



UNITED STATES
DEPARTMENT OF TRANSPORTATION

INTEGRATED LIGHT VEHICLE MODEL DEPLOYMENT RESEARCH PROJECT UPDATE

ITS-JPO Public Workshop
September 24, 2013

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V2V MD Collaborative Research Overview

V2V-Model Deployment (MD) Project is a collaborative effort between the Crash Avoidance Metrics Partnership Vehicle Safety Communications 3 (CAMP VSC3) Consortium and the US DOT

CAMP
Vehicle Safety Communications 3

Mercedes-Benz
Research & Development North America, Inc.

GM

TOYOTA

HONDA
Honda R&D Americas

Ford

NISSAN

HYUNDAI-KIA MOTORS
Hyundai-Kia America Technical Center, Inc.

KIA

VOLKSWAGEN
GROUP OF AMERICA

Intelligent Transportation Systems

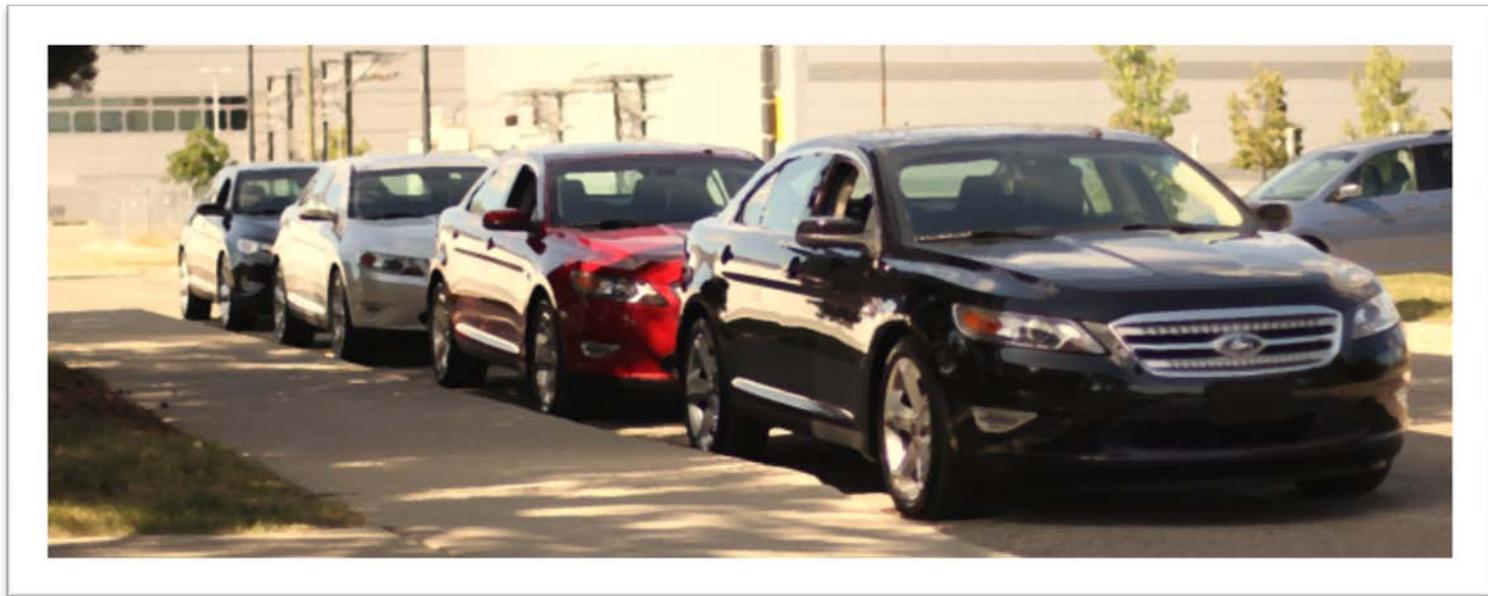


AUTOMOTIVE EVENTS



V2V Model Deployment Project

- Build and maintain sixty-four integrated light vehicles for Safety Pilot Model Deployment
- Harvest data monthly for the independent evaluation of safety applications
- Establish BSM minimum performance requirements based upon Safety Pilot data analysis





