



UNITED STATES
DEPARTMENT OF TRANSPORTATION

Vehicle to Infrastructure Communications: Application Development

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Crash Areas – Identification for Research

- Emphasis based on crash frequency and societal costs.
- Identified crash areas that cannot be addressed by a Vehicle to Vehicle or an Autonomous Vehicle Solution alone.
 - *Intersection Related Crashes*: Roadside Equipment (RSE) provide data such as Signal Phase & Timing to enable applications on the vehicle platform that help prevent intersection crashes.
 - *Speed Related Crashes*: RSE provide data such as roadway geometry and dynamic speed limit information to the vehicle application platform to prevent lane departure crashes.
 - *Vulnerable Road Users*: Covers Broad range of crash types such as work zones, pedestrians, and Highway Rail Intersections (HRI) crashes. RSE provides all data to enable the application on the vehicle.



V2I Safety Applications – Research Process

- *Selection of Safety Applications:* Based on crash scenario analyses, input from key stakeholders, industry partners, and State & local practitioners.
- *V2I Safety Application Development:* Based on User Needs, Systems Requirements, & Performance Specifications. End product is Design Documentation.
- *Simulation Planning, Build and Test:* An iterative process to refine V2I Safety Applications and prepare hardware and software for Field Operational Tests. End product is revised design documentation and revised/new standards (if needed).
- *FOT/CV Demos:* Multi-modal, multi-program testing in a real world environment of Safety, Mobility, and Environmental applications as well as Data Capture and Management for statistical analyses. End product is guidelines and recommendations.



V2I Safety Applications – Concepts

Accelerated
Development

- *Red Light Violation Warning*
- *Curve Speed Warning*
- *Stop Sign Gap Assist*

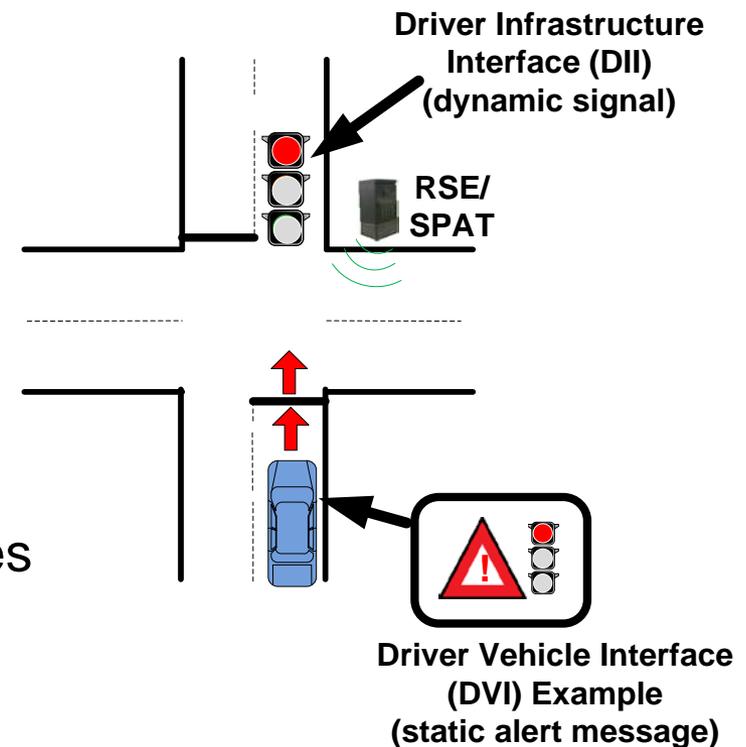
Additional
Potential
Applications

- *Stop Sign Violation*
- *Railroad Crossing Violation Warning*
- *Spot Weather Impact Warning*
- *Oversize Vehicle Warning*
- *Reduced Speed/Work Zone Warning*



