



FHWA Road Weather Management Program (RWMP) Connected Vehicle-Infrastructure (CVI) Research Project

Stakeholder Briefing

June 30, 2016



Project Focus and Organization

One year research project (May 1, 2015 – July 30, 2016) to investigate how weather, road condition, and related vehicle data may be collected, transmitted, processed, and used in road weather applications and services

Organization	Role
CAMP	<ul style="list-style-type: none"> • Overall program management • Coordination with FHWA • Technical support and assistance in Tasks 2, 3, and 4
VTTI	<ul style="list-style-type: none"> • Technical project management and liaising • Identification of vehicle data availability for RWMP research • RWMP CVI Applications Con-Ops review and research proposal development • RWMP stakeholder interfacing



Project Tasks

Task 1: Technical Program Management

Task 2: Coordination of Vehicle System Technical Assistance

Task 3: Technical Support, Reporting, and Demonstration on RWMP Concepts of Operation (ConOps)

Task 4: CAMP Representation at RWMP Events



Preliminary List of Weather Data Variables



Compilation of Weather Data Elements from recent RWMP Research

BSM Part 1
→

BSM Part 2
→

Weather Data Frame
→

OEM SYSTEMS

Ancillary Sensors

BSM Part	Parameter	Indication	Weather Data Category				Notes	Vehicle Information Exchange Needs for Mobility Applications (1)	NCAR Weather Data Frame (2)	Weather-related Information Needs for Connected Vehicles (3)
			General	Location/Heading	Road Surface	Atmospheric				
1	ID (temp)		x					x		
1	Vehicle Size/Type	Size	x				fleet only	x		
1	GPS Long	Position	x	x				x	x	
1	GPS Lat	Position		x				x	x	
1	GPS Elevation	Position		x				x		
1	GPS Positional Accuracy	Position		x				x		
1	Speed	Motion		x				x	x	x
1	Gear	Motion		x				x		
1	Throttle	Motion		x				x		
1	Accelerator Pedal	Motion		x				x	x	x
1	Accelerator Pedal (V)	Motion		x				x		x
1	Accelerator Pedal (A)	Motion		x				x		
1	Brake System Status	Motion						x		
1	Steering Angle	Motion						x		x
1	Yaw Rate	Motion			x			x		x
2	Ambient Air Temp	Traction, Visibility				x		x	x	x
2	Ambient Atmospheric Pressure	Weather				x		x	x	x
2	Precipitation Presence (yes/no)	Weather				x		x	x	
2	Tire Air Pressure	Weather				x		x		
2	Vehicle Type	Size, Config	x				other than fleet	x		
2	Wiper Status and Mode Change	Precipitation, Fog				x		x	x	x
2	Light Status and Mode Change	Weather, Visibility				x		x	x	x
2	ABS Active (> 300 msec)	Traction			x			x	x	x
2	Traction Control Active	Traction			x			x	x	x
2	Stability Control Active	Traction			x			x	x	x
2	Wheel Rotational Displacement	Traction			x			x		
na	Weather Info for Freight							x		
na	Road Chemistry and Application Rate							x		
na	Spot Wind Direction				x			x		
na	Spot Wind Speed				x			x		
na	Dewpoint Temp				x			x		
na	Surface Temp				x			x		
na	Radiation				x			x	x	
na	Relative Humidity				x			x		
na	Precipitation Intensity (V)				x			x		
na	Road Surface Temp				x			x		
na	Roadway Water Thickness				x			x	x	
na	Roadway Snow Thickness				x			x		
na	Adjacent Snow Thickness (Shoulder)				x			x		
na	Roadway Ice Thickness				x			x		
na	Visibility				x			x		
na	Detected Road Friction				x			x		

1 Vehicle Information Exchange Needs for Mobility Applications, DOT-RITA Final Report February 13, 2012, FHWA-JPO-12-021
 2 J735 Weather Report Data Frame, National Center for Atmospheric Research, Sheldon Robotics-based Intelligent NCIP 204 Environmental Sensor Station Standard
 3 Weather-related Information Needs for Connected Vehicles, Final Report April 1, 2014, RITA, NCAR



Targeted Weather Data Variables



Data elements potentially sourced from OEM systems for BSM Part 1 and 2 categorized by Weather Data Category

