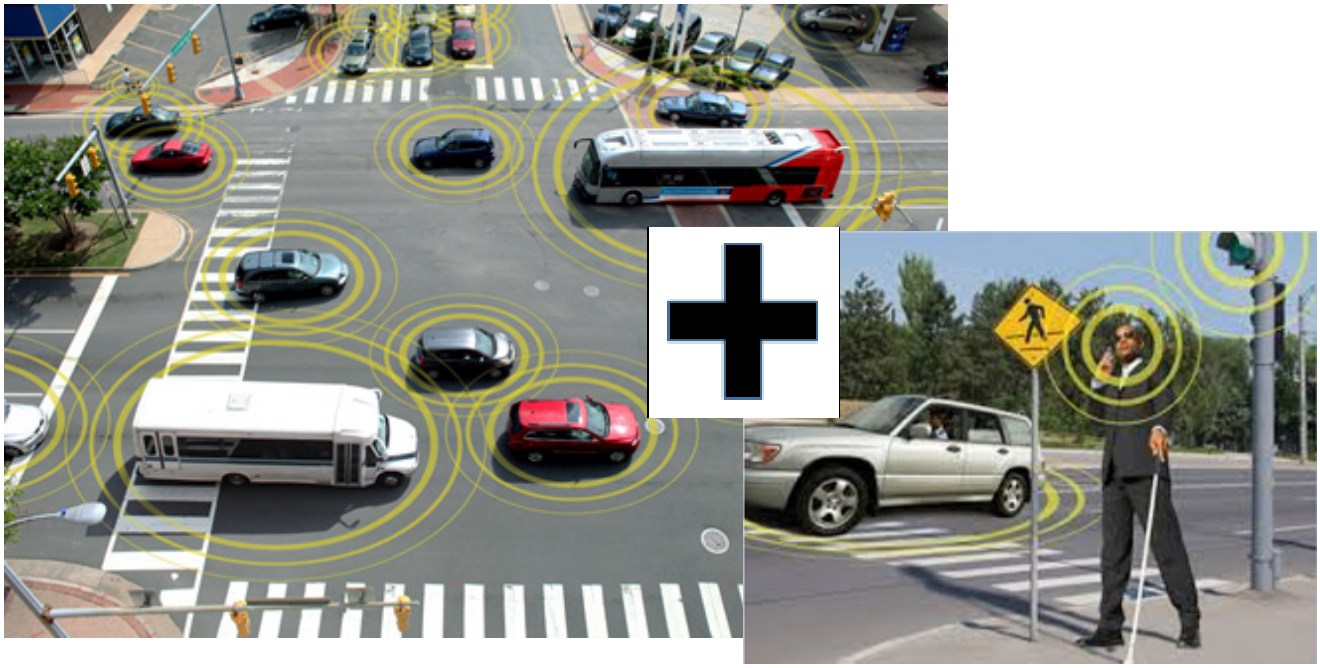
Sharing Data between Mobile Devices, Connected Vehicles and Infrastructure

Task 6: Prototype Acceptance Test Summary Report

www.its.dot.gov/index.htm
Final Report — October 30, 2017
FHWA-JPO-17-507



U.S. Department of Transportation
Office of the Assistant Secretary for Research and Technology

Produced by Battelle Memorial Institute under DTFH61-12-D-00046
U.S. Department of Transportation
- Office of the Assistant Secretary for Research and Technology
- Federal Highway Administration

Picture Source: U.S. DOT Office of the Assistant Secretary for Research and Technology, Intelligent Transportation Systems, Joint Program Office

Notice

Quality Assurance Statement

The Federal Highway Administration provides high quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-JPO-17-507		

4. Title and Subtitle	5. Report Date
Sharing Data between Mobile Devices, Connected Vehicles and Infrastructure Task 6: Prototype Acceptance Test Summary Report	October 30, 2017 6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
David Valentine, Kristina Guspan, Margaret Hailemariam, Rama Krishna Boyapati, Ben Paselsky, Greg Baumgardner	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Battelle 505 King Avenue Columbus, Ohio 43201	11. Contract or Grant No. DTFH61-12-D-00046 / 5015

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
United States Department of Transportation ITS Joint Program Office Office of the Assistant Secretary for Research and Technology 1200 New Jersey Avenue, SE Washington, DC 20590	Final Report 14. Sponsoring Agency Code

15. Supplementary Notes

Government Task Monitor – Jon Obenberger

16. Abstract

The Task 6 Prototype Acceptance Test Summary Report summarizes the results of Acceptance Testing carried out at Battelle facilities in accordance with the Task 6 Acceptance Test Plan. The Acceptance Tests were designed to verify that the prototype system operates in accordance with the system requirements documented in the Prototype System Requirements Specifications. The purpose of this testing was to assess prototype readiness for the subsequent Prototype Proof-of-Concept Test conducted at Turner-Fairbank Highway Research Center (TFHRC). This report does not include detailed analysis and findings which are the subject of the separate Field Test Evaluation Report.

17. Key Words	18. Distribution Statement
Connected Vehicle, Mobile Device, Personal Mobility Message, Personal Safety Message, Basic Safety Message, Test Case, Coordinated Message, Experimental Prototype System, Acceptance Test Plan, Acceptance Test Summary Report	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	66	N/A

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

Revision History

Revision	Date	Change Description	Affected Sections/Pages
1	2/10/2017	Draft Release	
2	10/30/2017	Final Release to address comments	All sections

Table of Contents

List of Tables

List of Figures

Chapter 1 Scope

This Acceptance Test Summary Report summarizes the results of Acceptance Testing for the Proof-of-Concept version of the Mobile Devices Prototype System. This testing was conducted at Battelle, Columbus, Ohio, on January 17-20, 2017. The version under test is D2X Hub version 1.0 targeted for the subsequent Proof-of-Concept Test at Turner-Fairbank Highway Research Center (TFHRC).

This Summary Report provides an overview of test results. Detailed test logs, digital data logs, and other test artifacts are not included herein.

Acceptance Testing was conducted in accordance with the Prototype Acceptance Test Plan (ATP). The Acceptance Tests were designed to verify that the prototype system operates in accordance with the system requirements documented in the System Requirements Specifications (SyRS).

The purpose of this testing was to assesses prototype system readiness for the Proof-of-Concept Test at TFHRC. This report does not include analysis and findings which will be the subject of the separate Proof-of-Concept Test Evaluation Report to follow the testing at TFHRC.

Finally, it should be noted that the subject system is an experimental system for the purpose of answering research questions. System performance is limited by the quality of input data and the limits of the underlying technology and equipment employed. As such, there is not a specific threshold for an “acceptable” level of overall system performance. All results, whether “pass” or “fail”, are instructive outcomes of this testing to answer the subject research questions.