Integrated Vehicle Builds



V2V Model Deployment Safety Applications

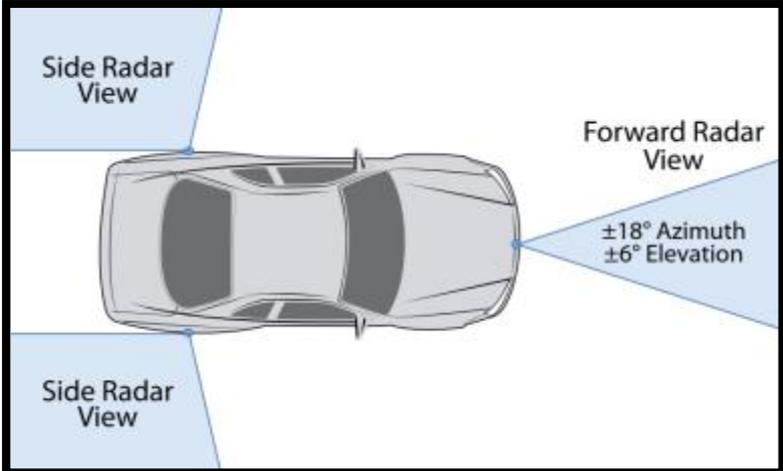
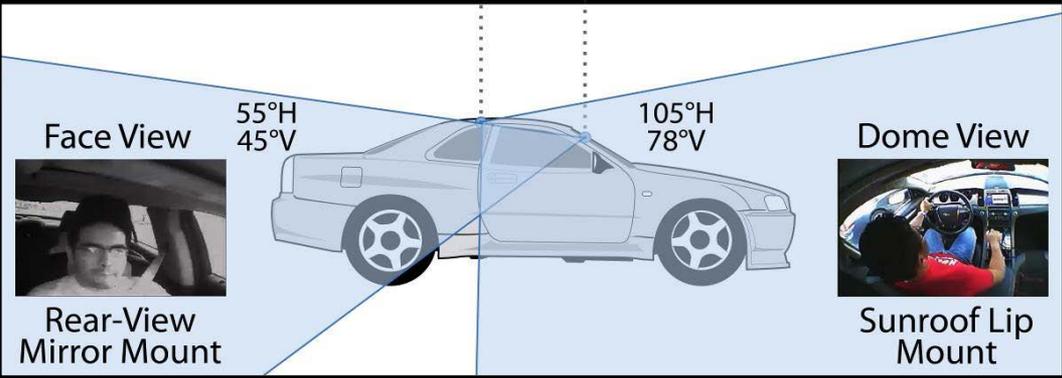
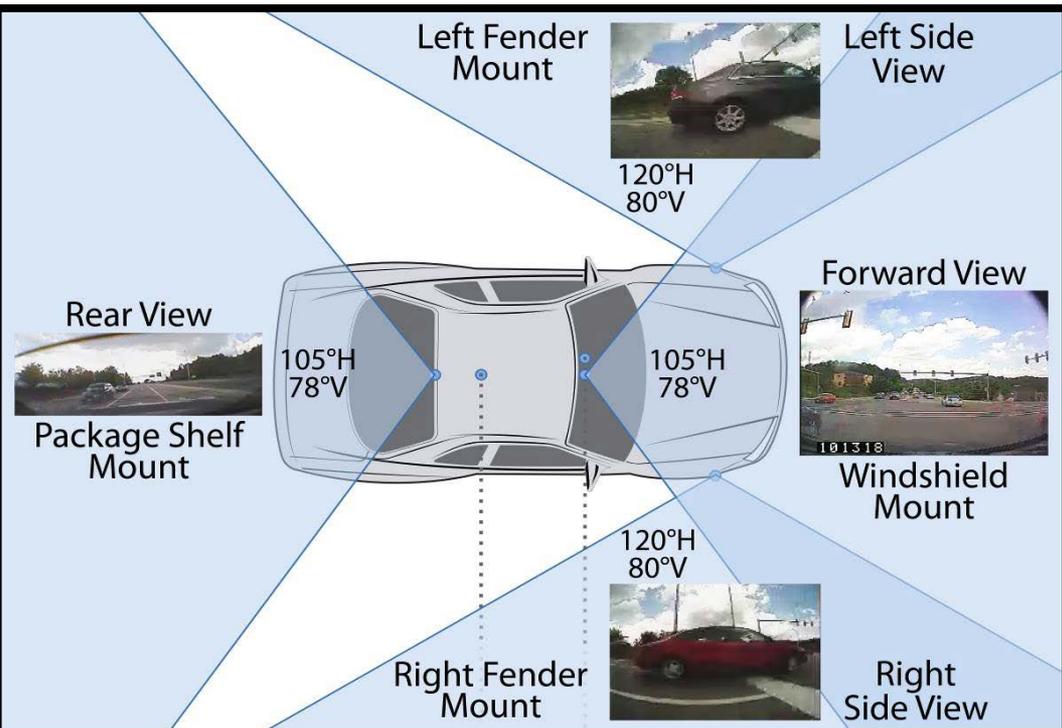
OEM/Applications	Ford	GM	Honda	Mercedes	Toyota	Hyundai-Kia	Nissan	VW-Audi
EEBL	X	X	X	X	X			X
FCW	X	X	X	X		X	X	X
BSW / LCW	X	X	X	X	X	X	X (BSW)	
DNPW	X	X	X					
IMA	X	X	X	X	X			X
LTA							X	