BSM Part	Parameter	Indication	Weather Data Category				Notes
			General	Location/Heading	Road Surface	Atmospheric	
1	ID (temp)		x				
	Vehicle Size/Type	Size	x				fleet only
	GPS Long	Position	x	x			
	GPS Lat	Position		x			
	GPS Elevation	Position		x			
	GPS Positional Accuracy	Position		x			
	GPS Heading	Motion		x			
	Transmission state	Motion			?		
	Acceleration Long. (X)	Motion			x		
	Acceleration Lat. (y)	Motion			x		
	Acceleration vertical (z)	Motion			x		
	Brake system status	Motion					
	Steering angle	Motion			x		
Yaw rate	Motion			x			
2	ABS Active (> 100msec.)	Traction			x		
	Ambient air temp	Traction, visibility				x	
	Ambient atmospheric pressure	Weather				x	
	Precipitation sensor	Weather				x	
	Tire air pressure	Weather				x	
	Vehicle type	Size	x				other than fleet
	Wiper status and mode change	Precipitation, fog				x	
	Light status and mode change	Weather, visibility				x	
	Traction Control active	Traction			x		
	Stability Control active	Traction			x		
Wheel rotational displacement	Traction			x			



Weather Variable Specifications



Priority	Variable	Unit	Desired Resolution	Acceptable Resolution	Desired Accuracy	Acceptable Accuracy	Desired Frequency	Acceptable Frequency
1	Air Temperature	Celsius	0.1 degree	1 degree	1 degree	2 degrees	once per 10 seconds	once per minute
2	Wiper Status	None	off, on, low, medium, high, intermittent speeds	off, on	correct category	correct category	once per 10 seconds	once per minute
3	Surface Temperature	Celsius	0.1 degree	1 degree	1 degree	3 degrees	once per 10 seconds	once per minute
4	ABS Brake Status	None	off, on	off, on	correct category	correct category	event driven	event driven
5	Dewpoint Temperature	Celsius	0.1 degree	1 degree	1 degree	3 degrees	once per 10 seconds	once per minute
6	Traction Control active	None	off, on	off, on	correct category	correct category	event driven	event driven
7	Stability Control active	None	off, on	off, on	correct category	correct category	event driven	event driven
8	Wheel Rotational Displacement	Revolutions per second	0.01 revolution per second	0.1 revolution per second	0.01 revolution per second	0.1 revolution per second	once per second	once per 10 seconds
9	Precipitation sensor	None	off, on (is there something else?)	off, on	correct category	correct category	once per 10 seconds	once per minute
10	Atmospheric Pressure	HectoPascals (hPa)	0.1 hPa	5 hPa	1 hPa	5 hPa	once per 10 seconds	once per minute
11	Lights	None	off, on for low beams, on for high beams, on for fog lights	off, on	correct category for different types of lights	correct category	once per 10 seconds	once per minute
12	Yaw	Angle						
13	Pitch	Angle						
14	Solar Radiation	Watts per meter squared	1 w/m ²	10 w/m ²	5 w/m ²	10 w/m ²	once per 10 seconds	once per minute
15	Total Radiation	Watts per meter squared	1 w/m ²	10 w/m ²	5 w/m ²	10 w/m ²	once per 10 seconds	once per minute



Weather Parameters and Candidate Vehicles - Part 1



BSM Part	Weather Parameter	Indication	SAE J2735 - 2015 Data Element / Data Field	Weather Data Category				MY 2015 Availability per SAE J2735 (Y/N)							RWMP Data Priority
				General	Location / Heading	Road Surface	Atmospheric	FCA Grand Cherokee	Ford F150	GM Silverado	Volvo Truck VNL670	VW Golf			
1	ID (temp)		DE_TemporaryID	X				NA - Part of Message Generation							
	Vehicle Size/Type	Size	DF_VehicleSize	X				Can be derived	Can be derived	Can be derived	N	N	N	Y	
	GPS Long	Position	DE_Longitude		X			Y	Y	Y	N	N	N	Y	
	GPS Lat	Position	DE_Latitude		X			Y	Y	Y	N	N	N	Y	
	GPS Elevation	Position	DE_Elevation		X			Y	Y	Y	N	N	N	Y	
	GPS Positional Accuracy	Position	DF_PositionalAccuracy		X			Y	Y	Y	N	N	N	Y	
	GPS Heading	Motion	DE_Heading		X			Y	Y	Y	N	N	N	Y	
	Transmission state	Motion	DF_TransmissionAndSpeed		X			Y	Y	Y	Y	Y	Y	Y	
	Acceleration Long. (X)	Motion	DF_AccelerationSet4Way			X		Y	Y	Y	Y	Y	Y	Y	
	Acceleration Lat. (y)	Motion	DF_AccelerationSet4Way			X		Y	Y	Y	Y	Y	Y	Y	
	Acceleration vertical (z)	Motion	DF_AccelerationSet4Way			X		Y	Y	N	N	N	N	N	
	Brake system status	Motion	DF_BrakeSystemStatus			X		Y	Y	Y	Y	Y	Y	Y	
	Steering angle	Motion	DE_SteeringWheelAngle			X		Y	Y	Y	Y	Y	Y	Y	
Yaw rate	Motion	DF_AccelerationSet4Way			X		Y	Y	Y	Y	Y	Y?	Y	12 no spec	

