBU)	The DSRC Radio and ancillary devices installed in vehicles which support V2V, V2I and V2X applications.
Partner	A stakeholder who has interest or limited participation in pilot without contractual relationship to THEA
Roadside Equipment	All equipment required to support the installation and operation of a Roadside Unit (RSU), inclusive of the RSU
Roadside Unit (RSU)	The DSRC Radio and ancillary devices installed at roadside infrastructure which support V2I and facilitate V2X applications.
SLA	Service-Level-Agreement, contract with the a service provider (supplier) that defines the service (versus products) and quality of service expected.
SOW	Statement-of-Work, a document to define the suppliers and other roles, deliverables and timing
Team Member	Technical or agency partner whose involvement with the pilot is based on contractual relationship with THEA
Vehicle/In-vehicle equipment	All equipment required to support the installation and operation of Onboard Units (OBU), inclusive of the OBU
Vendor	Supplier who is under contract with THEA or its Team Members to provide material, devices, or services to the Team member in support of the Pilot.

10 References

This section identifies references to other documentation used to create this document.

1. Application development Schedule August 2017
2. On Board Unit (OBU) COMPONENT SPECIFICATION, OBU_COMPSPEC_BM_THEA v2.2 August 2017
3. Connected Vehicle Pilot Deployment Program Phase 1 Comprehensive Deployment Plan- Tampa (THEA) August 2016
4. Connected Vehicle Pilot Deployment Program Phase 1 Human Use Approval Summary- Tampa July 2016
5. Connected Vehicle Pilot Deployment Program Phase 2 Comprehensive Acquisition Plan Draft August 2017
6. Connected Vehicle Pilot Deployment Program Phase 2 System Architecture Document August 2017
7. Connected Vehicle Pilot Deployment Program Phase 2 System Design Document August 2017
8. ESCoS Roadside Unit – WAVE User Manual. Installation Procedures; latest
9. ESCoS Roadside Unit – WAVE User Manual. Pre-Installation Procedures/Checklist; latest
10. ESCoS Roadside Unit – WAVE User Manual. Installation Procedures; latest
11. ESCoS Roadside Unit – WAVE User Manual. Post-Installation Procedures/Checklist latest
12. ESCoS Roadside Unit – WAVE User Manual. Quality Assurance/Quality Control Process; latest
13. USDOT RSU Specification 4.0
14. USDOT RSU Specification 4.1

11 Acronyms

Acronym	Definition
AO	Agreement Officer
AOR	Agreement Officer Representative
BM	Brandmotion
BOM	Bill of Materials
CAP	Comprehensive Acquisition Plan
CDP	Comprehensive Deployment Plan
CIP	Comprehensive Installation Plan
CM	Configuration Management
COTS	Commercial-Off-the-Shelf
CUTR	Center of Urban Transportation Research – University of South Florida
CV	Connected Vehicle
CVP	Connected Vehicle Pilot
DSRC	Dedicated Short Range Communications
ECO	Engineering Change Order
EU	Europe
GNSS	Global Navigation Satellite System
GPIO	General Purpose Input Output
GPS	Global Positioning System
GYR	Green/Yellow/Red
HART	Hillsborough Area Regional Transit
HCC	Hillsborough Community College
HMI	Human Machine Interface or User Interface
ICM	Inventory Control Method
IWD	Interface Wiring Diagram
OBU	Onboard Unit
PEP	Product Evolution Process
PID	Personal Information Device
PoE	Power over Ethernet
QPU	Quanergy Processing Unit
REL	Reversible Express Lanes
RMA	Return Material Authorization
RSU	Roadside Unit
SAD	System Architecture Document
SDD	System Design Document
SLA	Service-Level-Agreement
SOW	Statement-of-Work
SPaT	Signal Timing and Phasing
THEA	Tampa Hillsborough Expressway Authority
UK	United Kingdom
USA	United States of America
USDOT	United States Department of Transportation
VAS	Virtual Application Server
WBS	Work Breakdown Structure

Appendix

Comprehensive Acquisition Plan

Contents

List of Figures

List of Figures

1 Introduction

The Comprehensive Acquisition Plan (CAP) provides information on the policies, plans and processes to be used to procure the equipment, software and services to support the Tampa Hillsborough Expressway Authority (THEA) Connected Vehicle (CV) Pilot Deployment. In addition to documenting the procurement plans, it will serve as a baseline management tool for process improvement, lessons learned and financial performance. While individual partner procurement details may be sensitive, a blended reporting system is intended such that future CV deployers may benefit from their review.

As noted in the cooperative agreement general terms and conditions (paragraph 21), the Recipient must submit annual property report using the form SF-428 – Tangible Personal Property Report. However, the Tampa (THEA) Pilot has utilized firm fixed pricing model for its system development and deployment, there is no equipment to be reported separately from those costs. The Agreement Officer Representative (AOR) has agreed that these forms will not be required of the Tampa (THEA) Pilot under this set of procurement circumstances. But the THEA team will work cooperatively within the team and vendors to provide meaningful breakouts of costs that might be used to extrapolate future deployment budgetary insight.

1.1 Purpose of the Plan

This document describes acquisition policies and procedures for the THEA CV Pilot. It serves as a resource to the THEA team for guidance and management of the procurement process. It is also intended as a resource for others interested in early deployment of CV Technologies. Finally, it is intended to provide a documentation framework and validation tool for USDOT as the sponsor.

1.2 Organization of the Plan

The CAP is organized into the following sections:

- Section 1 Introduction
- Section 2 Acquisition Overview
- Section 3 Vehicle/In-vehicle Equipment
- Section 4 Roadside Equipment
- Section 5 Mobile Devices
- Section 6 Management Center Equipment
- Section 7 Other Equipment
- Section 8 Acronyms & Glossary
- Section 9 References