EEBL: Emergency Electronic Brake Lights
 FCW: Forward Collision Warning
 BSW/LCW: Blind Spot Warning/Lane Change Warning

DNPW: Do Not Pass Warning
 IMA: Intersection Movement Assist
 LTA: Left Turn Assist

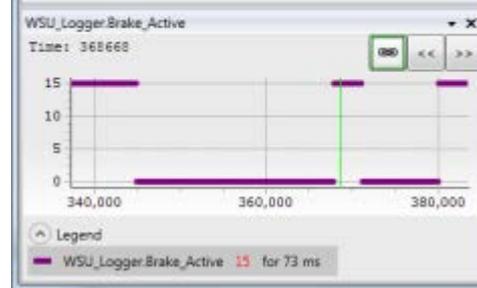
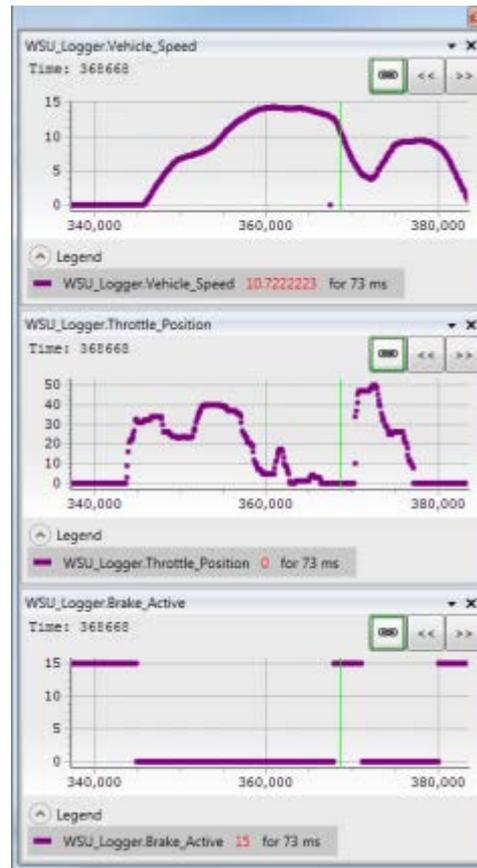
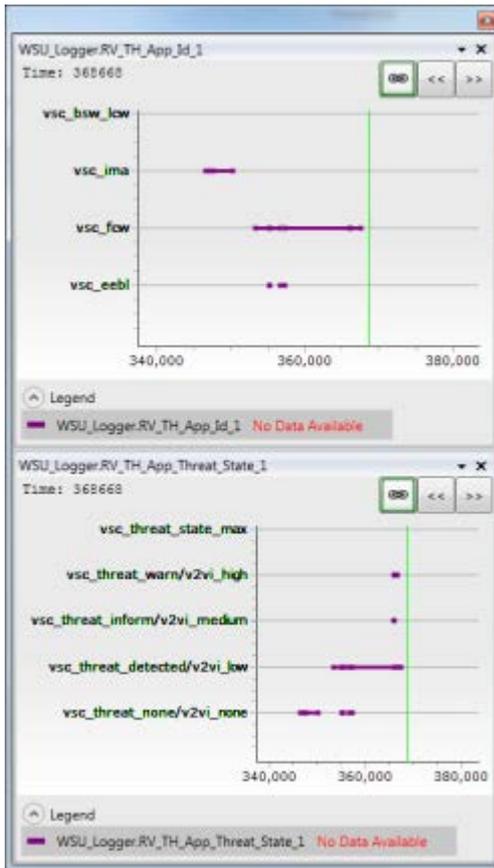