A - parameter thought to meet performance criteria defined as 'acceptable'
D - parameter thought to meet performance criteria defined as 'desired'
Y - parameter available - no performance criteria specified
N - parameter not available
? - only partial sensor performance information currently available



Weather Parameters and Candidate Vehicles - Part 2



BSM Part	Weather Parameter	Indication	SAE J2735 - 2015 Data Element / Data Field	Weather Data Category				MY 2015 Availability per SAE J2735 (Y/N)						RWMP Data Priority	
				General	Location / Heading	Road Surface	Atmospheric	FCA Grand Cherokee	Ford F150	GM Silverado	Volvo Truck VNL670	VW Golf			
								OEM Vehicles							
2	ABS Active (> 100msec.)	Traction	DE_EventFlags			X		D	D?	D	D	D	D	D	4
	Ambient air temp	Traction, visibility	DE_AmbientAirTemperature				X	A	A?	A?	A?	A?	A?	A	1
	Ambient atmospheric pressure	Weather	DE_AmbientAirPressure				X	A	Does not meet	A?	N	A?	A?	N	10
	Precipitation sensor	Weather	DE_RainSensor				X	A	N	N	N	N	D if equip	D	9
	Tire air pressure	Weather	DF_J1939-Data Items				X	Y	Y	Y	N	N	Y	Y	
	Vehicle type	Size	DE_VehicleType	X				Can be derived from VIN	Can be derived from VIN	Can be derived from VIN	N	N	N	N	
	Wiper status and mode change	Precipitation, fog	DE_WiperStatusFront & DE_EventFlags				X	A	D?	A	A	A	N	D	2
	Light status and mode change	Weather, visibility	DE_ExteriorLights & DE_EventFlags				X	D	D?	D	A	A	A	D	11
	Traction Control active	Traction	DE_EventFlags			X		D	D?	D	N	D	D	D	6
	Stability Control active	Traction	DE_EventFlags			X		D	D?	D	D	D	D if equip	D	7
Wheel rotational displacement	Traction	DE Does Not Exist			X		A	D?	D?	D?	D?	A?	D	8	

A - parameter thought to meet performance criteria defined as 'acceptable'
D - parameter thought to meet performance criteria defined as 'desired'
Y - parameter available - no performance criteria specified
N - parameter not available
? - only partial sensor performance information currently available



Task 2.4 Technical Support for RWMP Projects



- Integrated Mobile Observations
 - Onsite participation in project meetings
- Assessment of Pavement Conditions Using On-Board Vehicle Sensors
 - Project review and consultation
- Weather Data Environment
 - Assessment of availability of mobile data
- Vehicle Data Translator Development
 - Project and report review
 - Review and response with respect to its role in ConOps



Task 3.1 - RWMP CVI ConOps Review



Objectives:

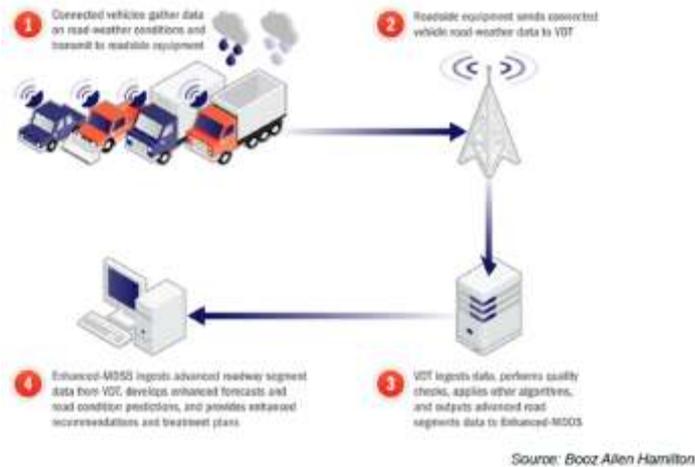
- Review RWMP technical documents and develop perspectives on various research topics considering:
 - Deployment and operational scenarios
 - Evolution of CVI capabilities
 - Additional research needs and OEM interests