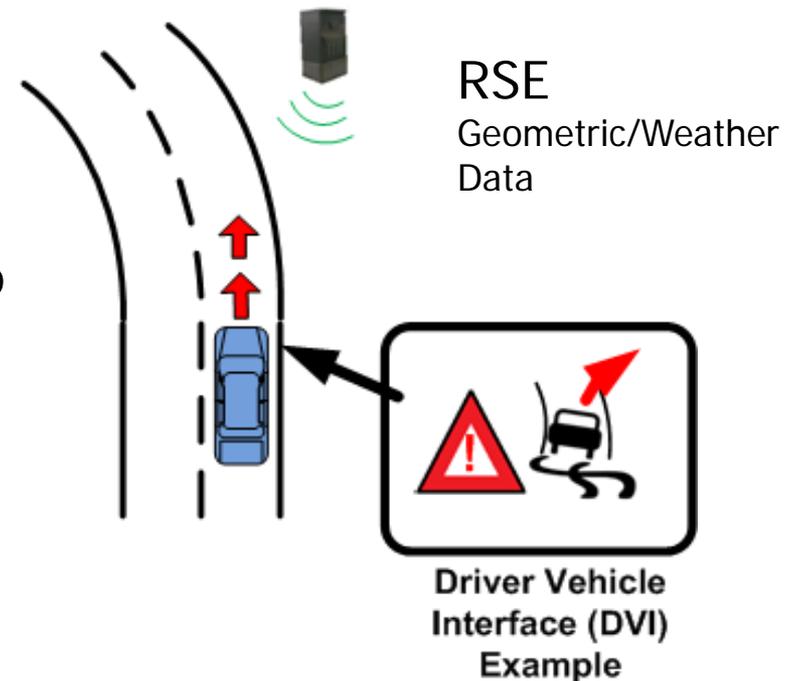
Red Light Violation Warning

- Roadside Equipment (RSE): broadcast Signal Phase and Timing (SPaT) message, map data, and GPS correction.
- In-vehicle Device: determine if the vehicle is in danger of violating a red light.
- Traffic signal logic may be evaluated to determine if extension of all-red phase is warranted to prevent crashes involving early violators.