2 Acquisition Overview

2.1 Acquisition Approach

2.1.1 Infrastructure and Back Office Equipment Acquisition

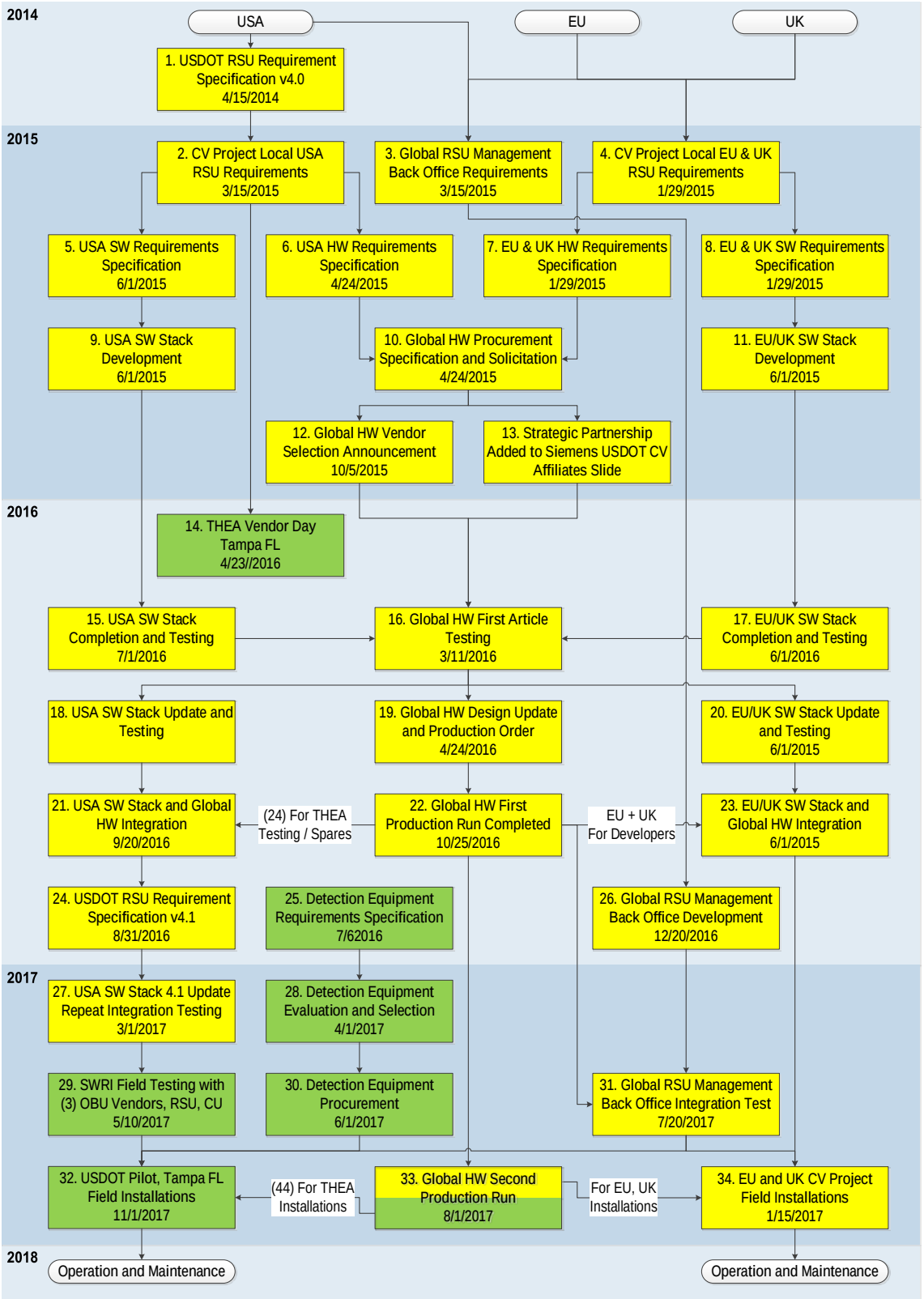
The THEA acquisition process for infrastructure and back office roadside unit (RSU) management is a continuation of a ten-year workflow beginning with the USDOT CV Pilot in Oakland County MI in 2007, through the USDOT Safety Pilot in Ann Arbor MI, plus the Vienna to Rotterdam corridor in the European Union (EU) and the Compass 4D project in the United Kingdom (UK). In each, Siemens provided signal controllers and software. In the USA, Siemens interfaced with Savari, Arada and Kapsch RSUs. In the UK and EU, Siemens provided the RSUs.

In 2013 Siemens and THEA signed the USDOT Test Bed Affiliates agreement and shortly thereafter began collaboration on the use of CV technology to solve existing safety issues in Tampa FL, including project planning for a small CV project funded by THEA. Those project requirements, along with requirements for similar CV projects in the EU and UK were used in the procurement process depicted in Figure 1. Activities highlighted in yellow are funded outside of the THEA project using internal R&D funding or funding from other global CV projects. Activities highlighted in green are funded by the THEA pilot project. Flow chart symbol numbering corresponds to descriptions below:

1. USDOT issues the RSU Requirements Specification, version 4.0 (v4.0) based on lessons learned in the prior test beds.
2. USA RSU Requirements Specification document based on v4.0, plus added requirements for THEA, including WiFi for pedestrian and cyclist safety, cellular backhaul to collect data, Bluetooth reader for travel times, high-speed multiple core processor to run multiple applications, plus added memory to collect data and to store multiple MAP files.
3. RSU management and back office requirements from USA, EU and UK.
4. EU and UK RSU requirements
5. USA software requirements for RSU version using the DSRC WAVE communications extracted as a separate document.
6. USA hardware requirements extracted as a separate document, based on v4.0 plus WiFi, Bluetooth, cellular, processing speed and memory capacity.
7. EU and UK hardware requirements
8. EU and UK software requirements based on EU and UK wireless standards
9. Development of USA RSU software
10. Procurement document for common RSU hardware based on combined USA, EU and UK requirements issued to RSU manufacturers for competitive bid.
11. Development of EU/UK RSU software
12. Announcement at ITSA World Congress, Bordeaux of strategic partnership among Siemens, Cohda and NXP Live demonstration conducted using a Honda test vehicle, Cohda RSU and OBU, Cohda OBU applications and Siemens RSU applications. These existing applications were matched to the THEA Use Cases and Study Areas for the USDOT Pilot.
13. Cohda and NXP added to the Strategic Partnership entry of the Siemens Affiliated Test Bed informational slide