Chapter 2 Referenced Documents

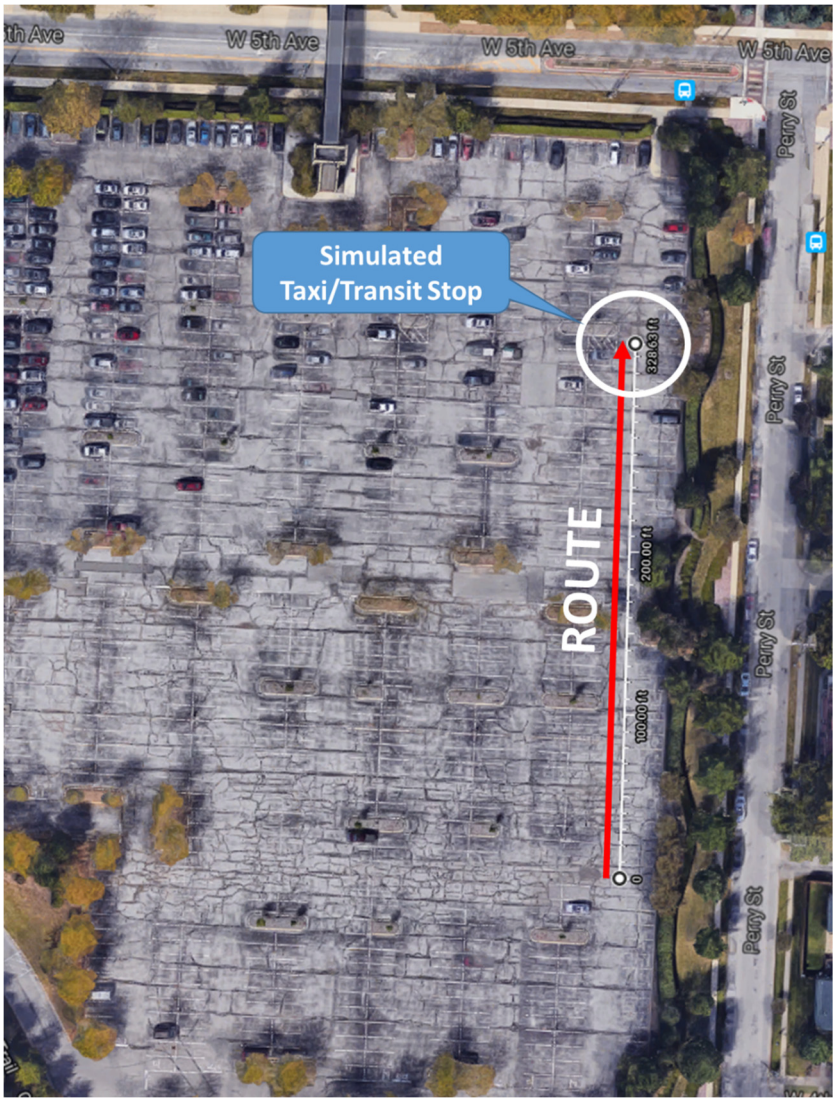
Battelle Memorial Institute

FHWA-JPO-16-423	Task 3: System Requirements Specifications (SyRS) for Sharing Data between Mobile Devices, Connected Vehicles, and Infrastructure (July 14, 2016)
FHWA-JPO-17-475	Task 5: Prototype Proof of Concept Field Demonstration Experimental / Field Demonstration Site Plan for Sharing Data between Mobile Devices, Connected Vehicles, and Infrastructure (October 6, 2016)
FHWA-JPO-17-477	Task 6: Prototype Acceptance Test Plan for Sharing Data between Mobile Devices, Connected Vehicles, and Infrastructure (December 21, 2016)

Chapter 3 Test Conduct

Acceptance Testing was conducted as described in the ATP document, with additional details and differences as noted herein.

The test site (Figure 3-1) was a Battelle parking lot south of West 5th Avenue and west of Perry Street.



Source: Battelle, Google Maps, January 2017

Figure 3-1. Test Site

Three vehicles were rented and temporarily outfitted with the system equipment as follows:

1. A Minivan serving as the Taxi/Transit vehicle with a Battelle Common Computer Platform (CCP) On-board Unit (OBU) hosting the In-Vehicle Device Experimental Application (VEA)
2. A Sedan serving as a second Light-Duty Vehicle with a Cohda OBU to generate BSMs.
3. A Minivan serving as the roadside cabinet with a Battelle CCP hosting the Roadside Unit Experimental Application (REA). The CV Inspector test tool was also located in this minivan.

Google Nexus 5X smartphones, paired with Arada Locomate ME DSRC radios, were used as the Mobile Devices hosting the Mobile Device Experimental Application (MDEA). A notable exception is that a Samsung tablet was used as the travel "leader" for tests that involved Travel Groups. This was because there were Wi-Fi Direct connection issues realized during development with the Nexus 5X smartphones serving as leader; therefore, for the purposes of testing the system as a whole a Samsung tablet was used instead of a Nexus 5X smartphone in the leader role.

There were instances where tests could not be performed exactly as written in the ATP document due to either errors or oversights in the original scripts. The test scripts were redlined during testing (when each issue was realized) to capture the necessary changes. The redlined scripts are presented in Appendix A of this report.

The number of test iterations was reduced from the thirty (30) iterations specified in the ATP to fifteen (15) iterations actually performed at Battelle. With Government agreement, this was done to save cost and time, since it was determined that fifteen (15) iterations would provide an adequate data set to evaluate the system. The actual test schedule is shown in Table 3-1.

Table 3-1. Test Schedule (Actual)

Test Case		Iterations 1-10	Iterations 11-15
5.4.1.1	PSM – Broadcasting PSM with Vehicle Within a Specified Radius (Transmit Timing)	1/17/2017	1/19/2017
5.4.1.2	PSM – Cease Broadcasting PSMs when In-Vehicle	1/17/2017	1/19/2017
5.4.1.3	PSM – Cease Broadcasting PSMs After Joining an Ad-Hoc Travel Group	1/18/2017	1/19/2017
5.4.1.4	PSM – Broadcasting PSM with Pedestrian in Unsafe Zone	1/18/2017	1/19/2017
5.4.2.1	PMM – Submitting Trip Requests – Single User	1/17/2017	1/20/2017
5.4.2.2	PMM – Communicate with Cloud Infrastructure via Cellular	1/19/2017	1/20/2017
5.4.2.3	PMM – Canceling Trip Requests	1/17/2017	1/20/2017
5.4.2.4	PMM – Sending Arrival Messages	1/18/2017	1/20/2017
5.4.3.1	BSM – Vehicle Experimental Application Functionality	1/17/2017	1/19/2017
5.4.4.1	ATG – Creating Coordination between the Mobile Devices of Travelers – Multiple Travelers	1/18/2017	1/20/2017

Test Case		Iterations 1-10	Iterations 11-15
5.4.4.3	ATG – Leaving an Ad-Hoc Travel Group by Choice – Multiple Travelers	1/18/2017	1/20/2017
5.4.4.4	Disbanding Ad-Hoc Travel Group When Entering a Vehicle or any other Reason	1/18/2017	1/20/2017
5.4.5.1	LDV – Bluetooth Proximity Sensor Functionality to Detect Passenger Entry into and Exiting from the Light-Duty Vehicle	1/17/2017	1/19/2017
5.4.5.2	LDV – Mobile Device Accelerometer Sensor Functionality to Detect Passenger Entry into and Exiting from the Light-Duty Vehicle	1/17/2017	1/19/2017
5.4.6.1	MGL – RSU DSRC Message Logging	Post-testing inspection of data (not a separate test)	
5.4.6.2	MGL – Cloud Service Message Logging		
5.4.6.3	MGL – Mobile Device Experimental Application Message Logging		
5.4.6.4	MGL – Vehicle Experimental Application Message Logging		
5.4.7.1	SFY – Safety Notifications (Mobile Device User in Unsafe Zone)	1/17/2017	1/19/2017
5.4.8.1	SMP – SPAT and MAP message support	Post-testing inspection of data (not a separate test)	

Source: Battelle

Chapter 4 Summary of Results

This chapter provides a summary of the test results, including pass/fail metrics according to the test steps for each Test Case. This report does not include analysis and findings which will be the subject of the separate Field Test Evaluation Report to follow the Proof-of-Concept Test at TFHRC.