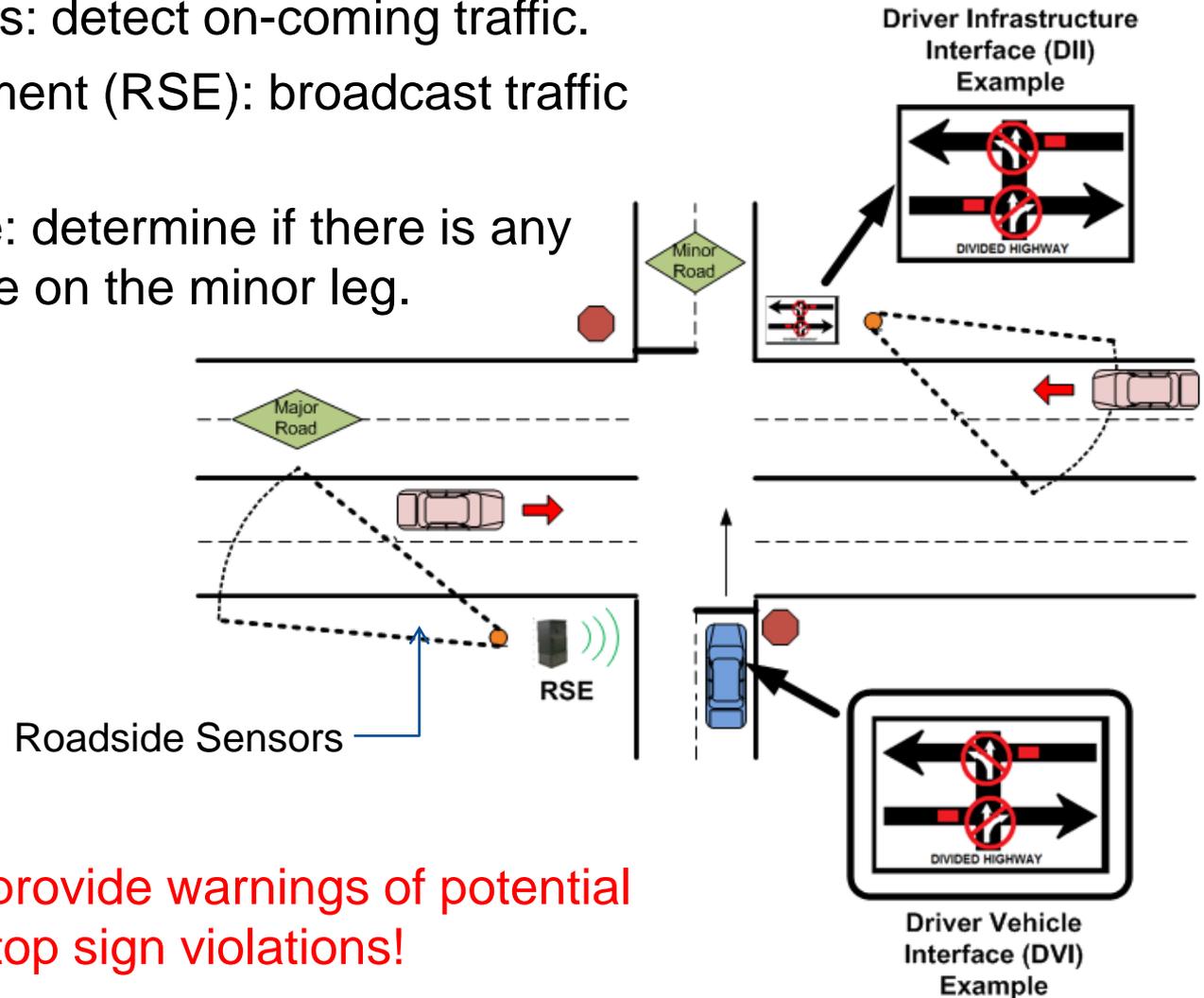
Curve Speed Warning

- Roadside Equipment (RSE): broadcast geometric and weather information for use by in-vehicle device.
- In-vehicle Device: determine appropriate speed for that particular vehicle. Warnings can be tailored to the specific vehicle capabilities.
- Potentially could be linked to dynamic driver feedback signs until majority of vehicles are equipped.



Stop Sign Gap Assist

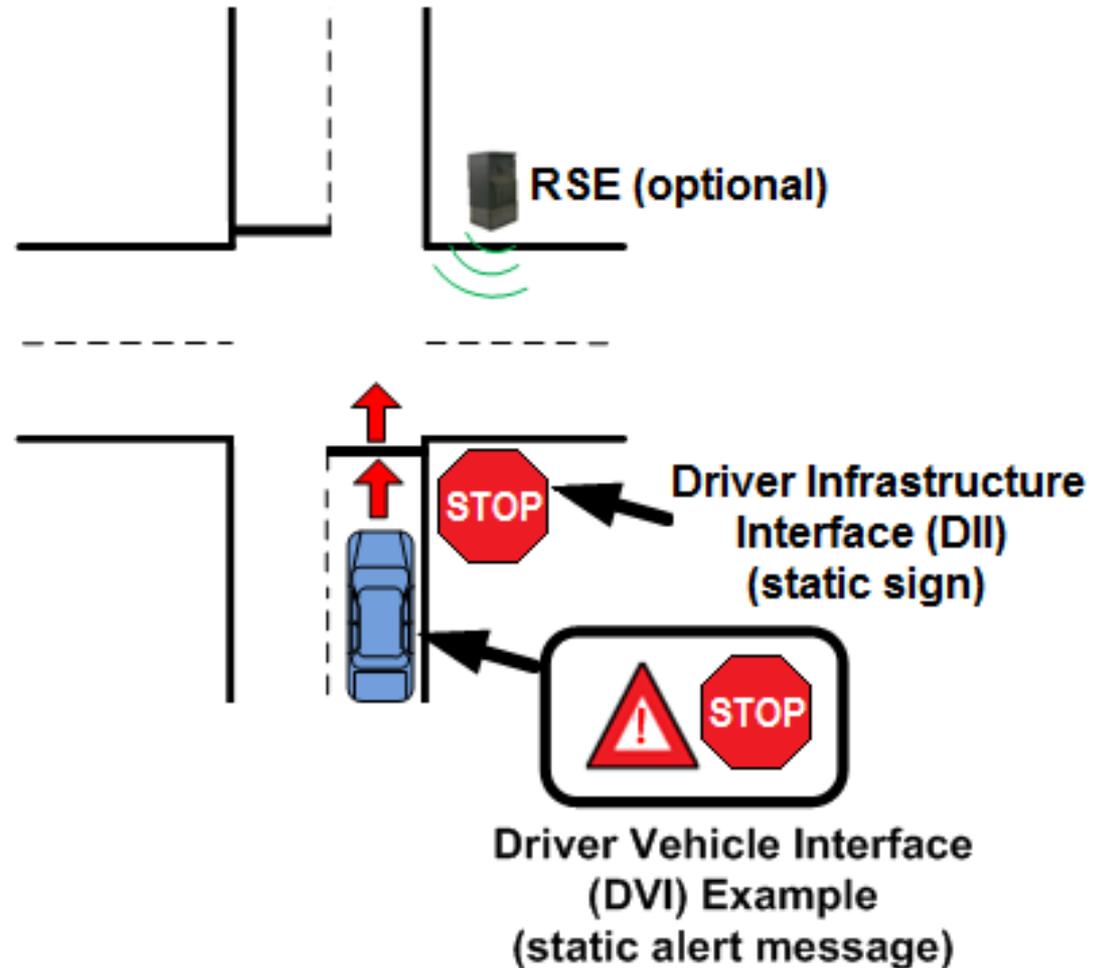
- Roadside sensors: detect on-coming traffic.
- Roadside Equipment (RSE): broadcast traffic status.
- In-vehicle Device: determine if there is any danger for vehicle on the minor leg.



- Not designed to provide warnings of potential crashes due to stop sign violations!