Task 3.1 - RWMP CVI ConOps Review



- CAMP reviewed and provided comments on each of the proposed Road-Weather Connected Vehicle Applications from the Concept of Operations for Road Weather Connected Vehicle Applications (Final – May 31, 2013 FHWA-JPO-13-047)
- A review meeting was held 9-3-15 with FHWA and support staff to discuss CAMP’s perspectives



- Enhanced Maintenance Decision Support System
- Information for Maintenance and Fleet-Management Systems
- Weather-Responsive Traffic-Management Strategies
- Motorist Advisories and Warnings
- Information for Freight Carriers
- Information and Routing Support for Emergency Responders



Task 3.1 - RWMP CVI ConOps Review



- ConOps Applications Summary Recommendations
 - All proposed applications appear to be based on collecting BSM Part 1 & 2 information. Moving forward it will be important to:
 - Understand the relative value of each requested data element to the individual applications
 - Identify potential high value parameters not currently available from vehicles
 - The Road Weather Connected Vehicle Application concepts are described at a high level:
 - Understanding application functionality in more detail will facilitate analysis of the value proposition involved in collecting weather related vehicle data.
 - The operation of the Vehicle Data Translator in particular appears to be a key aspect of such an analysis.
 - Continued coordination with State/Regional DOTs and Standards Development Organizations will be important to support successful deployment of Road Weather Connected Vehicle Applications.



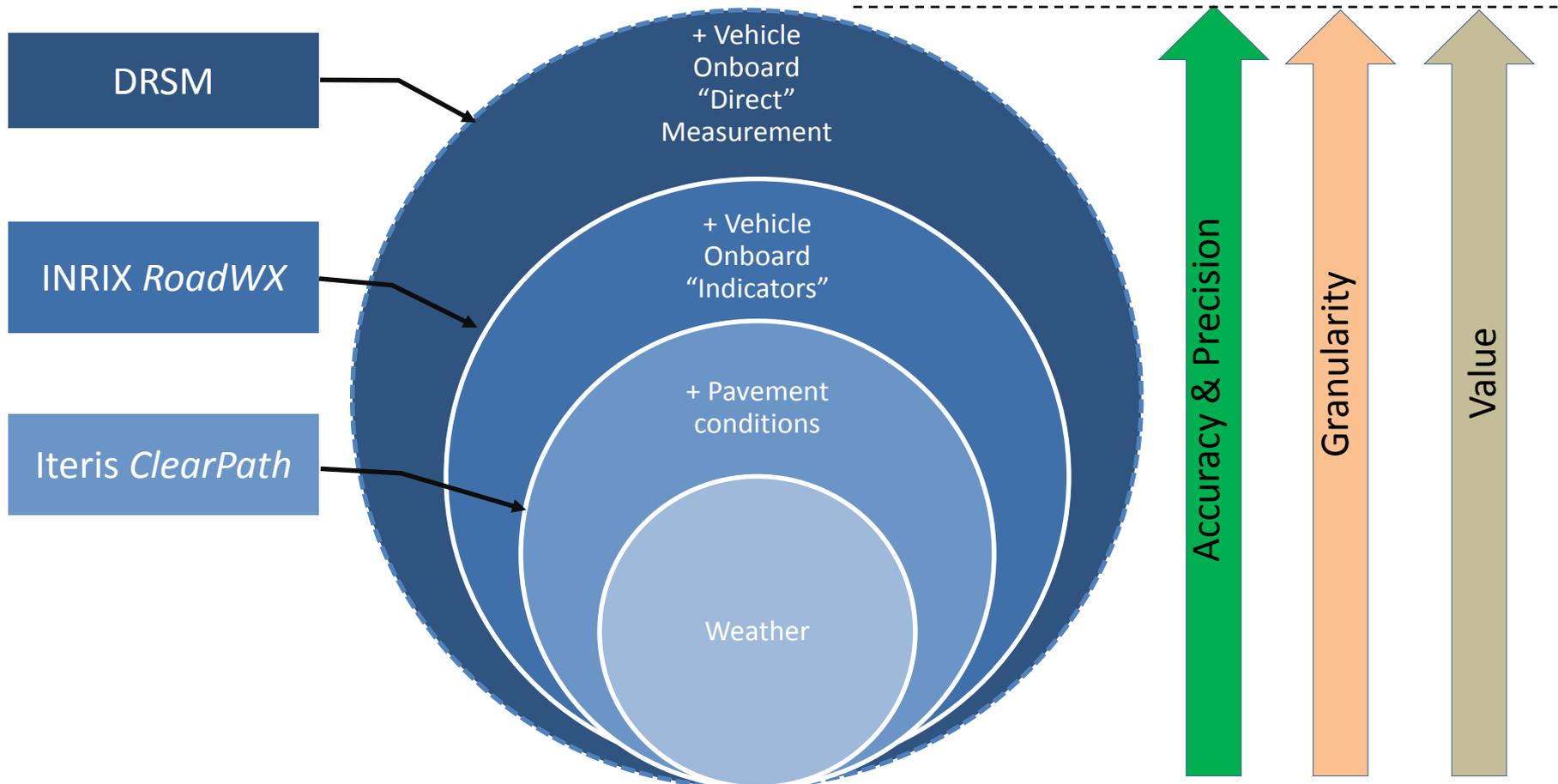
Task 3.2 Preliminary Follow-on Concept Development