14. THEA vendor day in Tampa FL. Multiple RSU and OBU manufacturers demonstrated their equipment. Based on the feature sets and verbal prices stated, decision to continue with the RSU designed to THEA requirements manufactured by Cohda instead of starting over with another RSU manufacturer.
15. USA RSU software completed for v4.0 plus the added THEA requirements.
16. Cohda delivers first article RSUs for integration test with the USA RSU software and EU/UK RSU software. Integration testing is completed for each.
17. EU/UK RSU software is completed.
18. USA RSU software is updated based on integration testing with first article RSU hardware.
19. Hardware design update completed based on integration and environmental testing
20. EU/UK RSU software is updated based on integration testing with RSU hardware
21. Final USA software is integrated with first production run of RSU hardware
22. RSU hardware first production run completed. (25) units delivered to THEA project for developers, testers, security scans and spares.
23. Final EU/UK software is integrated into first production run hardware
24. USDOT issues v4.1 RSU Requirements Specification that does not affect hardware, but requires software update and repeat of integration testing in the USA.
25. Requirements specification issued for pedestrian detection and vehicle detection equipment.
26. RSU Back Office and RSU Management development for USA, EU and UK requirements
27. USA RSU software update and repeat of integration testing to v4.1
28. Detection equipment cost quotes received and evaluated, including Lidar, radar and video.
29. Successful field test at Southwest Research Institute (SwRI). Included controller unit sending signal countdown to RSU. RSU created SPaT, MAP and TIM messages to three OBU vendor vehicles. Vehicles send BSM to RSU over complete 780 meter track distance.
30. Detection equipment procurement for vehicles and pedestrians.
31. RSU Management and Back Office integration test and subsystem test with RSUs
32. USDOT Pilot installations in Tampa FL
33. Second production run of RSUs, including 44 units for field installation in Tampa FL
34. EU and UK RSU field installations, using EU/UK RSU software.

Figure 9: Infrastructure and Back Office Equipment Acquisition Flowchart



Source- Siemens

2.2 Acquisition Schedule

2.2.1 Infrastructure and Back Office Acquisition Schedule

2.2.1.1 Infrastructure Acquisition Schedule

- April 2014: USDOT RSU Requirements Specification version 4.0
- March 2015: RSU Pedestrian, cyclist, Bluetooth, cellular and performance requirements
- March 2015: RSU Management and Back Office requirements
- April 2015: RSU Hardware Requirements Specification
- April 2015: RSU procurement solicitation
- June 2015: RSU Software Requirements Specification
- October 2015: RSU vendor selected and announced. First article purchase order
- April 2016: THEA project vendor days
- March 2016: RSU First Article received
- April 2016: RSU qualification and environmental testing
- July 2016: Detection equipment requirements specification
- September 2016: RSU software completed and integration testing
- March 2017: RSU software updated to RSU Requirements specification v4.1
- April 2017: Detection equipment evaluation and vendor selection
- May 2017: Repeat integration testing to RSU Requirements specification v4.1
- June 2017: Detection equipment procurement
- July 2017: RSU Management and Back Office Integration
- August 2017: Receive RSU second production run
- September 2017: RSU Management and Back Office installation
- November 2017: RSU and detection equipment Installation
- February 2018: Complete end-to-end validation testing, begin operation and maintenance

2.3 Vendor Outreach Plan

2.3.1 Infrastructure and Back Office Vendor Outreach Plan

Vendor outreach includes:

- April 2015: RSU procurement solicitation
- October 2015: RSU vendor selection, public announcement and first article purchase order issued
- April 2016: Conducted vendor demonstration week for OBU and RSU manufacturers as well as suppliers of software development and test tool suppliers.
- May 2016: Public demonstration at technical conference in live traffic in Austin TX
- November 2016: Public demonstration at Florida AV/CV summit in Tampa FL
- December 2016: Request for Information, pedestrian and vehicle detection equipment cost quotes
- November 2016: Demonstrations at vendor facilities
- November 2016: Attended USDOT Plug Fests for interoperability testing
- May 2017: USDOT Plug Fes, Field tests at SwRI with 3 OBU manufacturers and controller unit

- May 2017: First of five testing workflow project Quality Gates that allow adjustments to the requirements that do not impact fulfillment of User Needs
- July 2017: Procurement of vehicle and pedestrian detection equipment

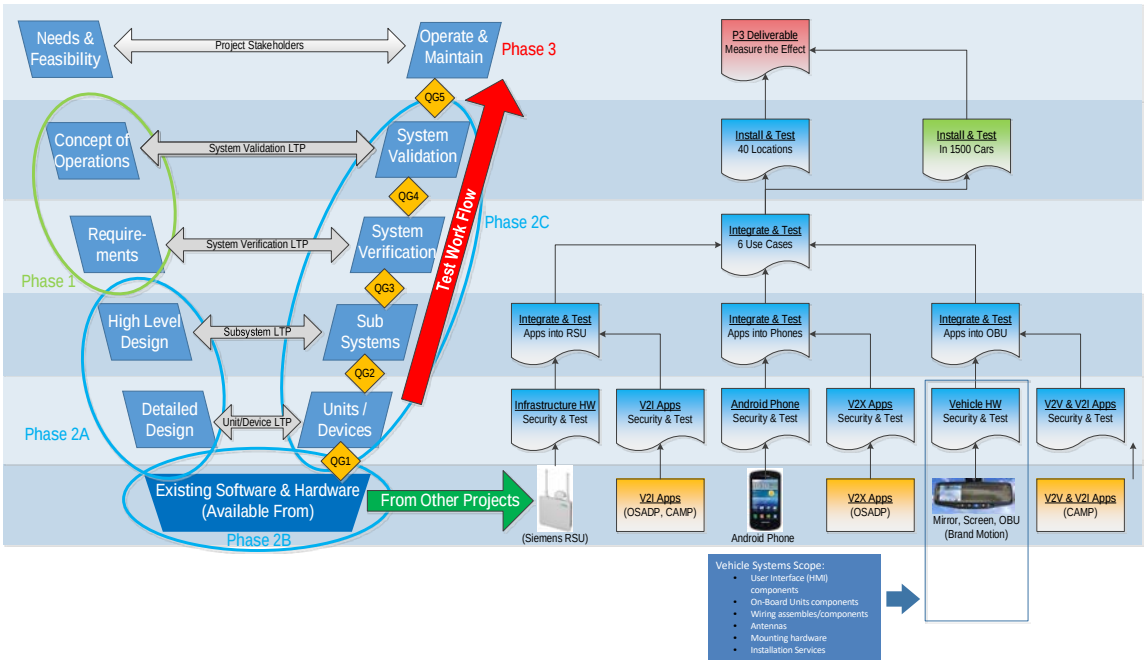
3 Vehicle/In-Vehicle Equipment

On September 1, 2016, the United States Department of Transportation (USDOT) initiated Phase II of the Connected Vehicle (CV) Deployment Pilot. The Tampa Hillsborough Expressway Authority (THEA) under USDOT cooperative agreement, DTFH6116H00025 defined the work plan and deliverables with several Vehicle System key tasks/services assigned to Brandmotion LLC as follows:

"On-board unit systems equipment, applications, integration and testing services as described in the U.S. Department of Transportation Cooperative Agreement Number DTFH6116H00025 "Connected Vehicle (CV) Pilot Deployment Program - Phase 2 and 3."