DAS Components Camera & Radar Views



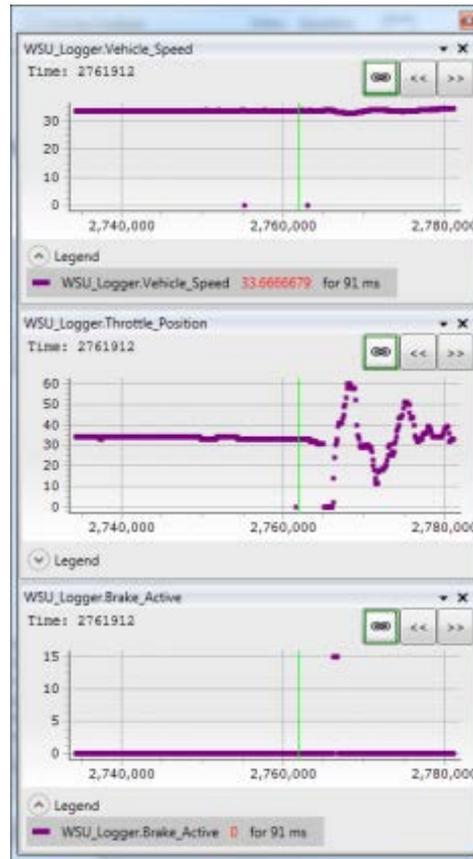
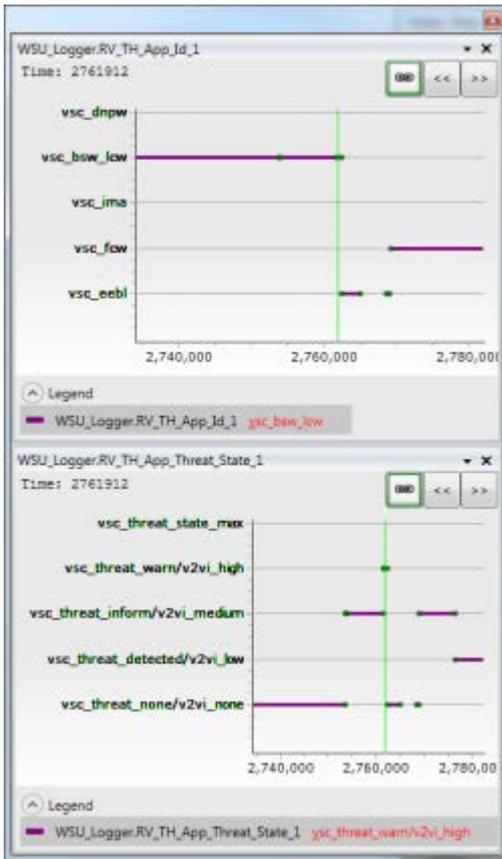
Event Examples