All test cases were executed a minimum of fifteen (15) times (iterations) at Battelle. Observations that could be made on the MDEA, VEA, or CV Inspector displays, as well as actual physical events were recorded in the test log "real-time" as specified by the test scripts. Digital data logs from the Mobile Devices, Vehicle OBU, and RSU were archived and later inspected as specified by the test scripts. Observations and Inspections versus Expected Results (as specified in the test scripts) were used to determine "pass" or "fail" for each test script step. Metrics were prepared for each Test Case as shown in Table 4-1, Test Results Summary. This table provides the step pass rate for each Test Case, which is the percentage of pass-fail steps that passed over all iterations. This metric provides a general measure of how well each functional area performed.

Note: A 10% tolerance was applied to the performance thresholds on Safety Notifications, since they are impossible to pass without doing so. This is to account for the latency in receiving messages upon which calculations are based, the time to calculate if the threshold is met, and the time to issue notifications. This tolerance was applied based upon distance, such that a tolerance of about 11 meters or 1 second is applied for vehicle speeds of 25 mph.

Table 4-1. Test Results Summary

Test Case		Step Pass Rate
5.4.1.1	PSM – Broadcasting PSM with Vehicle within a Specified Radius (Transmit Timing)	77%
5.4.1.2	PSM – Cease Broadcasting PSMs when in-Vehicle	98%
5.4.1.3	PSM – Cease Broadcasting PSMs after Joining an Ad-Hoc Travel Group	93%
5.4.1.4	PSM – Broadcasting PSM with Pedestrian in Unsafe Zone	94%
5.4.2.1	PMM – Submitting Trip Requests – Single User	95%
5.4.2.2	PMM – Communicate with Cloud Infrastructure via Cellular	100%
5.4.2.3	PMM – Canceling Trip Requests	93%
5.4.2.4	PMM – Sending Arrival Messages	100%
5.4.3.1	BSM – Vehicle Experimental Application Functionality	89%

Test Case		Step Pass Rate
5.4.4.1	ATG – Creating Coordination between the Mobile Devices of Travelers – Multiple Travelers	95%
5.4.4.2	ATG – Leaving an Ad-Hoc Travel Group Based on Distance – Multiple Travelers	84%
5.4.4.3	ATG – Leaving an Ad-Hoc Travel Group by Choice – Multiple Travelers	100%
5.4.4.4	Disbanding Ad-Hoc Travel Group when Entering a Vehicle or any other Reason	100%
5.4.5.1	LDV – Bluetooth Proximity Sensor Functionality to Detect Passenger Entry into and Exiting from the Light-Duty Vehicle	76%
5.4.5.2	LDV – Mobile Device Accelerometer Sensor Functionality to Detect Passenger Entry into and Exiting from the Light-Duty Vehicle	74%
5.4.6.1	MGL – RSU DSRC Message Logging	33%
5.4.6.2	MGL – Cloud Service Message Logging	100%
5.4.6.3	MGL – Mobile Device Experimental Application Message Logging	100%
5.4.6.4	MGL – Vehicle Experimental Application Message Logging	100%
5.4.7.1	SFY – Safety Notifications (Mobile Device User in Unsafe Zone)	50%
5.4.8.1	SMP – SPAT and MAP Message Support	100%

Source: Battelle

Chapter 5 Evaluation of Results

The purpose of Acceptance Testing was to assess the D2X Hub version 1.0 prototype system readiness for the Proof-of-Concept Test at TFHRC. The subject system is an experimental system to answer research questions. As such, there is not a specific threshold for an “acceptable” level of overall system performance.

Based on the results summarized in Table 4-1, a level of performance was achieved that will allow the system to meet Proof-of-Concept Test objectives; the system is expected to yield the data necessary to answer the research questions posed in the contract. The software applications and underlying messages to incorporate mobile devices into the CV environment are functioning correctly. Given a performance level sufficient for test, step passage rates of less than 100% are the kind of instructive outcomes sought by this research. The system is ready for the Proof-of-Concept Test.

All analysis and lessons learned are planned to follow the TFHRC testing event and will be documented in the Proof-of-Concept Test Evaluation Report.

APPENDIX A. Redlined Test Scripts

5.4.1 Personal Safety Message

Test Case

Test Case ID	5.4.1.1
Test Case Name	PSM – Broadcasting PSM with Vehicle within a Specified Radius (Transmit Timing)
Test Objective	• Verify the ability of the Mobile Device to broadcast PSMs via DSRC media in a configurable transmission interval in 0.1 second intervals • Verify the ability of the Mobile Device to transmit PSMs only when the Mobile Device determines a vehicle is within a specified radius of the mobile device
System Requirements	FR 1.01, FR 1.02, FR 1.08, SIR 1.01, SIR 1.02, SIR 1.03, SIR 1.04, SIR 1.05, SIR 1.06, SIR 1.07, SIR 1.08, SIR 1.09, PR 1.03, PR 1.04, PR 5.01
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is connected to the mobile device and the MDEA application is installed • A pedestrian holding a mobile device is standing five (5) meters perpendicular to the edge of the roadway at the bus stop in a safe zone • DSRC capable hardware is installed on the Light-Duty vehicle and the VEA application is installed • The Light-Duty vehicle is stationed west of the crosswalk and moves east toward the pedestrian o From a stop, the Light-Duty vehicle must achieve a constant speed of 25 mph over a distance of approximately 600 feet • The test is repeated with the mobile device under test in various locations (in-hand, in-pocket, in-backpack) on the pedestrian • MDEA Setting 'Send Psm Control' should be set to "IgnoreSafeZoneRule"

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	The Light-Duty Vehicle accelerates up to twenty-five (25) mph.	None			
2	Vehicle maintains constant speed of twenty-five (25) mph.	None			
3	The Light-Duty Vehicle comes within 100 meters of the pedestrian.	Mobile Device begins broadcasting PSMs via DSRC. This is verified by inspection using CV Inspector. A detailed inspection is performed using data recorded on the MDEA data log.			
4	Inspect the PSM data recorded on the RSU log	Following data should have been logged: Location Speed Heading Number of Pedestrians Radius of Protection Path History (20 seconds) Path Prediction (5 seconds) ~~Status (Safe/Unsafe)~~ Correction: This is not a part of the PSM.			
5	The Light-Duty Vehicle continues at a constant speed until it is more than 100 meters of the pedestrian	Mobile Device stops broadcasting PSMs. This is verified by inspection using CV Inspector. A detailed inspection is performed using data recorded on the MDEA data log.			
6	The Light-Duty Vehicle decelerates to a stop.	None			

Test Case

Test Case ID	5.4.1.2
Test Case Name	PSM – Cease Broadcasting PSMs when in-Vehicle
Test Objective	• Verify the ability of the Mobile Device to cease broadcasting PSMs when it has detected that it has entered a vehicle
System Requirement	FR 1.03, PR 5.03
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is installed on the Light-Duty vehicle and the VEA application is installed • A Taxi starts from a location east of the Taxi Stop and approaches the taxi stop • A Light-Duty vehicle approaches the Taxi Stop from the west • DSRC capable hardware is connected to the mobile device and the MDEA application is installed • A pedestrian holding a mobile device is positioned at the taxi stop • A Tablet running CV Inspector application to verify that the mobile device broadcasting DSRC messages is positioned at the taxi stop • MDEA Setting 'Send Psm Control' should be set to "IgnoreSafeZoneRule"