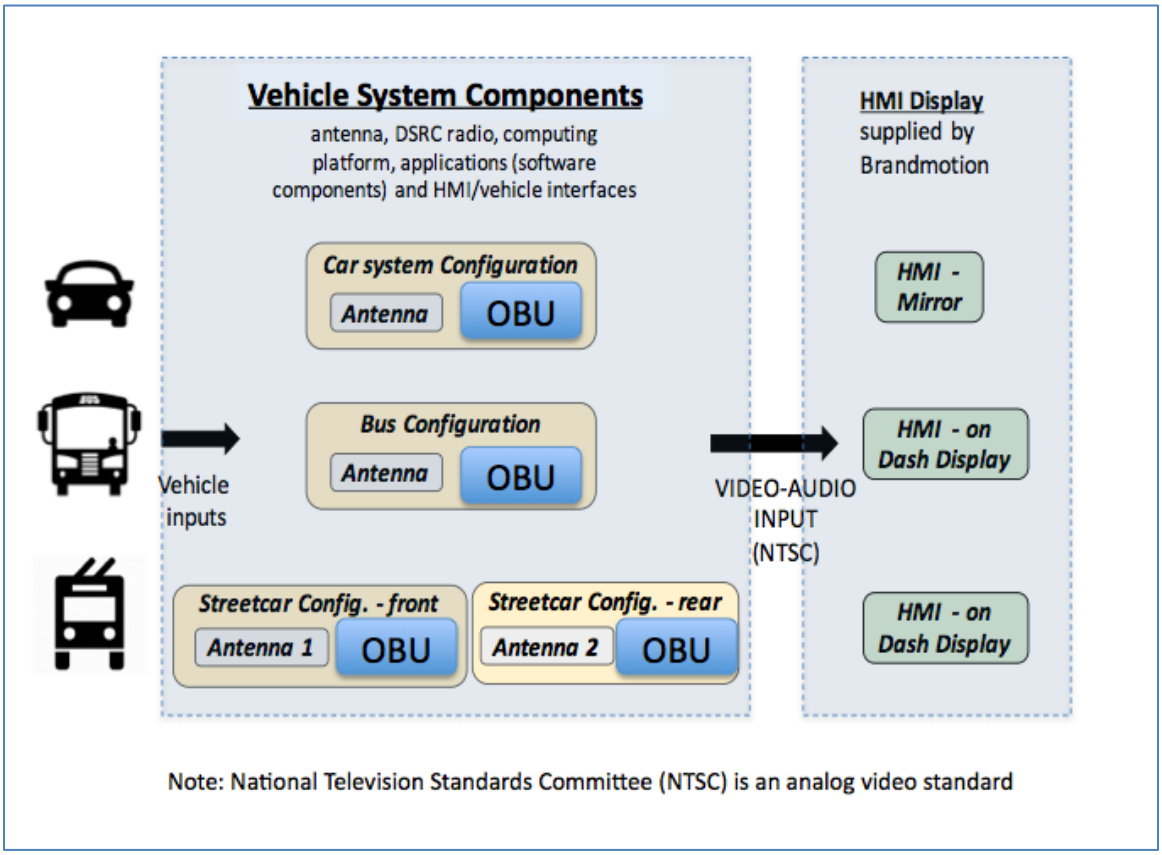
As described in Section 1.4.1 (Architecture Evaluations) of the Tampa CV Pilot System Architecture Document (SAD) and shown in Figure 2, Brandmotion is following the System Engineering process to design, acquire and test systems/components for which they have responsibility under the cooperative agreement.

Figure 10: Vehicle System within Project Lifecycle



Vehicle system alternatives were evaluated as described in the System Architecture Document (SAD) which resulted in the Vehicle System design in Figure 3.

Figure 11: Vehicle System Block Diagram



Source: Brandmotion

The key components and services requiring an acquisition plan are described in this document and can be summarized as:

- Human Machine Interface (HMI) components (cars, buses and streetcars)
- On-Board Units components (multiple suppliers)
- Wiring assembles/components (Brandmotion and supplier sourced)
- Antennas (multiple suppliers)
- Mounting hardware
- Installation Services

3.1 OBU Acquisition Schedule and Vendor Outreach Approach

The following process flow details the acquisition process used by Brandmotion in this project that includes the key steps of engineering design, supplier selection, sourcing and testing, and process improvement.

1) **Create Product Design Assumptions, completed Phase 1 by Brandmotion with THEA team input**
   a) Authority to proceed and/or business case
      i) targets – performance, quality, timing and affordability
   b) Product concept and key functional requirements
      i) core engineering with marketing support
2) **Initiate Request for Proposal as needed, completed Phase 1 by Brandmotion with THEA team input**
   a) Identify potential partners/suppliers and specific targets
   b) Partner/suppliers proposals
      i) Core entry provide directional specification
      ii) Marketing provide wants/needs
   c) Refine design assumptions with supplier input
3) **Required Request for Quotation to evaluate partners/suppliers, completed December 2016 by Brandmotion with THEA team input and review**
   a) Commercial/Legal requirements
      i) Business aspects/volumes
      ii) Selection criteria
   b) Program requirements (timing)
      i) Customer input
   c) Technical Requirements/Specification
      i) Core engineering with Marketing Support
4) **Supplier Selection, completed January 2017 by Brandmotion with THEA team input**
   a) Program musts (requirements) shall be met (Red/Green)
   b) Program wants forced ranged and weighted
   c) Evaluation matrix with sourcing team assessment, client input
   d) Appropriate feedback to non-selected suppliers
5) **Finalize Specifications, and Statement of Work (SOW) with Program Timing, completed July 2017 by Brandmotion with THEA team input**
   a) Collaborative supplier involvement
   b) Non-disclosure agreement
6) **Sourcing commitment, intent outsource completed by Brandmotion with THEA team input.**
   a) Sourcing letter or Memorandum of Understanding (MOU) to align agreement to program targets

7) Program Execution, completed August 2017

a) Contracts
   i) Terms and conditions – reflect client requirements
   ii) Service Level Agreement to address technical support and other associated services
   iii) SOW to define supplier, client and Brandmotion roles and timing for development/verification

b) Development program
   i) Program managers selected
   ii) Design reviews monthly with biweekly telecons
   iii) Shared document process
   iv) Verification testing

c) Product/service delivery
   i) Purchase Order
   ii) Validation
   iii) Technical support