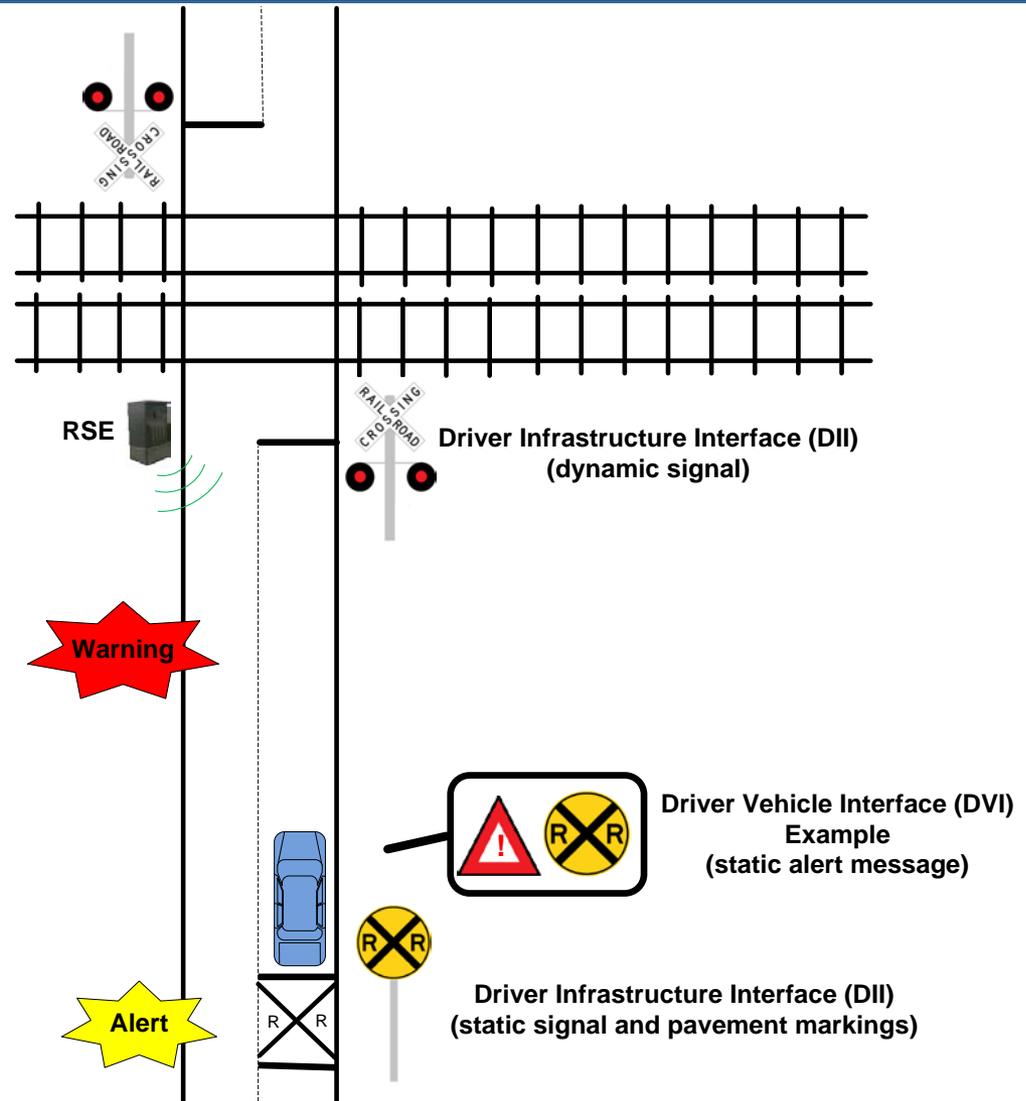
Stop Sign Violation Warning

- Roadside Equipment (RSE): broadcast map data and GPS Correction.
- In-vehicle Device: determines probability of vehicle running the stop sign.
- In-vehicle Device: issues warning to driver.