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Taxi arrives at Taxi Stop	None			
2	Light-Duty vehicle passes the Taxi Stop	MDEA broadcasts PSMs via DSRC. This is verified by inspection using CV Inspector. Inspect the RSU log to verify the reception of PSMs at one-tenth of a second frequency.			
3	Pedestrian enters Taxi. The mobile device detects that it has entered a vehicle. Taxi remains stationary.	MDEA transitions to 'In-Vehicle'. This is verified by inspecting the MDEA Log. As a result, the Mobile Device stops broadcasting PSMs.			
4	The Light-Duty vehicle passes in the opposite direction.	No PSMs are received by the Light-Duty vehicle. This is verified by inspection using CV Inspector. A detailed inspection is performed using data recorded on the RSU data log.			
5	Taxi drives away with pedestrian in vehicle	None			

Test Case

Test Case ID	5.4.1.3
Test Case Name	PSM – Cease Broadcasting PSMs after Joining an Ad-Hoc Travel Group
Test Objective(s)	• Verify the ability of the mobile device to cease broadcasting PSMs when it has joined an ad-hoc travel group
System Requirement	FR 1.05, SIR 1.05, SIR 1.07, PR 5.02
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is installed on the Light-Duty vehicle and the VEA application is installed • DSRC capable hardware is connected to two Mobile Devices and the MDEA application is installed on both devices • Traveler X holding a mobile device is positioned at the taxi stop and has already coordinated travel with a Taxi • Traveler Y holding a mobile device is positioned at the taxi stop and has not yet attempted to coordinate travel • A Tablet running CV Inspector application to verify DSRC messages is positioned at the taxi stop • MDEA Setting 'Send Psm Control' should be set to "IgnoreSafeZoneRule"

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Light-Duty vehicle passes the Taxi Stop	Traveler X MDEA broadcasts PSMs via DSRC. This is verified by inspection using CV Inspector. Traveler Y MDEA broadcasts PSMs via DSRC. This is verified by inspection using CV Inspector.			
2	Ad-Hoc Travel Group forms. (See Test Case 5.4.4.1 – Steps 1 through 4)	Traveler Y MDEA transitions to 'in travel group' This is verified by inspecting the Traveler 2 MDEA Log.			
3	The Light-Duty vehicle passes the Taxi Stop.	PSMs sent from Traveler X MDEA are received by the Light-Duty vehicle. Traveler Y MDEA does not broadcast PSMs. This is verified by inspection using CV Inspector. A detailed inspection is performed using data recorded on the Traveler X and Traveler Y MDEA data Logs.			

Test Case

Test Case ID	5.4.1.4
Test Case Name	PSM – Broadcasting PSM with Pedestrian in Unsafe Zone
Test Objective(s)	• Verify the ability of the mobile device detect transitions from a safe to an unsafe zone and to broadcast PSMs when it is in an unsafe zone. *Note: the intent of this requirement is to allow a travel group member to broadcast PSMs when positioned in the roadway while remaining part of the travel group.*
System Requirement	FR 1.06
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is connected to the mobile device and the MDEA application is installed • A pedestrian travel group member (traveler Y, not the group leader) is holding a mobile device at a taxi stop in a safe zone. • Tablet running CV Inspector application to verify DSRC messages

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Ad-Hoc Travel Group forms. (See Test Case 5.4.4.1 – Steps 1 through 4)				
2	Traveler Y stands still in a safe zone five (5) meters perpendicular from the roadway. Light-Duty vehicle passes the Taxi Stop	Traveler Y MDEA detects that it is in a safe zone and will display the grey safety indicator icon. This is verified by inspecting the MDEA logs. The MDEA does not broadcast PSMs. This is verified by inspection using CV Inspector.			
3	Traveler Y walks into the crosswalk halfway across the roadway – an unsafe zone – and stands still. Light-Duty vehicle passes the Taxi Stop	Traveler Y MDEA (detects that it is in an unsafe zone and will display the red safety indicator icon (as determined by the vehicle lanes specified in the received MAP file). This is verified by inspecting the MDEA logs. The MDEA broadcasts PSMs via DSRC. This is verified by inspection using CV Inspector.			
4	Traveler Y walks back to the starting point to the safe zone five (5) meters perpendicular from the roadway	Traveler Y MDEA detects that it is in a safe zone. This is verified by inspecting the MDEA logs. The MDEA does not broadcast PSMs. This is verified by inspection using CV Inspector.			

5.4.2 Personal Mobility Message

Test Case

Test Case ID	5.4.2.1
Test Case Name	PMM – Submitting Trip Requests – Single User
Test Objective	• Verify users are able to enter and submit trip requests • Verify users are able to enter and submit trip details through the application
System Requirement	FR 2.01, FR 2.01.01, FR 2.02, FR 2.03, FR 2.03.01, FR 2.04, FR 2.06, SIR 2.01, SIR 2.02, SIR 2.03, SIR 2.04, SIR 2.05, SIR 2.06, SIR 2.07, SIR 2.08, SIR 3.01, SIR 3.02, SIR 3.03, SIR 15.01, SIR 15.02, PR 5.04, PR 5.06
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is connected to the Mobile Device and the MDEA is installed and initiated for use • A pedestrian holding a mobile device is standing at a taxi stop in a safe zone • DSRC capable hardware is connected to the In-Vehicle Device and the VEA is installed and initiated for use • The Taxi is stationed within the DSRC range *Note: Devices are placed within 1,000 meters (generally accepted DSRC range given clear line of sight) of each other with a clear line of sight* • User interacts with the MDEA to enter and submit trip request to Taxi/Transit Vehicle

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Traveler X arrives at a stop.	None			
2	Traveler X prepares to schedule a trip.	MDEA displays “Trip Information” display. This is verified by inspection of the MEDA log.			
3	Traveler X enters trip request information including current Location, the Number of Travelers (associated to the Mobile Device user), Pickup Time, Destination, Mode of Transport, and Mobility Needs into the MDEA.	None			
4	Traveler X submits trip request information.	MDEA checks for any existing travelers via Wi-Fi Direct. This is verified by inspection of the MDEA log. Traveler X MDEA broadcasts PMM via DSRC. This is verified by inspection of the MDEA log. Taxi VEA receives PMM via DSRC. This is verified by inspection of the VEA Log.			
5	Taxi/Transit Vehicle Driver receives a Ride Request.	The VEA accepts the request.			
6	Taxi/Transit Vehicle driver accepts Ride Request.	Taxi VEA sends a PMM-RSP message via DSRC. This is verified by inspection of the VEA log. MDEA is notified with Accepted PMM request. This is verified by inspection of the MDEA Log.			

Test Case

Test Case ID	5.4.2.2
Test Case Name	PMM – Communicate with Cloud Infrastructure via Cellular
Test Objective	• Verify PMMs can be transmitted via various communications media
System Requirement	FR 2.03, FR 2.03.04, FR 2.06, PR 5.03, PR 5.04
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• Cellular communications capable hardware is connected to the Mobile Device and the MDEA Applications installed and initiated for use • A pedestrian holding a mobile device is standing at a transit stop in a safe zone • DSRC capable hardware is connected to the In-Vehicle Device and the VEA is installed and initiated for use • The Taxi/Transit Vehicle is stationed outside of DSRC range *Note: To accomplish this, devices are proposed be placed on opposite sides of the Turner Fairbank facility – the building is expected to provide enough interference to limit DSRC communications between the two devices. If this does not work, the alternative plan would be to drive the light-duty vehicle sufficiently far away from the Turner Fairbank campus*

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Traveler X arrives at a stop and enters trip request information. (See Test Case 5.4.2.1, Steps 1-3)				
2	Traveler X submits trip request information.	MDEA checks for any existing travelers via Wi-Fi Direct. This is verified by inspection of the MDEA log. Traveler X MDEA broadcasts PMM via DSRC. This is verified by inspection of the MDEA log. MDEA does not receive PMM-RSP in configurable interval. This is verified by inspection of the MDEA log. MDEA sends PMM to the cloud via Cellular. This is verified by inspection of the MDEA log. The cloud infrastructure receives the PMM. This is verified by inspection of the cloud infrastructure log. Taxi VEA receives PMM via Cellular. This is verified by inspection of the VEA Log.			
3	Taxi/Transit Vehicle Driver receives a Ride Request.	The VEA will accept the request. This is verified by visual inspection of the VEA display.			
4	Taxi/Transit Vehicle driver accepts Ride Request.	VEA sends PMM-RSP to the cloud via Cellular. This is verified by inspection of the VEA log. The cloud infrastructure receives the PMM-RSP. This is verified by inspection of the cloud infrastructure log. Taxi MDEA receives PMM-RSP via Cellular. This is verified by inspection of the MDEA Log.			