FCW



Event Examples

BSW

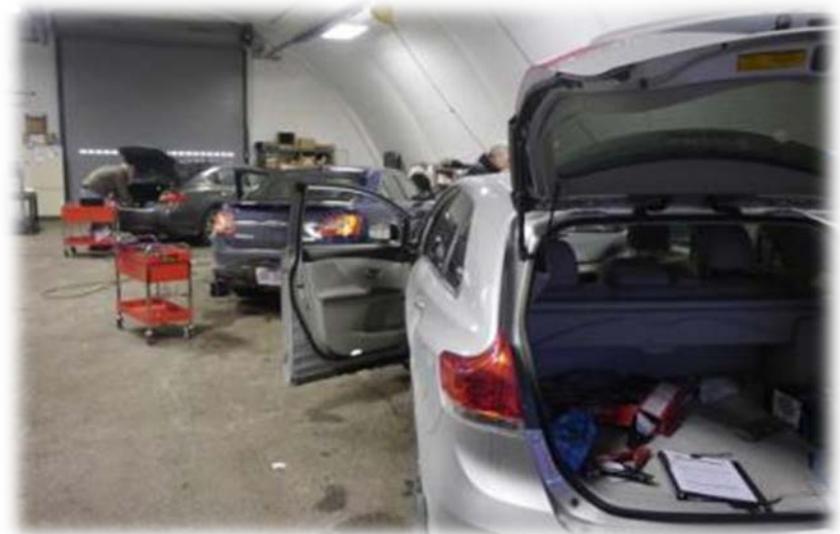


ILV Data Harvest Summary

Harvest:	Trips:
01	6335
02	10827
03	9399
04	9068
05	11937
06	7560
07	11318
08	9869
09	9053
10	In Queue
TOTAL	85366

Data Export Facts:

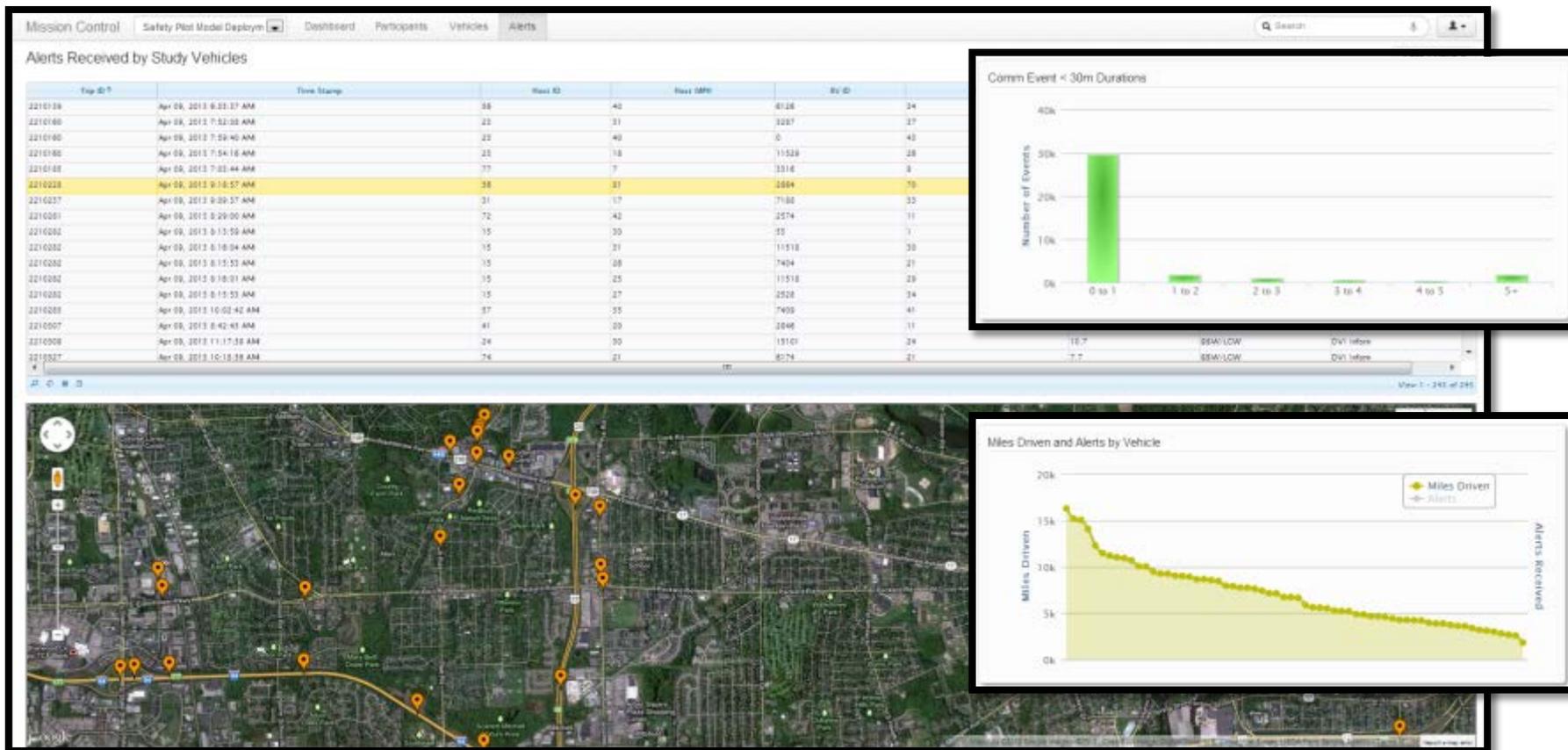
- Database Size: 361 GB
- Video Size: 10.3 TB