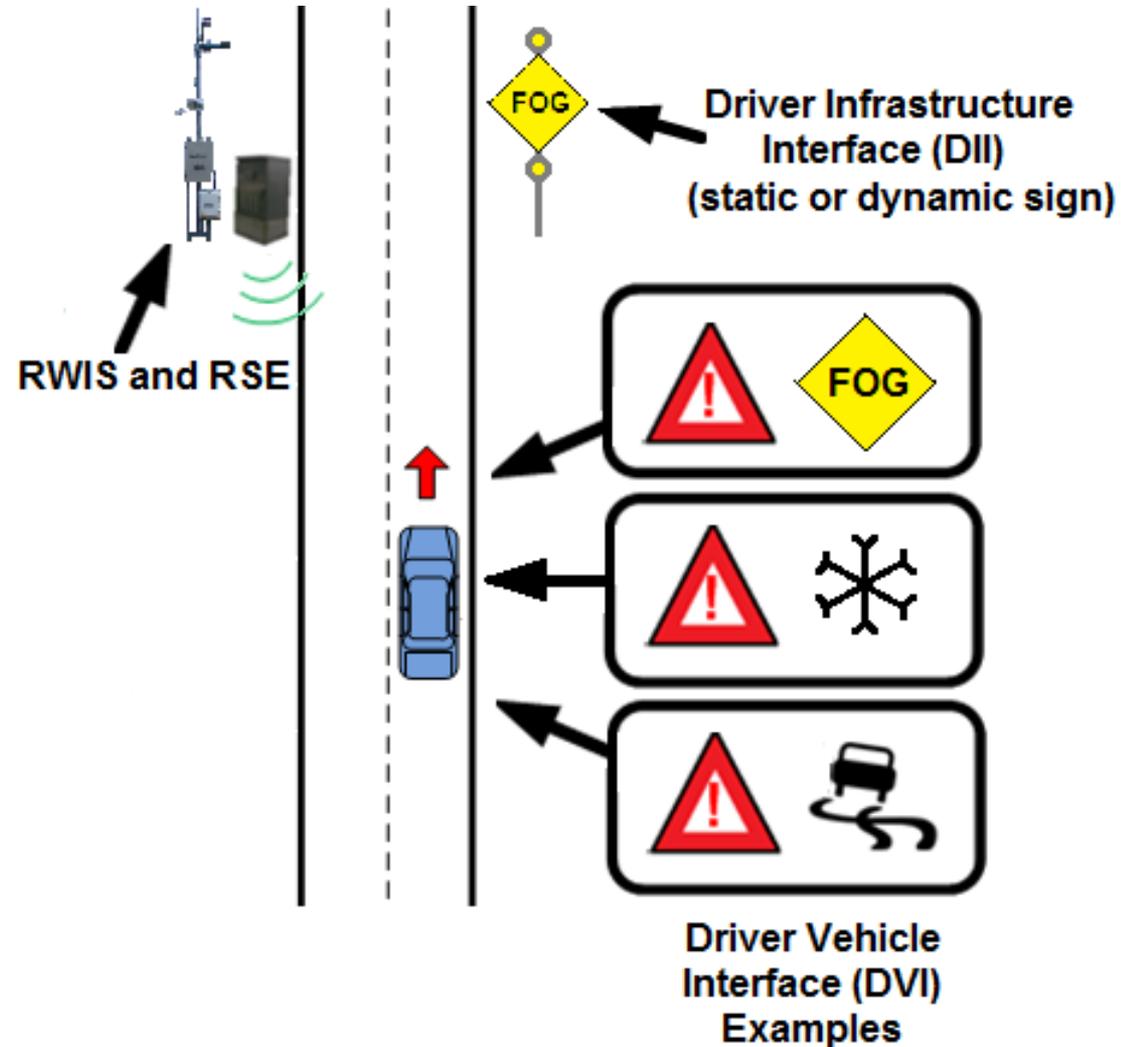
Railroad Crossing Violation Warning

- Roadside Equipment (RSE): connection with existing train detection system or dedicated sensor.
- Train speed and map of crossing broadcast to vehicles.
- In-vehicle Device: issues alert or warning to driver.