Test Case

Test Case ID	5.4.2.3
Test Case Name	PMM – Canceling Trip Requests
Test Objective	• Verify users are able to cancel trip requests
System Requirement	FR 2.03, FR 2.05, FR 2.06, FR 2.08, SIR 4.01, PR 5.4.2.3, PR 5.04
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is connected to the Mobile Device and the MDEA Applications installed and initiated for use • A pedestrian holding a mobile device is standing at a transit stop in a safe zone • DSRC capable hardware is connected to the In-Vehicle Device and the VEA is installed and initiated for use • The Taxi/Transit Vehicle is stationed within the DSRC range *Note: Devices are placed within 1,000 meters (generally accepted DSRC range given clear line of sight) of each other with a clear line of sight.*

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Traveler X arrives at a stop and arranges travel with a Taxi. (See Test Case 5.4.2.1, Steps 1-6)				
2	Traveler X submits a trip cancellation request.	Traveler X MDEA broadcasts PMM-CANCEL via DSRC. This is verified by inspection of the MDEA log. Taxi VEA receives PMM-CANCEL via DSRC. This is verified by inspection of the VEA Log.			
3	Taxi/Transit Vehicle driver receives a Ride Cancellation.	The currently-active trip will be removed from the display now that it has been canceled. This is verified by visual inspection of the VEA display.			

Test Case

Test Case ID	5.4.2.4
Test Case Name	PMM – Sending Arrival Messages
Test Objective	• Verify Taxis/Transit Vehicles are able to send arrival messages • Verify Taxis/Transit Vehicles are able to send arrival details through the application
System Requirement	FR 2.09, FR 2.10, SIR 5.01, SIR 5.02, SIR 5.04, SIR 15.02, SIR 15.04, SIR 15.05
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is connected to the Mobile Device and the MDEA Applications installed and initiated for use • A pedestrian holding a mobile device is standing at a transit stop in a safe zone • DSRC capable hardware is connected to the In-Vehicle Device and the VEA is installed and initiated for use • The Taxi/Transit Vehicle is stationed within the DSRC range *Note: Devices are placed within 1,000 meters (generally accepted DSRC range given clear line of sight) of each other with a clear line of sight.*

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Traveler X arrives at a stop and arranges travel with a Taxi. (See Test Case 5.4.2.1, Steps 1-6)				
2	Taxi/Transit Vehicle arrives Traveler X's stop.	Taxi VEA broadcasts PMM-ARRIVE via DSRC at configured interval. This is verified by inspection of the VEA log. Traveler X MDEA receives PMM-ARRIVE via DSRC. This is verified by inspection of the MDEA Log.			
3	Traveler X receives arrival message.	An action screen will be displayed to the traveler that the Taxi is about to arrive. This is verified by visual inspection of the MDEA display.			
4	Traveler X enters Taxi/Transit Vehicle and departs from the stop.	Taxi VEA ceases broadcasting PMM-ARRIVE via DSRC. This is verified by inspection of the VEA log.			

5.4.3 Basic Safety Message

Test Case

Test Case ID	5.4.3.1
Test Case Name	BSM – Vehicle Experimental Application Functionality
Test Objective	• Verify ability to generate BSMs by vehicles equipped with DSRC Radio and VEA Application • Verify BSM message contents • Verify ability to receive BSMs by vehicles equipped with DSRC Radio and VEA Application
System Requirement	FR 4.01, FR 4.01.01, FR 4.02, FR 4.03, SIR 7.01, SIR 7.02, SIR 7.03, SIR 7.04, SIR 15.07
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is installed on the vehicle and VEA application is installed • Other DSRC equipped vehicles transmitting BSMs in the DSRC area • Tablet running CV Inspector application to verify DSRC messages • Access to RSU admin web portal to verify BSM message activity

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Launch VEA Application if it's not running.	VEA application starts up and starts to broadcast BSM messages			
2	Launch CV Inspector Application	Application is initialized and a map zoomed into the test area is displayed Observe BSM message traffic on the CV Inspector. Verify that the location of the vehicle is updated on the map as the vehicle is moving 2-3 times per second.			
3	Open a browser and browse to RSU web admin portal at IP Address _____	Browser displays the RSU login page			
4	Log in to the portal using username:_____ password:_____ and click on the "View Message Activity" under Main Menu	Browser displays BSM module status, showing number of processed BSMs to indicate reception of a BSM message.			
5	Browse to the message log screen and filter data for BSM messages or log in to the database and execute the following query: <insert query>	The BSM message data is displayed. Inspect data to verify vehicle location, vehicle speed, vehicle heading, and vehicle size are logged. Inspect the timestamps to indicate that BSMs are being logged every tenth of a second.			

5.4.4 Ad-hoc Travel Group

Test Case

Test Case ID	5.4.4.1
Test Case Name	ATG – Creating Coordination between the Mobile Devices of Travelers – Multiple Travelers
Test Objective	• Verify travelers are able to temporarily be grouped into ad-hoc travel group and transmit trip request through the application • Verify travelers are able to transmit trip requests as a group (with a leader) rather than transmitting individual messages from every member of the group • Verify the ad-hoc group leader is able to enter and submit ad-hoc group trip details through the application
System Requirement	FR 2.07, FR 5.01, FR 5.01.01, FR 5.02, FR 5.03, FR 5.03.01, FR 5.04, FR 5.06, FR 5.06.01, FR 5.07, SIR 8.01, SIR 8.02, SIR 8.03, SIR 8.04, SIR 8.05, SIR 8.06, SIR 8.07, SIR 8.10, SIR 8.11, SIR 15.08, SIR 20.01, PR 5.06
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is connected to the Mobile Devices and the MDEA is installed and initiated for use in each • Pedestrians holding Mobile Devices are standing five (5) meters perpendicular to the edge of the roadway at the crosswalk in a safe zone • DSRC capable hardware is connected to the In-Vehicle Device and the VEA is installed and initiated for use • The Taxi/Transit Vehicle is stationed within the DSRC range *Note: Devices are placed within 1,000 meters (generally accepted DSRC range given clear line of sight) of each other with a clear line of sight* Users interact with the MDEA to enter and submit trip request to Taxi/Transit Vehicle