8) Post Program, Phase III

a) Continuous Improvement
   i) Target improvement
   ii) Lessons learned
   iii) Supplier assessment/feedback

The Brandmotion Supplier Policy, updated May 2017, guides the acquisition of the vehicle system components, and is available upon request, as follows (an excerpt):

Purpose:

1. Brandmotion's *Supplier Policy* summarizes our commitments to ethical business practices and compliance with national laws and internationally recognized standards, while considering our own internal policies and regulations.
2. The *Supplier Policy* is a foundation for Brandmotion's employees and associates working responsibly with suppliers. It is the basis for establishing a sustainable supply chain.
3. The *Supplier Policy* ensures working collaboratively with suppliers to align with Brandmotion's *Business Principles,* or adopt similar principles, and fosters the establishment of stable and mutually beneficial relationships with our suppliers.
4. The *Supplier Policy* provides every stakeholder – suppliers, customers, employees and partners – a clear understanding of our expectations and activities and explains our *Business Principles*.

Scope:

1. It is the responsibility of senior level management involved in sourcing, purchasing, finance, accounting and quality to set the *Business Principles* established herein the *Supplier Policy* and oversee compliance.
2. It is the responsibility of Brandmotion's employees exposed to dealing with suppliers to adhere to the *Supplier Policy*.
3. All suppliers working with Brandmotion will be required to comply with Brandmotion's *Supplier Policy*.
4. The Supplier Policy applies to all purchase of product and services for Brandmotion, regardless of its operations and geography.

Other key aspects of the Brandmotion *Supplier Policy* include customer focus, quality assurance, supplier privacy and compliance and supplier requirements to address governance, conflict of interest, anti-corruption, adherence to applicable government regulations and quality record retention.

3.2 Technical Description/Specification

The SAD describes in detail the Vehicle Systems and a brief description of the key requirements summarized as follows:

1. On-board Unit (OBU) with applications and interface to the Human Machine Interface (HMI) supplied by Brandmotion
2. User interfaces (HMI)
3. GPS and Dedicated Short Range Antennas.
4. Vehicle harnesses
5. Documentation, participant training and technical support
6. Installation services and test

On-Board units as supplied by the three sourced suppliers Commsignia, SiriusXM and Savari to a common OBU Specification to be released by August 7, 2017 and to meet the requirements as detailed below:

3.3 Brandmotion Procured Services

Brandmotion will execute a contract and a service level agreement with the Hillsborough Community College for the installation of Brandmotion supplied components, as described in the next section, in participant vehicles per a schedule developed in conjunction with Global-5.

3.4 Vehicle System Components

The vehicle system components will be configured by Brandmotion supervised technicians and Installers to fit the specific vehicles as identified and scheduled by Global-5. The participants will undergo training and other activities as the systems are installed in their vehicles at the Hillsborough Community College facilities. Table 1 is the required component acquisition plan matrix that details part numbers, design purchasing, testing and delivery status.

3.5 Associated Software

The application software for the THEA applications are listed in the SAD and are part of the OBU purchase. A license for use of the software for the THEA pilot is addressed in the OBU purchasing contract.

3.6 Acquisition Method

Brandmotion will acquire and assemble all vehicle system related components as a kit, that is all necessary components assembled/packaged together, for the installers at HCC. Global 5 will identify the participant's specific vehicle and schedule for installation, so that Brandmotion can provide the correct vehicle kit to be installed during the participant's visit to HCC.

3.7 Supplier identification, evaluation and sourcing

The current status for identifying, evaluating and sourcing suppliers is described in Table 1.

3.8 Acquisition Schedule

The acquisition schedule based on the required Application Development Schedule is shown in Table 1.

Table 11 – OBU Component Acquisition Plan Matrix

Acquisition Readiness	Brandmotion Part Number	Industry Part Number	Description	Design and Release Engr.	Purchasing	Test Engr.	Design Status		Acquisition Status		Production Delivery			Memo: Vehicle Launch
							Design Release	ADS Requirement	Acquisition Status	ADS Requirement	Production Site	Production Units	ADS Requirement	
Yellow-development	OBUC-0001	TBD	Commsignia On Board Units - Cars	Rafal L	Kirthi D.	Bob K.	Specification	06/05/17	Contract Draft	07/17/17	Community College	250	10/03/17	11/02/17
Yellow-development	OBUC-0002	TBD	SiriusXM On Board Units - Cars	Rafal L	Kirthi D.	Bob K.	Specification	06/05/17	Contract Draft	07/17/17	Hillsborough Community	80	10/03/17	11/02/17
Yellow-development	OBUC-0003	TBD	Savari On Board Units - Cars	Rafal L	Kirthi D.	Bob K.	Specification	06/05/17	Contract Draft	07/17/17	Hillsborough Community	1250	12/15/17	01/12/18
Yellow-development	OBUB-0001	TBD	Savari On Board Units - Buses	Rafal L	Kirthi D.	Bob K.	Specification	06/05/17	Contract Draft	07/17/17	Hillsborough Community	10	12/15/17	01/12/18
Yellow-development	OBUB-0002	TBD	Savari On Board Units - Streetcars	Rafal L	Kirthi D.	Bob K.	Specification	06/05/17	Contract Draft	07/17/17	Hillsborough Community	10	12/15/17	01/12/18
Yellow-development	FLTW-7690 FLTW-7691 FLTW-7693 FLTW-7695 FLTW-7696 FLTW-7720 FLTW-7730	N/A	Rear-View Mirror with integrated display and speaker - Cars	John K.	Kirthi D.	Bob K.	Specification	08/18/17	Contract Draft	09/17/17	Hillsborough Community College	1500	10/03/17	11/02/17
Yellow-development	ODVD- 0001	TBD	On Dash Video Displays - Buses/Streetcars	John K.	Kirthi D.	Bob K.	Specification	08/18/17	Contract Draft	07/17/17	Hillsborough Community College	20	10/03/17	11/02/17
Yellow-development	TBD (custom-made)	N/A	Wiring Harnesses	Bob. K.	Kirthi D.	James Mc	Design Assumptions/N	08/18/17	Internal Sourced	09/17/17	Brandmotion	1500	09/22/17	11/02/17
Yellow-development	TBD	TBD	Antenna DSRC	Bob. K.	Kirthi D.	Bob K.	Design Assumptions/N DA	08/18/17	RFQ	09/17/17	Hillsborough Community College	1520	10/03/17	11/02/17
Yellow-development	TBD	TBD	Antenna GNSS	Bob. K.	Kirthi D.	Bob K.	Design Assumptions/N DA	08/18/17	RFQ	09/17/17	Hillsborough Community College	1520	10/03/17	11/02/17
Green-Ready to Acquire	9002-6117	NAV-TV	Video switching modules	Rafal L	Kirthi D.	Bob K.	Validation Prototypes approved	08/18/17	Contract	09/17/17	Hillsborough Community College	1600	10/03/17	11/02/17
Green-Ready to Acquire	ADAP-0001	TBD	HDMI/NTSC Adapters	Rafal L	Kirthi D.	Bob K.	Validation Prototypes approved	08/18/17	Contract	09/17/17	Hillsborough Community College	1600	10/03/17	11/02/17
Yellow-development	Multiple Part numbers based on vehicle type	NA	Mounting hardware/brackets	James Mc	Kirthi D.	Bob K.	Design Assumptions/N DA	08/18/17	Sourcing Letter/SOW	09/17/17	Hillsborough Community College	1600	10/03/17	11/02/17

