NHTSA Update: Connected Vehicles V2V Communications for Safety

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NHTSA
www.nhtsa.gov

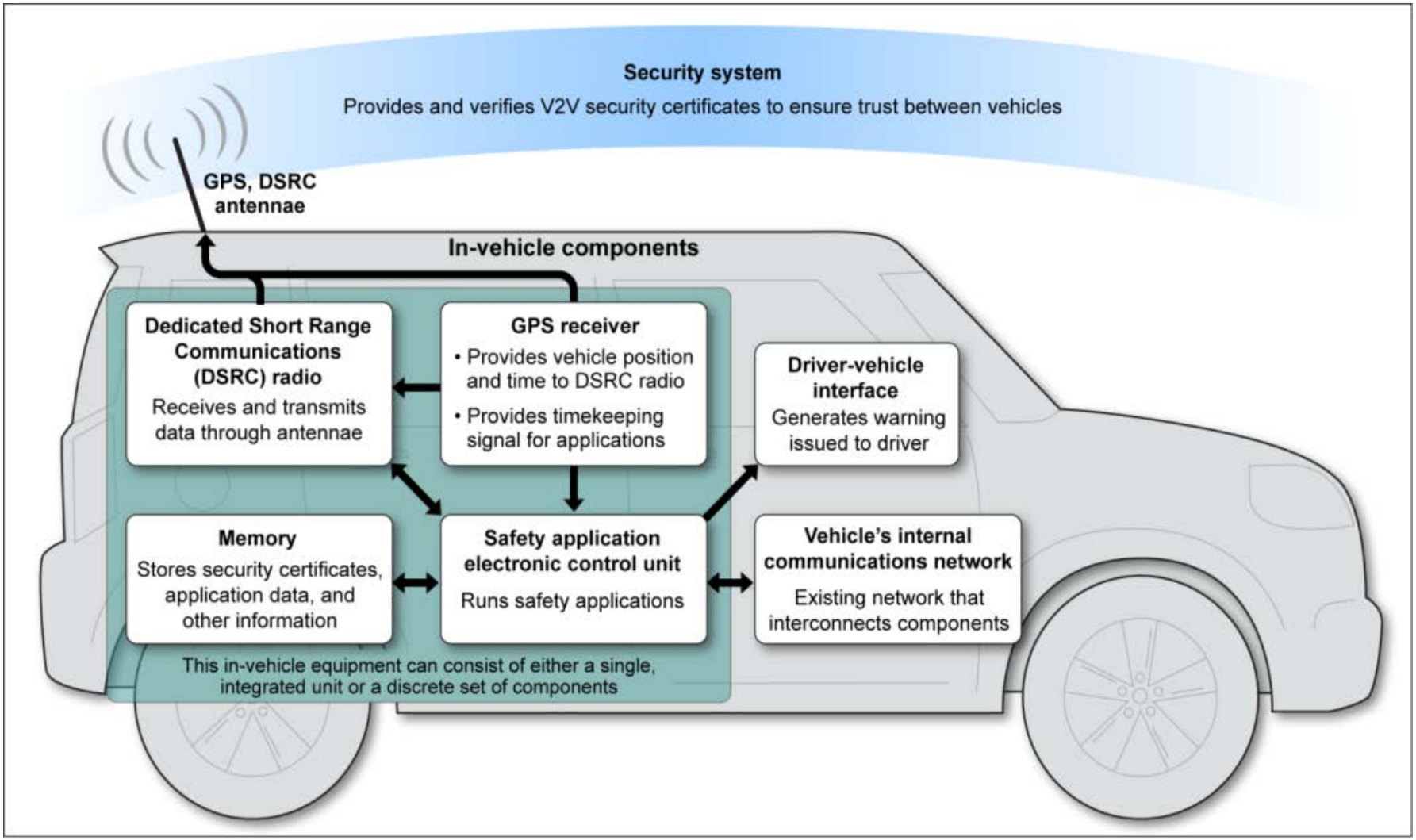
V2V Overview

- Wireless exchange of anonymous safety relevant data (precise location[1], heading, speed[2]) between nearby vehicles.
- Uses DSRC (5.9 GHz) to sense threats with a 360 degree “view” to issue driver warnings.
- In some cases, the driver is not able to see the potential threat.
- Each vehicle communicates with other vehicles to support a new generation of safety applications.
- Can supplement existing sensing technology (radar, camera)
- Provides a building block for automation

1) Relative position accuracy of about 1.5 m. Represents “lane level” accuracy.