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Traveler X arrives at a stop. Schedules a trip. (See Test Script for Test Case 5.4.2.1 – Steps 1 through 5)	Ride Request Monitor looks for a local group for the same trip. None is found. MDEA establishes a new Group ABC, Leader 1, adds self as Pending member and enters Leader mode.			
2	Taxi/Transit Vehicle receives a Ride Request.	Ride Request Monitor identifies a new PMM request with the Destination, Departure Time, Seat Type and Vehicle Type requested. The VEA accepts the request.			
3	Taxi/Transit Vehicle driver accepts Ride Request.	Taxi/Transit Vehicle sends a PMM-RSP message via DSRC. MDEA is notified of accepted PMM request.			
4	Traveler Y arrives at a stop. Schedules a trip to the same destination location as Traveler X.	Ride Request Monitor looks for a local group for the same trip. One (1) is found. MDEA asks to be added to existing Group ABC via Wi-Fi Direct. MDEA of Leader receives request, adds Traveler Y to Pending Members and returns acceptance for Traveler Y to become follower within Group ABC. MDEA of Traveler Y receives response and enters Follower mode. MDEA of Traveler X (Group ABC Leader), creates new Pending PMM Request to dispatch to Taxi/Transit Vehicle, reflecting two (2) seats required.			
5	Taxi/Transit Vehicle receives updated Ride Request.	Ride Request Monitor identifies an updated PMM request with the Destination, Departure Time, Seat Type and Vehicle Type requested. The VEA accepts the request.			
6	Taxi/Transit Vehicle Driver Accepts the PMM Request displayed on VEA.	Group ABC Leader receives a PMM-RSP from VEA indicating it has accepted PMM Request for two (2) seats.			

Step	Test Action	Expected Results	Pass/Fail P	Pass/Fail F	Actual Results
7	Traveler Z arrives at a stop. Schedules a trip to the same destination location as Traveler X and Y.	Ride Request Monitor looks for a local group for the same trip. One (1) is found. MDEA asks to be added to existing Group ABC via Wi-Fi Direct. MDEA of Leader receives request, adds Traveler Z to Pending Members and returns acceptance for Traveler Z to become follower within Group ABC. MDEA of Traveler Z receives response and enters Follower mode. MDEA of Traveler X (Group ABC Leader), creates new Pending PMM Request to dispatch to Taxi/Transit Vehicle, reflecting three (3) seats required.			
8	Taxi/Transit Vehicle receives updated Ride Request.	Ride Request Monitor identifies a new PMM request with the Destination, Departure Time, Seat Type and Vehicle Type requested. The VEA accepts the request.			
9	Taxi/Transit Vehicle Driver Accepts the updated PMM Request displayed on VEA.	VEA accepts updated PMM Request. Group ABC Leader receives a PMM-RSP from VEA indicating it has accepted PMM Request for three (3) seats.			
10	Traveler W arrives at a stop. Schedules a trip to the same destination location as Traveler X, Y and Z.	Ride Request Monitor looks for a local group for the same trip. One (1) is found. MDEA asks to be added to existing Group ABC via Wi-Fi Direct. MDEA of Leader receives request, determines the max group size (3) has been reached and rejects the request. MDEA of Traveler W ~~receives rejection and~~ creates new PMM Request for a new Group. Correction: Traveler W will not "receive rejection" however will create a new PMM Request and a new group.			

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
11	Taxi/Transit Vehicle arrives stop.	VEA sends PMM-ARRIVE with location and arrival time to Group Leader MDEA via DSRC of Group ABC. Group ABC leader's MDEA forwards the Arrival message to the followers The MDEA's notify all travelers about the vehicle arrival using a display alert			

Test Case

Test Case ID	5.4.4.2
Test Case Name	ATG – Leaving an Ad-Hoc Travel Group Based on Distance – Multiple Travelers
Test Objective	• Verify that an Ad-Hoc Travel Group Leader's Mobile Device can detect when a Mobile Device within the Ad-Hoc Travel Group leaves the Travel Group by exceeding the configurable distance between the Travel Group Leader
System Requirement	FR 5.01.03, FR 5.08, SIR 8.20, SIR 8.21, SIR 8.22, PR 5.06
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is connected to the Mobile Devices and the MDEA is installed and initiated for use in each • Pedestrians holding Mobile Devices are standing five (5) meters perpendicular to the edge of the roadway at the crosswalk in a safe zone • Mobile Device leaves Ad-Hoc Travel Group if exceeding Wi-Fi Direct range

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Ad-Hoc Travel Group forms. (See Test Case 5.4.4.1 – Steps 1 through 9)	None			
2	Ad-Hoc Travel Group Member walks away from Ad-Hoc Travel Group Leader's Mobile Device exceeding the Wi-Fi Direct range (e.g., 200 meters). 75 m was selected for ease of testing.	Ad-Hoc Travel Group Leader's MDEA detects change in group. Ad-Hoc Travel Group Leader's MDEA automatically updates PMM with number of seats requested and sends it to the Taxi/Transit Vehicle via DSRC/Cellular.			
3	Taxi/Transit Vehicle Receives updated Ride Request.	The VEA accepts the request.			
4	Taxi/Transit Vehicle Driver enters acceptance of updated PMM into VEA.	VEA sends a PMM-RSP message via DSRC. MDEA is notified with Accepted PMM request			

Test Case

Test Case ID	5.4.4.3
Test Case Name	ATG – Leaving an Ad-Hoc Travel Group by Choice – Multiple Travelers
Test Objective	• Verify that an Ad-Hoc Group Leader's Mobile Device can detect when a Mobile Device within the Ad-Hoc Travel Group requests to leave the Travel Group
System Requirement	FR 5.05, FR 5.09
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is connected to the Mobile Devices and the MDEA is installed and initiated for use in each • Pedestrians holding Mobile Devices are standing five (5) meters perpendicular to the edge of the roadway at the crosswalk in a safe zone • Ad-Hoc Travel Group Members interact with the Mobile Device and requests to leave the Ad-Hoc Travel Group manually

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Ad-Hoc Travel Group forms. (See Test Case 5.4.4.1 – Steps 1 through 9)	None			
2	Ad-Hoc Travel Group Member requests to leave the Travel Group by submitting cancel request manually.	Ad-Hoc Travel Group Leader's Mobile Device receives the cancel request via Wi-Fi Direct. Ad-Hoc Travel Group Leader's Mobile Device automatically creates and sends an updated (group) PMM to Taxi/Transit Vehicle via DSRC.			
3	Taxi/Transit Vehicle Receives updated Ride Request.	The VEA accepts the request.			
4	Taxi/Transit Vehicle Driver enters acceptance of updated PMM into VEA.	VEA sends a PMM-RSP message via DSRC. MDEA is notified with Accepted PMM request.			

Test Case

Test Case ID	5.4.4.4
Test Case Name	ATG – Disbanding Ad-Hoc Travel Group when Entering a Vehicle or any other Reason
Test Objective	• Verify that Ad-Hoc Travel Group Leader's Mobile Device can disband an Ad-Hoc Travel Group when entering a vehicle
System Requirement	FR 5.10, FR 5.11, SIR 8.30, SIR 8.31
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is connected to the Mobile Devices and the MDEA is installed and initiated for use in each • Pedestrians holding Mobile Devices are standing five (5) meters perpendicular to the edge of the roadway at the crosswalk in a safe zone • Ad-Hoc Travel Group Leader's MDEA detects vehicle entry and disbands group

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Ad-Hoc Group forms. (See Test Case 5.4.4.1 – Steps 1 through 9)	None			
2	Taxi/Transit Vehicle approaches and arrives at stop.	VEA issues a PMM-ARRIVE via DSRC to Ad-Hoc Travel Group Leader's Mobile Device. MDEA receives the PMM-ARRIVE.			
3	Ad-Hoc Travel Group enters Taxi/Transit Vehicle.	MDEA updates its vehicle status to "In Vehicle" and sends Coordination End message to all Travel Group members to disband group. Log of "Uncoordinated" status will show on Group Leader MDEA and a Status of "In Vehicle".			