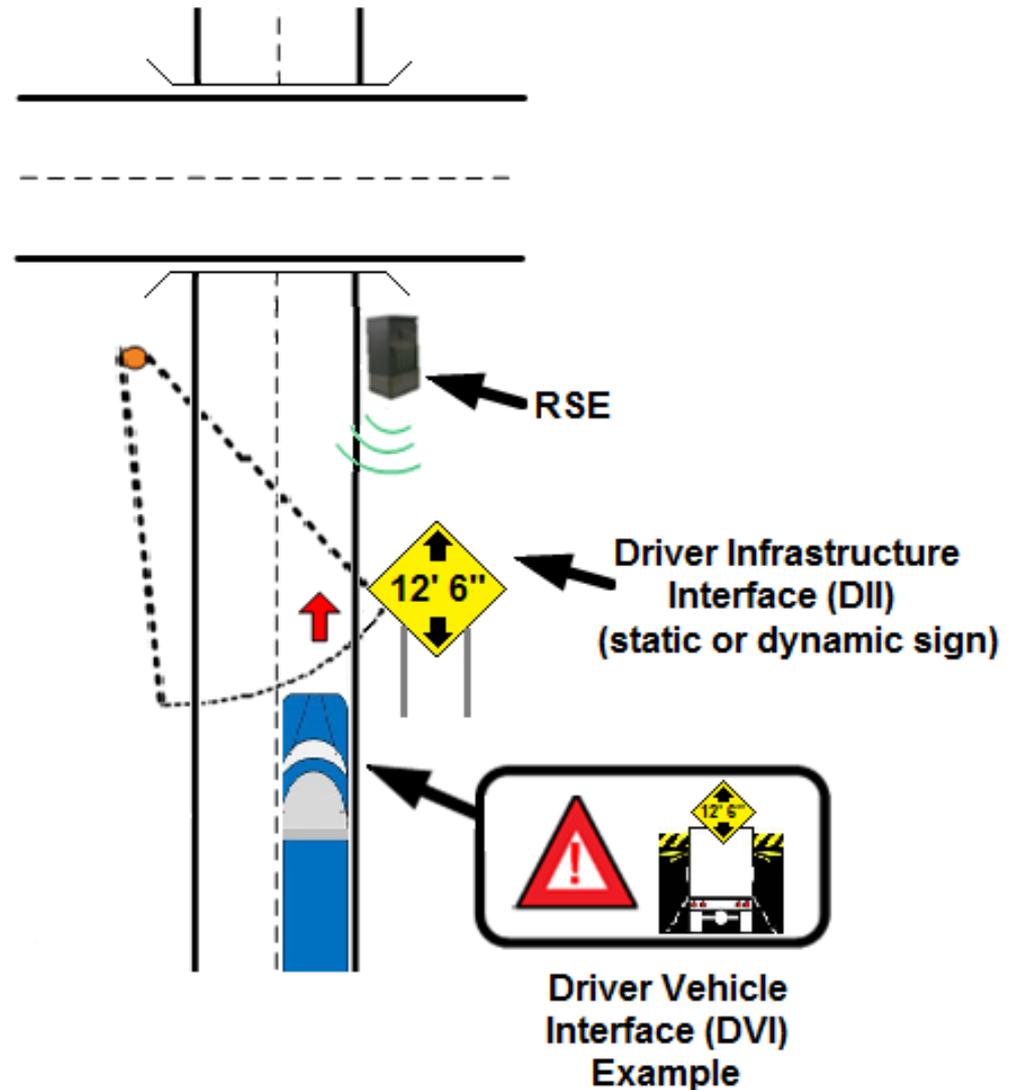
Spot Weather Impact Warning

- Roadside Equipment (RSE): connection with TMC and other weather data collection sites/services.
- Weather events and locations broadcast to vehicles in real-time.
- In-vehicle Device: issues alert or warning to driver.