Remote Monitoring

All vehicles are remotely monitored via cell link

- Study parameters are tracked to ensure exposure is sufficient
- Systems are scheduled for repair when anomalies detected



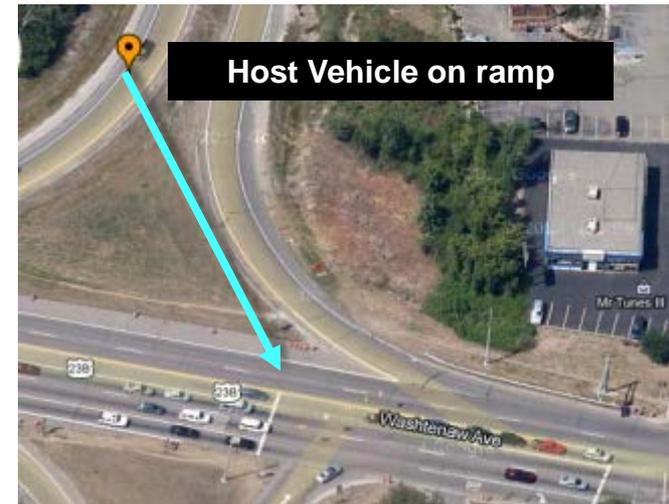
CAMP VSC 3 OEM Alert Analysis

- Alerts are being classified into the following categories:
 - True Positives
 - Valid
 - Nuisance Alert
 - False Positives, with the following as potential root causes:
 - Algorithmic
 - Road Geometry (curved roads, overpass/underpass, cloverleaf)
 - Environmental (challenging GPS conditions, VAD/ASD installation misconfigurations, etc.)
 - System synchronization errors
 - Unknown
- Model Deployment Data provides a rich set of connected vehicle naturalistic data that will guide future development
 - Safety application and warning timing refinement
 - Minimum performance requirements/standards



IMA improvements from Phase I to Phase II

Example IMA false alert scenarios observed during Phase I and eliminated in Phase II