5.4.5 Entering and Leaving Light-Duty Vehicle

Test Case

Test Case ID	5.4.5.1
Test Case Name	LDV – Bluetooth Proximity Sensor Functionality to Detect Passenger Entry into and Exiting from the Light-Duty Vehicle
Test Objective	• Demonstrate prototype capability to detect passenger entry into vehicle • Demonstrate prototype capability to detect passenger exiting from vehicle
System Requirement	FR 1.03, FR 6.01, FR 6.03, FR 7.01, FR 7.03, FR 7.04, SIR 15.09, SIR 20.03, PR 1.16, PR 1.17, PR 1.18, PR 1.19
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• Light-Duty vehicle equipped with Estimote Bluetooth sensor • Passenger with Mobile Devices with experimental application initiated and running • Countdown timer to measure status change time to detect entry or exit events • Tablet running CV Inspector application to verify DSRC messages • MDEA Setting 'Send Psm Control' should be set to "IgnoreSafeZoneRule"

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Passenger is waiting and a vehicle equipped with Estimote beacon is approaching the stop	MDEA displays its vehicle status indicator as a red not-in-car icon. This is verified by visual inspection of the MDEA display. Inspect the CV Inspector to verify the reception of PSM			
2	Vehicle stops at the stop	MDEA continues to indicate vehicle status icon as red/"NOT IN VEHICLE". This is verified by visual inspection of the MDEA display			
3	Passenger embarks (opens the door to vehicle~~) and vehicle starts to move~~. A test Observer ~~in the vehicle~~ starts the countdown timer from 3 seconds.	MDEA updates its vehicle status indicator to a green in-car icon within 3 seconds of Vehicle starting to move. This is verified by visual inspection of the MDEA display and the countdown timer.			
4	At the moment, the mobile device application updates its vehicle status to "IN VEHICLE" the test observer notes whether or not the countdown has expired.	Inspect the CV Inspector to verify that the PSM broadcasting has ceased.			
5	Vehicle stops, passenger disembarks the vehicle (closes door) and starts to walk away from the vehicle. A test Observer outside of the vehicle starts the countdown timer from 3 seconds as the passenger steps outside.	Mobile device application updates its vehicle status icon to red/"NOT IN VEHICLE" within 3 seconds of passenger exiting the vehicle. This is verified by visual inspection of the MDEA display and the countdown timer.			
6	At the moment, the mobile device application updates its vehicle status to "NOT IN VEHICLE" the test observer notes whether or not the countdown has expired. Vehicle drives away.	Inspect the CV Inspector to verify the reception of PSM			

Test Case

Test Case ID	5.4.5.2
Test Case Name	LDV – Mobile Device Accelerometer Sensor Functionality to Detect Passenger Entry into and Exiting from the Light-Duty Vehicle
Test Objective	• Demonstrate prototype capability to detect passenger entry into vehicle • Demonstrate prototype capability to detect passenger exiting from vehicle
System Requirement	FR 1.03, FR 1.04, FR 6.01, FR 6.02, FR 6.03, FR 6.04, FR 7.02, FR 7.05
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• Light-Duty vehicle not equipped with Estimote Bluetooth Sensor • Passenger with Mobile Devices with experimental application initiated and running • Countdown timer to measure status change time to detect entry or exit events • MDEA Setting 'In Vehicle Detection' should be set to "UseGps" • MDEA Setting 'Send Psm Control' should be set to "IgnoreSafeZoneRule"

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Passenger is waiting and a vehicle is approaching the stop	MDEA displays its vehicle status indicator as a red not-in-car icon. This is verified by visual inspection of the MDEA display. Inspect the CV Inspector to verify the reception of PSM			
2	Vehicle stops at the stop	MDEA continues to indicate vehicle status icon as red/"NOT IN VEHICLE". This is verified by visual inspection of the MDEA display			
3	Passenger embarks (opens the door to vehicle~~) and vehicle starts to move~~. A test Observer ~~in the vehicle~~ starts the countdown timer from 3 seconds.	MDEA updates its vehicle status indicator to a green in-car icon within 3 seconds of Vehicle starting to move. This is verified by visual inspection of the MDEA display and the countdown timer.			
4	At the moment, the mobile device application updates its vehicle status to "IN VEHICLE" the test observer notes whether or not the countdown has expired.	Inspect the CV Inspector to verify that the PSM broadcasting has ceased.			
5	Vehicle stops, passenger disembarks the vehicle (closed door) and starts to walk away from the vehicle. A test Observer outside of the vehicle starts the countdown timer from 3 seconds as the passenger steps outside.	Mobile device application updates its vehicle status to "NOT IN VEHICLE" within 3 seconds of passenger exiting the vehicle. This is verified by visual inspection of the MDEA display and the countdown timer.			
6	At the moment, the mobile device application updates its vehicle status to "NOT IN VEHICLE" the test observer notes whether or not the countdown has expired. Vehicle drives away	Inspect the CV Inspector to verify the reception of PSM			

5.4.6 Message Logging

Test Case

Test Case ID	5.4.6.1
Test Case Name	MGL – RSU DSRC Message Logging
Test Objective	• Verify all DRSC messages are logged and timestamped
System Requirement	FR 10.01, SIR 16.01, SIR 20.05, PR 1.20, PR 1.21, PR 1.23, PR 1.24
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• Access to database on RSU • Access to a database browser tool

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Query the RSU database to verify that DSRC messages are being logged by executing the query: _____	The query returns data for all DSRC messages that are logged including the millisecond-based timestamps of when the message was transmitted.			

Test Case

Test Case ID	5.4.6.2
Test Case Name	MGL – Cloud Service Message Logging
Test Objective	• Verify all messages are logged and timestamped in the Cloud
System Requirement	FR 10.02, SIR 16.02
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• Access to database on Azure Cloud Service • Access to a Cloud Service Studio to view data

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Query the Azure database to verify that cellular messages are being logged by executing the query: Select * from PMMRequests where RequestDate > “TBD” and RequestDate < “TBD”; Select * from PMMResponses where RequestDate > “TBD” and RequestDate < “TBD”	The query returns data for all cellular messages that are logged including the millisecond-based timestamps of when the message was transmitted.			

Test Case

Test Case ID	5.4.6.3
Test Case Name	MGL – Mobile Device Experimental Application Message Logging
Test Objective	• Verify all sent and received mobile device messages are logged and timestamped • Verify all messages displayed to the users on the mobile device are logged
System Requirement	FR 10.03, FR 10.04
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• Access to database on Mobile Device • Access to SQLiteManager

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Query the MDEA's database to verify messages being logged by executing the query:	The query returns data for all sent and received messages including the millisecond-based timestamps of when the message was transmitted.			
2	View the message activity log	All message displayed to the users are logged with timestamps of occurrence.			

Test Case

Test Case ID	5.4.6.4
Test Case Name	MGL – Vehicle Experimental Application Message Logging
Test Objective	• Verify all messages sent and received by the vehicle are logged and timestamped • Verify all messages displayed to the driver of the vehicle are logged
System Requirement	FR 10.05, FR 10.06
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• Access to Vehicle Experimental Application log files • Access to Vehicle Experimental Application database • Access to Application Admin Portal • Access to a database browser tool

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Query the VEA's database to verify messages being logged by executing the query:	The query returns data for all sent and received messages including the millisecond-based timestamps of when the message was transmitted.			
2	View the message activity log	All message displayed to the users are logged with timestamps of occurrence.			