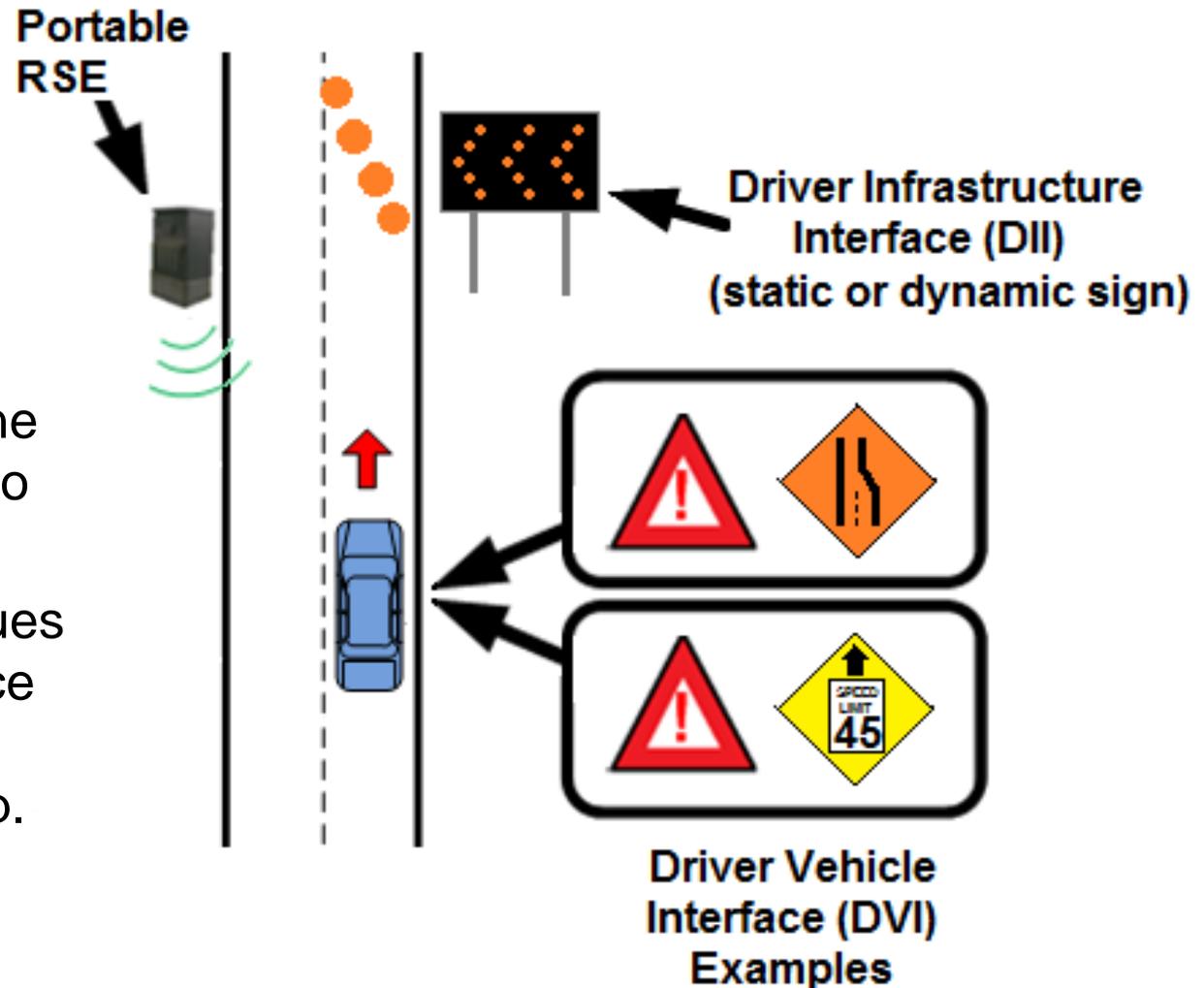
Oversize Vehicle Warning

- Roadside Equipment (RSE): connection with Infrastructure-based detectors.
- Bridge/tunnel dimensions broadcast to oversize vehicles.
- In-vehicle device: issues alert to driver to take alternate route or a warning to stop.



Reduced Speed/Work Zone Warning

- Roadside Equipment (RSE): connection to TMC and/or local network in work zone.
- Speed limit / work zone information provided to vehicle.
- In-vehicle device: issues alert to driver to reduce speed, change lanes, and/or prepare to stop.



Next Steps for Application Development

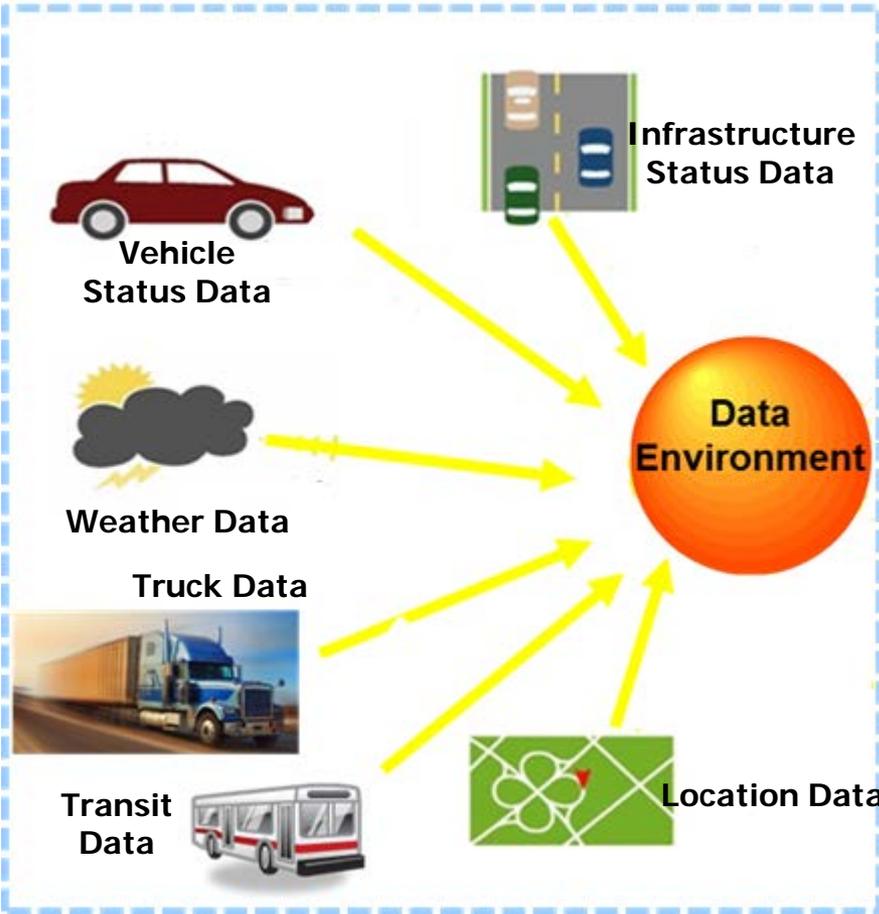
- Complete Systems Engineering work to develop Performance Requirements
- Contract for Application Development
 - Design Documentation
 - Prototyping
 - Simulation / small-scale testing
 - Refinement
- Perform field operational tests in a real world environment
- CV Multi-modal demonstrations