2) Also called basic safety message, or BSM

In-Vehicle Components of a V2V System

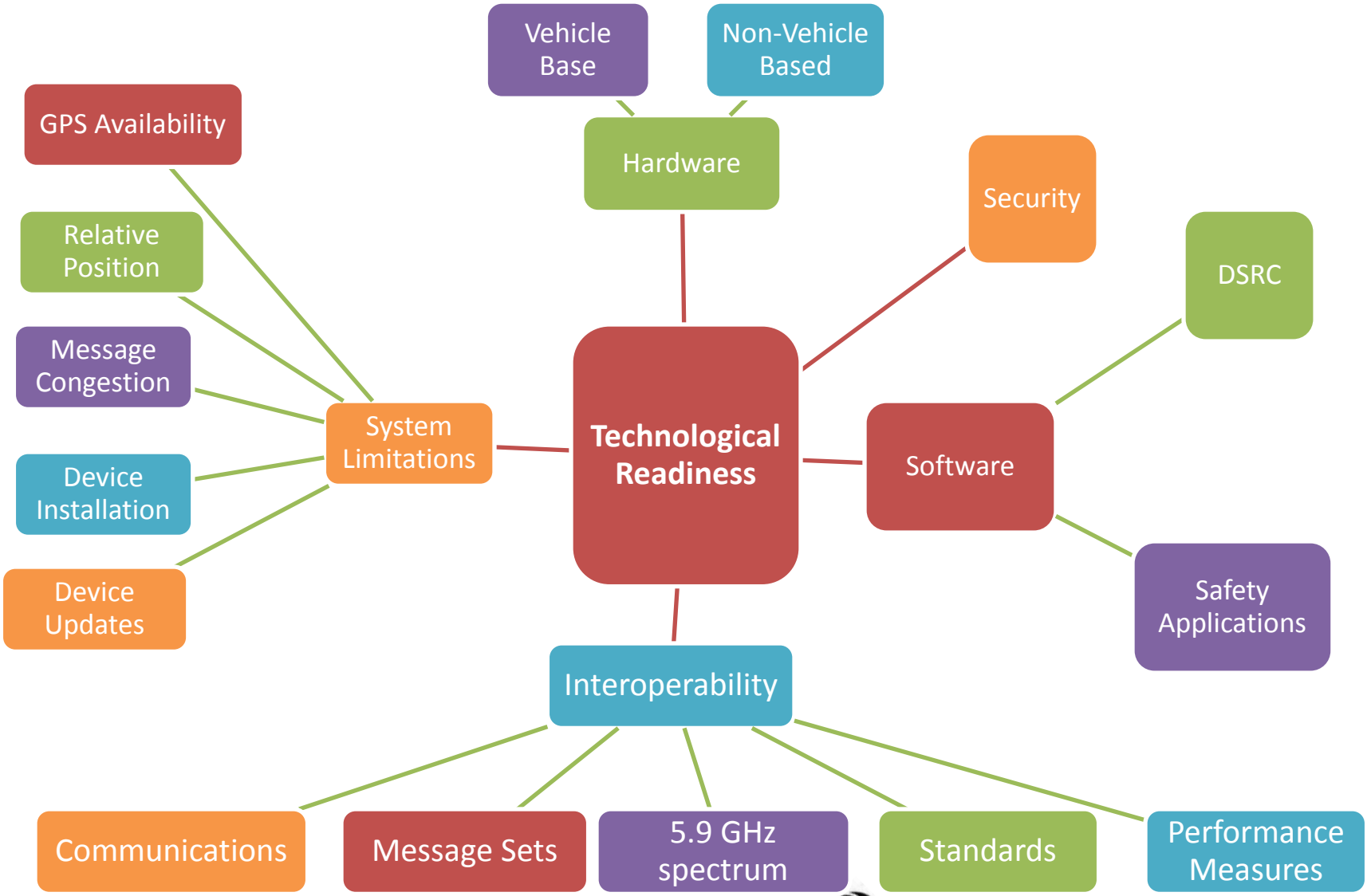


Sources: Crash Avoidance Metrics Partnership and GAO.

U.S. DOT V2V Research Activities/Milestones

- **ITS Joint Program Office (JPO)** - The JPO has been coordinating intelligent vehicle safety research with NHTSA since 1998.
- **2009 NHTSA V2V Research Plan -** Included identifying the crash problem, interoperability needs, application testing; driver acceptance, and estimation of V2V benefits.
- **Safety Pilot Driver Clinics** - Conducted across the U.S. on controlled test track environments to understand driver acceptance of the V2V safety technology on light and heavy vehicles.
- **Safety Pilot Model Deployment** – 2,800 V2V equipped vehicles operated by regular drivers in Ann Arbor, MI to collected data on V2V crash avoidance warnings in support of benefit estimation.
- **NHTSA's Light Vehicle V2V Agency Decision** – February, 2014: Culmination of NHTSA V2V Research Plan.
- **NHTSA V2V Readiness Report** – Comprehensive presentation of NHTSA research on V2V technology, testing, and implementation considerations. Released to public August, 2014
- **Request for Information (RFI)** for security system published on October 15, 2014