Source: Brandmotion

Note: **Standard GYR risk assessment process, Green means no issues, yellow mean issues with high confidence mitigation plans, red means issue with no plans – high risk**

4 Roadside Equipment

This section provides info on the procurement activities for the Roadside Equipment

4.1 Roadside Equipment Item: Roadside Unit

This section covers the Roadside Unit (RSU).

4.1.1 Technical Description/Specification

This section includes a technical description of the item being procured as well as brief technical specification with references to the appropriate requirements and design specifications derived from the System Design Document (SDD) for that specific item.

The procured RSU complies with the USDOT RSU Requirements Specification version 4.1, plus the following added features to fulfill the System Requirements:

- Added WiFi hot spot communicating to personal information devices (PIDs) for pedestrian and cyclist safety applications
- Two independent radio modules
- Service Console
- Communications to RSU management central software
- Added Bluetooth reader implementing a Personal Area Network
- Added cellular backhaul for central monitoring and control as well as collection of agency data, such as vehicle counts and speeds
- High speed, multi-core microprocessor to support multiple simultaneous V2I applications
- Added non-volatile memory for storage of collected data and map files

4.1.2 Ancillary Equipment

Each RSU is installed with the following ancillary equipment that is included as part of the RSU Kit purchased under one vendor part number:

- Power over Ethernet (PoE) Injector
- Two DSRC antennas
- Two WiFi antennas
- One cellular antenna
- One Global Positioning System (GPS) antenna
- One Bluetooth antenna
- Ethernet CAT 6 cable from RSU to PoE Injector, outdoor rated
- Ethernet CAT 6 cable from PoE Injector to controller unit, outdoor rated
- Mounting hardware

4.1.3 Part Numbers and Quantities

Table 12 – RSU Equipment Part Numbers

Qty	Description	Vendor	Part Number
65	RSU Kit, including: RSU Antennas Cables Mounting hardware RSU software	Siemens	L24707-E100-A7
65	RP100 PoE Injector	Siemens	6GK6010-0A901-1AA0

Source – Siemens

RSU Usage:
(21) Development staff, testing staff and cyber security penetration testing
(44) Deployment in Tampa FL

4.1.4 Associated Software

RSU custom built software is included in the RSU Kit. The Kit contains:

- DSRC wireless stack including USDOT RSU Spec v4.1 software features (e.g. SNMP)
- Communications to back office
- V2I applications: Infrastructure software objects
    - ERDW
    - WWE
    - MMITSS v1.1 including I-Sig and TSP
    - PED-SIG
    - PED-X

4.1.5 Acquisition Method

Working back from the required installation date of November 2017, plus considering development and production lead times of 12 to 20 weeks for First Article production run, followed by a similar lead time for Deployment production run, the acquisition process began in March 2015. Acquisition method is described in Section 2.

4.1.6 Potential Vendors

As described in Section 2, the RSU procurement process evaluated multiple RSU manufacturers with prior manufacturing experience both with the USA DSRC standards as well as the European / UK standards. The evaluation also included advice from manufacturers of the electronic components used in the RSU. A competitive bid resulted in the selection of NXP as electronic component supplier and Cohda Wireless as the RSU manufacturer, as announced at ITSA World Congress in Bordeaux. That strategic partnership was included in the USDOT Test Bed Affiliates information sheet.

Acquisition Schedule

Please refer to Figure 1 for the RSU acquisition schedule.

5 Mobile Devices

We are acquiring no mobile devices. Participants are expected to supply their own device. We validate the device and operating system to be compatible with the THEA apps. Only Android based devices will be enrolled in the Pilot

6 Management Center Equipment

6.1 Management Center Equipment: Master Server

6.1.1 Technical Description/Specification

Master server consists of a module installed in a 19" instrument rack that also houses the Transit server and the Center for Urban Transportation Research (CUTR) server. Master server supports Siemens Concert™ area maps, collection of agency data, collection of OBU BSMs, alerts and warnings, as well as the NextConnect communications layer to the various devices.

6.1.2 Ancillary Equipment

Ancillary equipment includes hard drive for mass storage and a network switch implementing a VLAN with security firewall.

6.1.3 Part Numbers and Quantities

Siemens has volume procurement contracts in place with multiple suppliers for similar Traffic Management Center equipment. Specific part numbers and quantities will be determined once the data storage requirements are finalized.

6.1.4 Associated Software

Master Server software consists of the Siemens Concert ™ Advanced Transportation Management System, which includes an RSU management module developed and deployed on prior Connected Vehicle projects.

6.1.5 Acquisition Method

Please refer to Section 2 for a description of the acquisition method. Included in RSU Management and Back Office Software

6.1.6 Potential Vendors

No vendor can supply a COTS RSU management system that includes area maps, ability to download RSU software updates and aggregate BSMs into vehicle counts and speeds. Siemens is reusing the COTS Concert system developed for EU and UK connected vehicle projects.

6.1.7 Acquisition Schedule

Please refer to Figure 1 for acquisition schedule of software.

6.2 Management Center Equipment: Transit Server

6.2.1 Technical Description/Specification

HART server consists of a module installed in a 19" instrument rack that also houses the Master server and the CUTR server. HART sever supports the collection of Transit Signal Priority Signal Request Messages (SRM), bus schedule, authentication of vehicles and other transit functions.