Connected Vehicle Mobility Applications

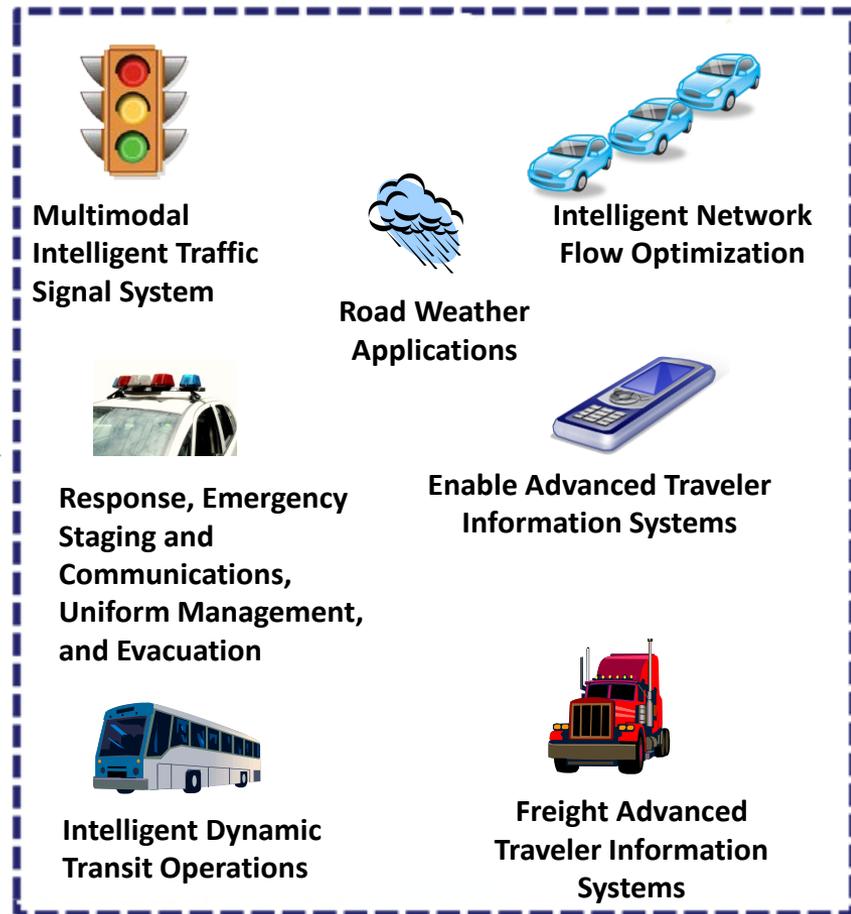
DCM Program www.its.dot.gov/data_capture

Real-time Data Capture and Management



DMA and Weather Programs

Dynamic Mobility Applications



DMA Program <http://www.its.dot.gov/dma>

WX Program http://www.its.dot.gov/connected_vehicle/road_weather.htm



AERIS Transformative Concepts & Applications

■ Eco-Signal Operations

- Eco-Approach and Departure at Signalized Intersections*, *DSRC*
- Eco-Traffic Signal Timing*
- Eco-Traffic Signal Priority*, *DSRC*

■ Dynamic Eco-Lanes

- Dynamic Eco-Lanes Management*
- Eco-Speed Harmonization*
- Eco-Cooperative Adaptive Cruise Control*, *DSRC*
- Eco-Ramp Metering*

■ Dynamic Low Emissions Zones

- Dynamic Emissions Pricing*

■ Support for Alternative Fuel Vehicle Operations

- Engine Performance Optimization
- Alternative Fuel Vehicle (AFV) Charging / Fueling*

■ Eco-Traveler Information

- Dynamic Eco-Routing*
- Eco-Smart Parking*
- Connected Eco-Driving *DSRC*
- Multi-Modal Traveler Information*

■ Eco-Integrated Corridor Management (Eco-ICM)

- Eco-ICM Decision Support System
- *Applications from the Other Transformative Concepts*

Notes

- * Denotes Application requiring V2I Communication
- DSRC* Denotes Applications Requiring Dedicated Short Range Communications (DSRC) or Other Low Latency Communications



V2I Applications – Questions?



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Thank you!