- Develop a high-level demonstration concept for a weather-related application for review and discussion with FHWA
- Dec. 3- CAMP briefed FHWA on the follow-on concept, received preliminary approval to proceed
- Dec. 6 - Briefing slides submitted to FHWA
- Dec. 15 - FHWA approval to proceed with technical/cost proposal



Dynamic Road Surface Mapping (DRSM) to Support V2I Safety Applications





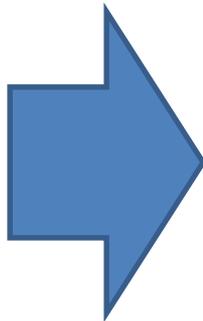
Dynamic Road Surface Mapping to Support V2I Safety Applications



Objective: Replace *'miles and minutes'* with *'meters and milliseconds'* using detailed vehicle dynamics information available on-board vehicles to dynamically crowd-source detailed road surface condition information.

Real-time, high granularity, assessment of road conditions

- Weather impacts
 - Ice/snow
 - Hydroplane hazard
 - High winds
- Structural and maintenance
 - Potholes / Rough Surface
 - Rutting, shoving
 - Pavement aggregate polish
 - Dirty roads



Improved V2I safety applications incorporating real-time localized pavement condition information

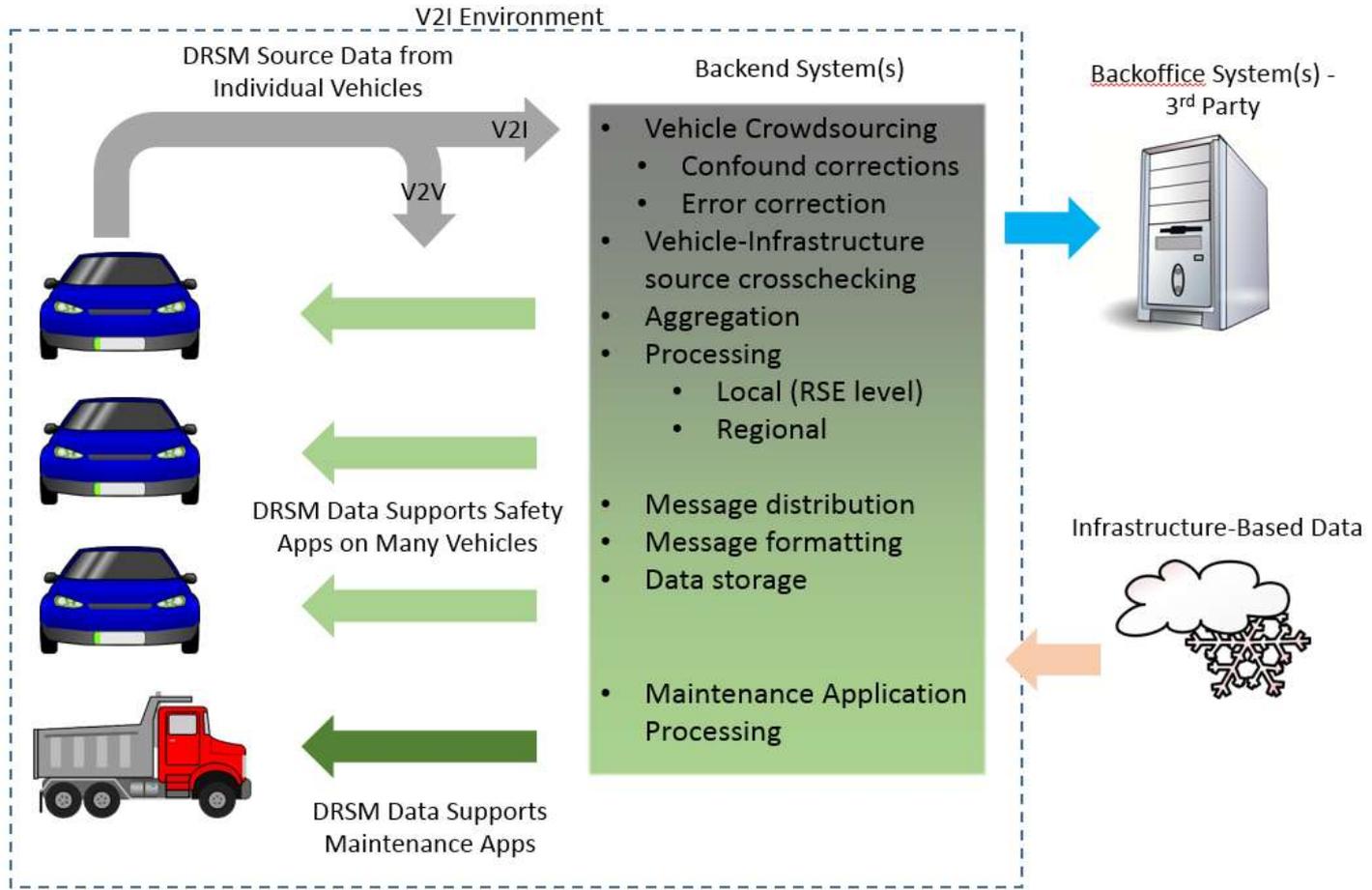
- Curve Speed Warning
- Red Light Violation Warning
- Variable speed limits
- Vehicle Automation Systems

Improved V2I maintenance applications

- Maintenance decision support system (MDSS, e-MDSS)



DRSM Conceptual Operation





DRSM Project Outline

- 36 month Period of Performance - 30 month task execution and 6 month administrative close out