6.2.2 Ancillary Equipment

Ancillary equipment includes hard drive for mass storage and a network switch implementing a VLAN with security firewall.

6.2.3 Part Numbers and Quantities

Siemens has volume procurement contracts in place with multiple suppliers for similar Traffic Management Center equipment. Specific part numbers and quantities will be determined once the data storage requirements are finalized.

6.2.4 Associated Software

HART server software consists of the Siemens TSP Connect™, which includes a Transit Signal Priority module developed and deployed on prior Transit Signal Priority projects. TSP Connect is a COTS software application that meets the System Requirements

6.2.5 Acquisition Method

Back office equipment is procured under existing Siemens negotiated volume prices already in place for ongoing ITS central Traffic Management Center projects.

6.2.6 Potential Vendors

Siemens is reusing the COTS TSP Connect system developed for prior Transit Signal Priority projects.

6.2.7 Acquisition Schedule

- July 2017: Meetings with the THEA Information Technology manager to develop the communications, security, hardware server and network topology requirements.
- August 2017: Obtain configuration and cost quotations from IT equipment suppliers under existing volume purchase agreements for ITS back office equipment.
- September 2017: Purchase order issued for equipment and software

6.3 Management Center Equipment: CUTR Server

6.3.1 Technical Description/Specification

CUTR server consists of a module installed in a 19" instrument rack that also houses the HART server and the Master server.

6.3.2 Ancillary Equipment

Ancillary equipment includes hard drive for mass storage and a network switch implementing a VLAN with security firewall.

6.3.3 Part Numbers and Quantities

Siemens has volume procurement contracts in place with multiple suppliers for similar Traffic Management Center equipment. Specific part numbers and quantities will be determined once the data storage requirements are finalized.

6.3.4 Associated Software

Software consists of database management software to be selected in collaboration with CUTR.

6.3.5 Acquisition Method

Back office equipment is procured under existing Siemens negotiated volume prices already in place for ongoing ITS central Traffic Management Center projects.

6.3.6 Potential Vendors

Vendors selection to collect and access of data will be accomplished in collaboration with CUTR.

6.3.7 Acquisition Schedule

Hardware acquisition schedule:

- March 2017: Meetings with CUTR to estimate the volume, storage and communications requirements of the research data to be collected
- July 2017: Meetings with the THEA Information Technology manager to develop the communications, security, hardware server and network topology requirements.
- August 2017: Obtain configuration and cost quotations from IT equipment suppliers under existing volume purchase agreements for ITS back office equipment.
- September 2017: Purchase order issued for equipment and software

7 Other Equipment

7.1 Pedestrian Detection

Each item that is being acquired, and its' associated components required for full installation and operation, has its' own section with the following sub-sections.

7.1.1 Technical Description/Specification

The procured pedestrian detection system is used to precisely locate pedestrians within and nearby a non-signalized midblock crosswalk. The equipment then converts the location, direction and speed of each pedestrian into an SAE J2735 Personal Safety Message which is then sent to a nearby RSU via WiFi. The RSU translates the received PSM into a DSRC to approaching vehicles. The technical specification is contained in a separate Pedestrian Detection System Requirements Specification Requirements document.

7.1.2 Ancillary Equipment

The Pedestrian Detection System includes the following ancillary equipment:

- Two mounting poles
- Outdoor electrical cabinet for VAS Server
- Conduits and power service entrance

7.1.3 Part Numbers and Quantities

Table 13 – Pedestrian Detection Equipment Part Numbers

Qty	Description	Vendor	Part Number
1	VAS Sever	Metrotech	Unassigned
2	PTZ cameras with routers	Metrotech	Unassigned
2	Mark 5 LiDAR sensors, including Power supply and cables Quanergy Processing Unit (QPN) Linux Ubuntu environment M8 drivers Q-Guard security software Q-View sensor management tool Installation and sensor configuration Q-Guard plug-in visualizer Object list processing	Quanergy	Unassigned

Source: Siemens

7.1.4 Associated Software

COTS software provided by Metrotech is included in the pedestrian detector.

7.1.5 Acquisition Method

Acquisition method is described in Section 2 and preceded as follows:

- Requirements specification document provided to potential vendors
- One vendor responded with a proposal without exceptions to the requirements
- All other vendors responded with "no bids" as unable to meet requirements
- Two separate Requirements Reviews were conducted with successful bidder
- Purchase order issued for equipment and software

7.1.6 Potential Vendors

Potential vendors of pedestrian equipment considered:

- Radar:
  - Wavetronics
  - Siemens
- Video:
  - Iteris
  - Econolite
  - Flir
  - Gridsmart
- Lidar:
  - Metrotech
  - Quanergy

7.1.7 Acquisition Schedule

Key procurement milestones:

- October 2016: Final Pedestrian Detector procurement document, Request for Proposals
- December 2016: Requirements review with affirmative responder
- June 2017: Second requirements review with successful vendor after project Quality Gate 1
- July 2017: Purchase order to successful vendor

7.2 Vehicle Detector

7.2.1 Technical Description/Specification

The procured vehicle detection system is used to support vehicles queuing on to the Reversible Elevated Lane (REL). The vehicle detection equipment is used to indirectly produce the data contained in a Basic Safety Message, as if each car was equipped. This Infrastructure Safety Message is supplied to the I-SIG application to measure queue length on the REL. No separate requirements specification was developed. The Vehicle Detector solution was selected from available COTS products that met the System Requirements.

7.2.2 Ancillary Equipment

Ancillary equipment is included in the kit. The parts are listed in Table 4.