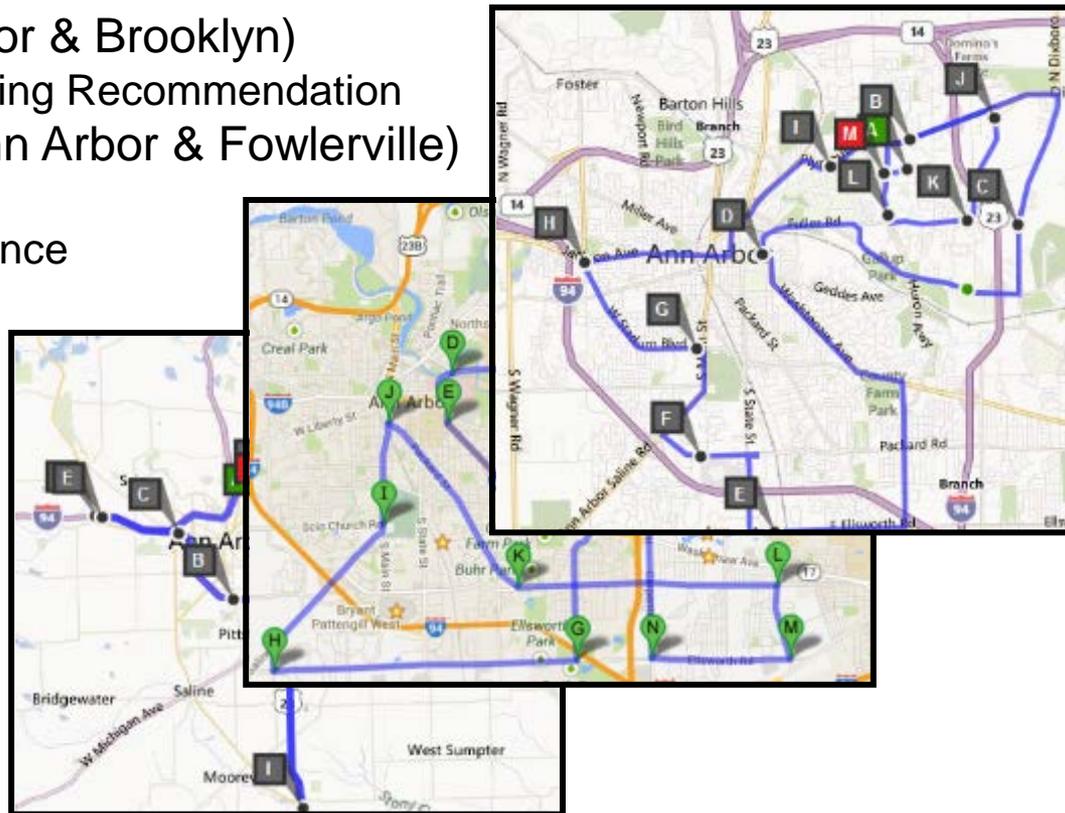
VAD/ASD Performance Characterization

Safety Application Level Testing:

- Integrated Light Vehicle (ILV) application performance against ASDs / VADs
- Characterize w.r.t Basic Safety Message (BSM) elements
- Update of Minimum Performance Requirements (MPR)

Tests Conducted:

- Sep 2012 VAD Tests (Ann Arbor & Brooklyn)
 - Acceleration and Speed Filtering Recommendation
- April 2013 VAD/ASD Tests (Ann Arbor & Fowlerville)
 - Application Performance
 - Relative Positioning Performance
 - BSM Element Performance



Summary of Safety Application Tests

Primary focus is Application Testing:

- Integrated light vehicles as host vehicles
- Target Vehicles with ASD/VADs mounted as recommended in Model Deployment

Performance:

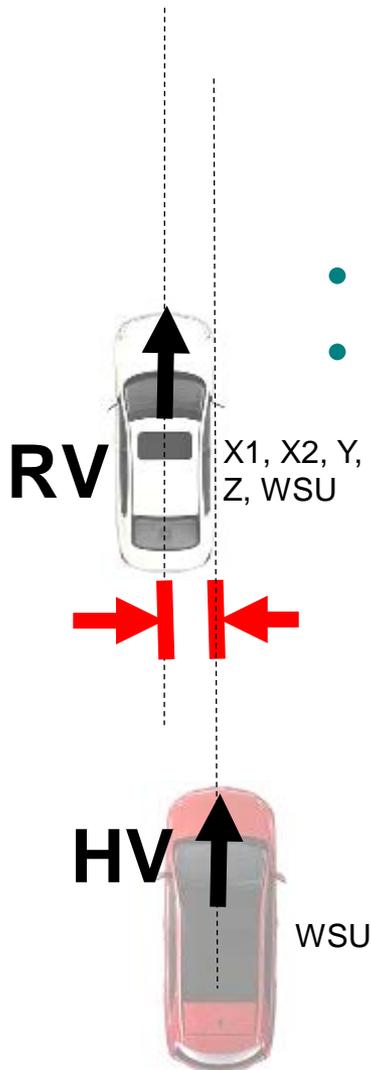
VSC-A Application	VAD		
	X	Y	Z
BSW	10/10	10/10	10/10
LCW	10/10	10/10	6/10
DNPW	10/10	10/10	9/10
EEBL	10/10	10/10	9/10
FCW Stopped Same Lane	10/10	9/10	9/10
FCW Stopped Adjacent Lane	10/10	10/10	7/10
FCW Slow Same Lane	10/10	10/10	6/10
IMA Stopped	10/10	10/10	9/10
IMA Approach	10/10	10/10	8/10



Positioning Across Path

(In-Lane Target Classification)

- Classification based on relative lateral position
- Percentage of “Ahead” classification at speeds above 15mph:



<u>Route:</u>	<u>Device Under Test (DUT)</u>				
	ILV2	X1(VAD)	X2 (VAD)	Y (VAD)	Z (ASD)
<i>Freeway</i>	95	93	83	94	87
<i>Local 1</i>	94	97	93	88	77
<i>Local 2</i>	94	96	91	94	84

Phase 2 Of Model Deployment

Over-the-Air Security Credential Management

- Sixteen vehicles were equipped with a Security Framework Access Device (SFAD)
 - 2 per OEM: 1 DSRC, 1 3G-based
- Forty-seven non-SFAD equipped vehicles
 - Use short term certificates preloaded on USB drives
- Vehicles configured for 28-day short term cert batches, subsequent batches requested starting at 21-days
- Security health monitoring being performed using a variety of data source
 - Local data harvested from vehicle SFAD (monthly)
 - Health checks provided by DAS over 3G modem (per drive cycle)
 - SCMS activity logs (monthly or on request to SAIC)



3G vs. DSRC Certificate Downloads

Download Times	3G Avg (Total 21)	DSRC Avg (Total 31)
Model Deployment ¹	43s (12 – 325s)	76s (16 – 217s)
Benchmark Tests (Jan 2013)	51s	45s (moving) / 16s (static)

¹ Harvests 6 – 9 (April – July)

- Background
 - 28-day certificate batches (~2.7MB)
 - Average download times do not include certificate generation time
- Conclusions
 - 3G/DSRC infrastructure reliability key to end user security performance
 - Phase 2 SCMS downtime biggest factor in failed certificate requests/downloads
 - Phase 2 RSE outages limited DSRC availability for security functions
 - Certificate batch download performance impacted by:
 - Vehicle in motion
 - Connection quality to infrastructure (distance / line-of-sight)
 - Peak hour congestion (rush hour commute / major thoroughfare)
 - 3G downloads on average 1.76x faster than DSRC



Summary

- Initial results show that VADs are capable of acceptable performance with obvious improvements possible
- MD Data and Analysis is available for use by all OEMs for future V2V safety application development
- MD environment characterization is critical to V2V safety application performance analysis
- Certification procedures need to be developed based on MD experience for successful deployment



Questions?
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