- Phase 1 – Operational Concept Development (17 months)
 - All available vehicle onboard systems/data explored
 - Closed test track testing with limited public road evaluation
 - Multiple light vehicles + Class 8 truck
 - Backend system with crowdsourcing processing
 - Planning for Phase 2
- Phase 2 – Limited Field Evaluation (13 months)
 - Multi-platform evaluation on public roads
 - Data backhaul and backend processing with “real world” implementation



Task 4 - Representation at RWMP Events



Objective:

- Participation (by VTTI or CAMP members on behalf of the CAMP-VTTI Team) in events and project-related activities pertinent to the RWMP
 - To gain exposure to the types of research and discussions occurring between stakeholders and within the industry
 - To provide support per Task 2.4 - Technical Support for RWMP Projects



Task 4 - Representation at RWMP Events



Q2, 2015

- June IMO meeting in Minneapolis
- NCAR online briefing to CAMP technical team on the VDT

Q3, 2015

- IMO meeting, Lansing, Aug. 17.
- RWMP Stakeholders meeting Aug. 25
- MDOT Detroit Traffic Management Center Aug. 13.

Q4, 2015

- IMO meeting, Boulder CO, Nov. 17, 18

Q1, 2016

- Transportation Research Board Annual Meeting, Washington DC, Jan. 10-14
- IMO meeting, Reno NV, Feb. 10-11

Q2, 2016

- RWMP Spring Regional Roundtable Online Meetings - March 8, 15, 16, 29, & 31



End