5.4.7 Safety

Test Case

Test Case ID	5.4.7.1
Test Case Name	SFY – Safety Notifications (Mobile Device User in Unsafe Zone)
Test Objective(s)	• Verify the ability of the MDEA to provide an advisory notification to the pedestrian • Verify the ability of the VEA to provide an advisory notification to the driver • Verify the ability of the MDEA to provide an alert notification to the pedestrian • Verify the ability of the VEA to provide an alert notification to the driver • Verify the ability of the MDEA to provide a warning notification to the pedestrian • Verify the ability of the VEA to provide a warning notification to the driver
System Requirement	FR 11.01, FR 11.02, FR 11.03, FR 11.04, FR 11.05, FR 11.06
Verification Method	Test
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• DSRC capable hardware is installed on the vehicle and the VEA application is installed • DSRC capable hardware is connected to the mobile device and the MDEA application is installed • The test is repeated with the mobile device in various locations (in-hand, in-pocket, in-backpack) on the pedestrian • The pedestrian must be standing in the path of the vehicle • MDEA Setting 'Send Psm Control' should be set to "IgnoreSafeZoneRule"

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	The Light-Duty vehicle accelerates up to 25 mph.	None			
2	The Light-Duty vehicle maintains constant speed of 25 mph.	None			
3	The Light-Duty vehicle comes within 100 meters of the mobile device.	Mobile device issues advisory to pedestrian. This is verified by inspection of the MDEA and detailed analysis of the MDEA Logs. Vehicle issues advisory to driver. This is verified by inspection of the VEA and detailed analysis of the VEA Logs.			
4	The Light-Duty vehicle comes within 57 meters of the mobile device. (the Light-Duty vehicle is moving toward the pedestrian.)	Mobile device issues alert to pedestrian. This is verified by inspection of the MDEA and detailed analysis of the MDEA Logs. Vehicle issues alert to driver. This is verified by inspection of the VEA and detailed analysis of the VEA Logs.			
5	The Light-Duty vehicle comes within 49 meters of the mobile device. (the Light-Duty vehicle is moving toward the pedestrian.)	Mobile device issues warning to pedestrian. This is verified by inspection of the MDEA and detailed analysis of the MDEA Logs. Vehicle issues warning to driver. This is verified by inspection of the VEA and detailed analysis of the VEA Logs.			

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
6	The Light-Duty vehicle passes the location where the pedestrian is standing (the Light-Duty vehicle is moving away from the pedestrian).	Mobile device ceases issuing warning to pedestrian. Mobile device ceases issuing alert to pedestrian. This is verified by inspection of the MDEA and detailed analysis of the MDEA Logs. Vehicle ceases issuing warning to driver. Vehicle ceases issuing alert to driver. This is verified by inspection of the VEA and detailed analysis of the VEA Logs.			
7	The Light-Duty vehicle continues at a constant speed until it is more than ~~100~~25 meters of the mobile device.	Mobile device does not issue advisory to pedestrian. This is verified by inspection of the MDEA and detailed analysis of the MDEA Logs. Vehicle does not issue advisory to driver. This is verified by inspection of the VEA and detailed analysis of the VEA Logs.			
8	The Light-Duty vehicle decelerates to a stop.	None			

5.4.8 SPAT and MAP Support

Test Case

Test Case ID	5.4.8.1
Test Case Name	SMP – SPAT and MAP Message Support
Test Objective(s)	• Verify the ability of the MDEA to receive SPAT and MAP messages
System Requirement	SIR 9.01, SIR 9.02, SIR 9.03, SIR 10.01, SIR 10.02, SIR 10.03, SIR 10.04, SIR 15.10, SIR 15.11, PR 1.01, PR 1.02, PR 1.15, PR 2.02
Verification Method	Testing
Test Date	
Test Location	
Tester Name	
Test Method/ Configuration Comments	• Availability of an RSU connected to a Signal Controller to broadcast SPAT and MAP messages • DSRC capable hardware is connected to the mobile device and the MDEA application is installed • Tablet running CV Inspector application to verify DSRC messages

Test Script

Step	Test Action	Expected Results	Pass/Fail		Actual Results
			P	F	
1	Observe signal controller and CV Inspector to monitor the simulated signal status.	CV Inspector display reflects the status of the simulated signal controller phases and actuations on a map using the SPAT and MAP message data.			
2	Inspect MDEA log for SPAT and MAP messages	SPAT and MAP messages are logged at 1 second and 5 second frequencies respectively.			

APPENDIX B. Acronyms and Abbreviations

ATG	Ad-Hoc Travel Group
ATP	Acceptance Test Plan
BSM	Basic Safety Message
CCP	Common Computing Platform
CV	Connected Vehicle
DSRC	Dedicated Short Range Communications
EPS	Experimental Prototype System
FHWA	Federal Highway Administration
FR	Functional Requirement
ITS	Intelligent Transportation Systems
LDV	Light-Duty Vehicle
MAP	Map Data
MDEA	Mobile Device Experimental Application
MGL	Message Logging
OBU	On-board Unit
PMM	Personal Mobility Message
PMM-ARRIVE	Personal Mobility Message Arrival Message
PMM-CANCEL	Personal Mobility Message Cancel Message
PMM-RSP	Personal Mobility Message Response Message
PR	Performance Requirement
PSM	Personal Safety Message
REA	Roadside Experimental Application
RSU	Roadside Unit
SFY	Safety
SIR	System Interface Requirement
SMP	SPaT and MAP
SPaT	Signal Phasing and Timing
SyRS	System Requirements Specifications
TFHRC	Turner-Fairbank Highway Research Center
U.S. DOT	U.S. Department of Transportation

VEA	Vehicle Experimental Application
Wi-Fi	Wireless Fidelity

APPENDIX C. Terms and Definitions

Basic Safety Message (BSM)	Connected vehicle message type which contains vehicle safety-related information that is broadcast to surrounding vehicles
Bluetooth	Short range wireless technology used to exchange data between enabled devices
Cellular	Uses short-range radio stations to cover areas of communication
Connected Vehicle	A vehicle that can communicate with other vehicles and infrastructure via communication media such as DSRC, Wi-Fi, cellular or Bluetooth
Coordinated	Messages are coordinated when two or more mobile devices have establish a travel group based on the same origin, destination, and time, and function as a single, cohesive sender/recipient
CV Inspector	An application that verifies if the Mobile Device is broadcasting messages to Connected Vehicles
Destination	The end point of a traveler's trip
Dedicated Short-Range Communications (DSRC)	A low-latency, high-reliability, two-way communications tool used for sending transportation safety messages
Light-Duty Vehicle	Of or relating to vehicles that way less than 4,000 lbs
Message Type	Type of personal safety or personal mobility message that is transmitted based on the technology used and level of coordination available
Personal Mobility Message (PMM)	Similar to PDM, message intended for the exchange of mobility messages between individual travelers and vehicles/infrastructure, via mobile device
Personal Safety Message (PSM)	Similar to BSM, message intended to transmit low-latency, urgent safety messages between individual travelers and vehicles/infrastructure, via mobile device
Test Case	A set of conditions or variables that a Tester can determine if system meets requirements
Transit Vehicle	Large vehicles mainly used for public transportation as well as support services.
Transmitting	The state in which a traveler has opted in and is sending/receiving messages via mobile device
Uncoordinated	Messages are uncoordinated when travel groups are not established (see coordinated definition)
Wi-Fi	Local area wireless technology that allows enabled devices to connect to the Internet

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-17-507