7.2.3 Part Numbers and Quantities

Table 14 – Vehicle Detector Equipment Part Numbers

Qty	Description	Vendor	Part Number
1	1 amp AC to DC Power Converter	Wavetronix	CLK-201
1	Surge Protector	Wavetronix	CLK-200
1	Misc Mech, hardware, steel, 9" DIN Rail	Wavetronix	100-0064
1	SmartSensor HD Retrofit	Wavetronix	101-0414
1	SmartSensor 3 year extended warranty	Wavetronix	SS-611
1	8 Conductor Cable, 26 pin Connector 60'	Wavetronix	SS-708-060

Source: Siemens

7.2.4 Associated Software

None

7.2.5 Acquisition Method

Acquisition method is described in Section 2 and preceded as follows:

- Requirements specification document provided to potential vendors
- Multiple vendors responded with proposals without exceptions to the requirements
- Requirements Reviews were conducted with the Florida distributor of the successful bidder after project Quality Gate 1.
- Purchase order issued for equipment

7.2.6 Potential Vendors

- Radar:
  - Wavetronics
  - Siemens
- Video:
  - Iteris
  - Econolite
  - Flir
  - Gridsmart

7.2.7 Acquisition Schedule

Key procurement milestones:

- December 2016: Analysis of available COTS vehicle detection systems to the System Requirements
- June 2017: Requirements review with Florida distributor of vendor after project Quality Gate 1
- July 2017: Purchase order issued to successful vendor

7.3 Wrong-Way Detector

7.3.1 Technical Description/Specification

The procured Wrong-Way detection system is used to support vehicles approaching closed lanes of the Reversible Elevated Lane (REL). The Wrong-Way detection equipment is wired into the traffic controller's extra detection inputs. The wrong-way detection comes in as a single binary detection event. No separate requirements specification was developed. The Wrong-Way Detector solution was selected from available COTS products that meet the System Requirements.

7.3.2 Ancillary Equipment

Ancillary equipment is included in the kit. The parts are listed in Table 5.

7.3.3 Part Numbers and Quantities

Table 15 – Wrong Way Detector Equipment Part Numbers

Qty	Description	Vendor	Part Number
1	Detector	MsSedco	TC-CK1-SBC
2	4-channel card	MsSedco	TCIB 4.1
1	SkyBracket Sedco Mounting Bracket	MsSedco	SS-SBC120

Source: Siemens

7.3.4 Associated Software

None

7.3.5 Acquisition Method

Acquisition method is described in Section 2 and preceded as follows:

- Requirements specification document provided to potential vendors
- Multiple vendors responded with proposals without exceptions to the requirements
- Requirements Reviews were conducted with the Florida distributor of the successful bidder after project Quality Gate 1.
- Purchase order issued for equipment

7.3.6 Potential Vendors

- Radar:
  - Wavetronics
  - Siemens
- Video:
  - Iteris
  - Econolite
  - Flir
  - Gridsmart

7.3.7 Acquisition Schedule

Key procurement milestones:

- December 2016: Analysis of available COTS vehicle detection systems to the System Requirements
- June 2017: Requirements review with Florida distributor of vendor after project Quality Gate 1
- July 2017: Purchase order issued to successful vendor

8 Acronyms & Glossary

AO	Agreement Officer - The FHWA representative responsible for administering the agreement under which the grant funding is/was provided
AOR	Agreement Officer Representative -Representative who provides the ongoing oversight of the Pilot ensuring both technical excellence and administrative compliance
BSM	Basic Safety Message
COTS	Commercial-Off-the-Shelf
CV	Connected Vehicle
CUTR	Center for Urban Transportation Research – University of South Florida
DSRC	Dedicated Short Range Communications
ERDW	End of Ramp Deceleration Warning
EU	European Union
GPS	Global Positioning System
HART	Hillsborough Area Regional Transit Authority
HCC	Hillsborough Community College
HMI	Human Machine Interface or User Interface
I-SIG	Intelligent Signal Systems
ITS	Intelligent Transportation System
ITSA	Intelligent Transportation Society of America
LTE	Long Term Evolution
MMITSS	Multi Modal Intelligent Transportation Signal System
MOU	Memorandum of Understanding
OBU	On-Board Unit - The DSRC Radio and ancillary devices installed in vehicles which support V2V, V2I and V2X applications.
Partner	A stakeholder who has interest or limited participation in pilot without contractual relationship to THEA
PED	Pedestrian
PID	Personal Information Device
RE	Roadside Equipment - All equipment required to support the installation and operation of a Roadside Unit (RSU), inclusive of the RSU
REL	Reversible Express Lanes
RSU	Roadside Unit - The DSRC Radio and ancillary devices installed at roadside infrastructure which support V2I and facilitate V2X applications.
SAD	System Architecture Document
SAE	Society of Automotive Engineers
SDD	System Design Document

SLA	Service-Level-Agreement, contract with the a service provider (supplier) that defines the service (versus products) and quality of service expected.
SNMP	Simple Network Management Protocol
SOW	Statement-of-Work, a document to define the suppliers and other roles, deliverables and timing
TSP	Transit Signal Priority
Team Member	Technical or agency partner whose involvement with the pilot is based on contractual relationship with THEA
THEA	Tampa Hillsborough Expressway Authority
SwRI	Southwest Research Institute
UK	United Kingdom
V2I	Vehicle to Infrastructure
Vehicle/In-vehicle equipment	All equipment required to support the installation and operation of On-board Units (OBU), inclusive of the OBU
Vendor	Supplier who is under contract with THEA or its Team Members to provide material, devices, or services to the Team member in support of the Pilot.
VLAN	Virtual Local Area Network
WAVE	Wireless Access Vehicular Environments
WWE	Wrong Way Entry

9 References

THEA. (Task 2, ConOps, February 2016). Connected Vehicle Pilot User Oriented Concept of Operations - Tampa, FHWA-JPO-16-311. Federal Highway Administration, USDOT. http://ntl.bts.gov/lib/57000/57000/57032/FHWA-JPO-16-311.pdf.

THEA. (Task 6, SyRS, May 2016). Connected Vehicle Pilot System Requirements Specification - Tampa, FHWA-JPO-16-315. Federal Highway Administration, USDOT.

THEA. (Task 7, ADP, June 2016). Connected Vehicle Pilot Application Deployment Plan - Tampa, FHWA-JPO-16-316. Federal Highway Administration, USDOT.

THEA. (Task 13, DRS, September 2016). Connected Vehicle Pilot Deployment Readiness Summary - Tampa, FHWA-JPO- 16-322 Federal Highway Administration, USDOT.

THEA. (Task 12, CDP, June 2016). Connected Vehicle Pilot Application Deployment Plan - Tampa, FHWA-JPO- 16-321 Federal Highway Administration, USDOT.

CVRIA website, http:// iteris.com/cvria/, accessed November 30, 2015.

SET-IT Download Page, http://www.iteris.com/cvria/html/resources/tools.html.

THEA (Task xx, SAD, January 2017) Connected Vehicle Pilot Development Program Phase 2 – System Architecture Document – Tampa (THEA), FHWA-JPO-17-459

Comprehensive Installation Plan (under Development)

Brandmotion Supplier Policy

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
www.its.dot.gov

FHWA-JPO-17-463

U.S. Department of Transportation