Technical Practicability— Issues Addressed in V2V Readiness Report



V2V Warning Scenarios

- V2V communications technology can address approximately 2.5 M annual light and heavy vehicle crashes.
- Key types of crashes addressed by V2V include:
  - Rear-end and head-on
  - Intersection related
  - Turning across path (left hand turns)
  - Lane change related (blind spot warning)

37 Pre-Crash Scenarios
All Heavy-Truck (HT) Crashes (**384,000**) Unimpaired HT Crashes (**375,000**)

22 V2V Pre-Crash Scenarios
266,000 HT Crashes
(69% of All HT Crashes, 71% of Unimpaired HT Crashes)

15 V2I or Single-Vehicle Pre-Crash Scenarios
31% of all HT Crashes
29% of Unimpaired HT Crashes
Not Used

17 Target V2V Pre-Crash Scenarios
224,000 HT Crashes
(58% of All, 60% of Unimpaired)

- 5 - Rear-End
- 3 - Lane Change
- 2 - Opposite Direction
- 3 - Junction Crossing
- 2 - LTAP/OD (controlled & non-controlled junctions)

- 2 - Traffic Control Device Violation (Best addressed by V2I safety applications)

5 V2V Pre-Crash Scenarios
11% of all HT Crashes
Not Used

- 2 - Control Loss
- 1 - Backing
- 1 - Parking
- 1 - Other

10 Priority Pre-Crash Scenarios
201,000 HT Crashes
(52% of All, 54% of Unimpaired)

- 3 - Rear-End
- 3 - Lane Change
- 2 - Opposite Direction
- 1 - LTAP/OD (combined)
- 1 - Junction Crossing

Safety Need
Heavy Vehicles (HV)

* Note that the numbers preceding the pre-crash scenarios refer to the total number of scenarios

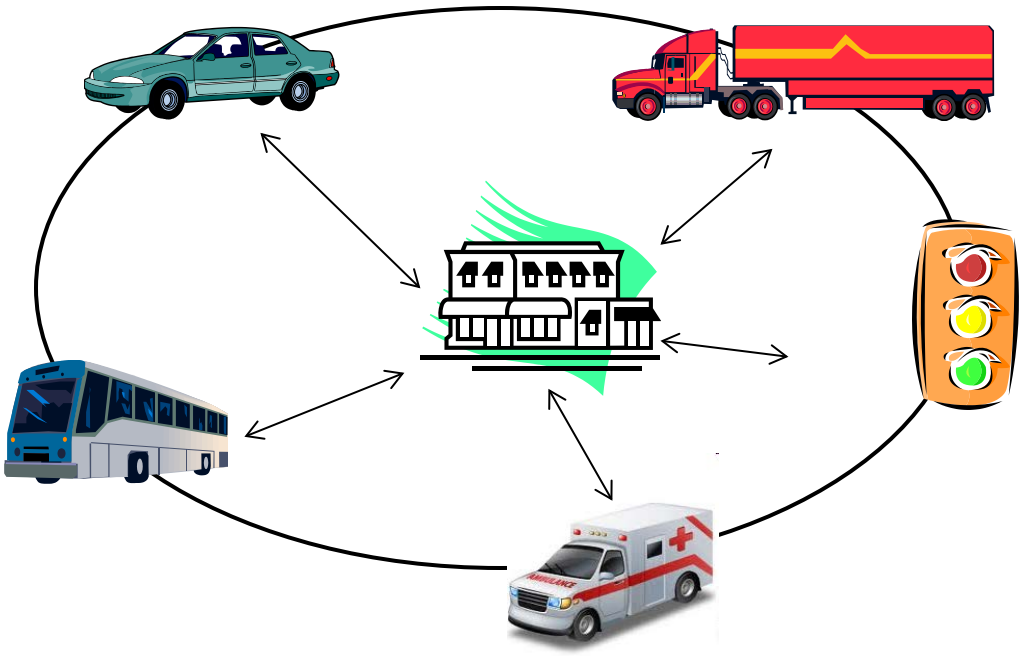
Heavy Vehicle Crash Scenario Analysis

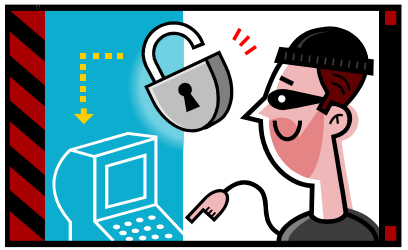
- Volpe Report Now Available: Heavy Truck Pre-Crash Scenarios For Safety Applications Based on Vehicle-to-Vehicle Communications
  - DOT HS 812 023, June 2014

- Available for download at:

http://www.nhtsa.gov/Research/Crash+Avoidance/Office+of+Crash+Avoidance+Research+Technical+Publications

Challenge - Need for Security





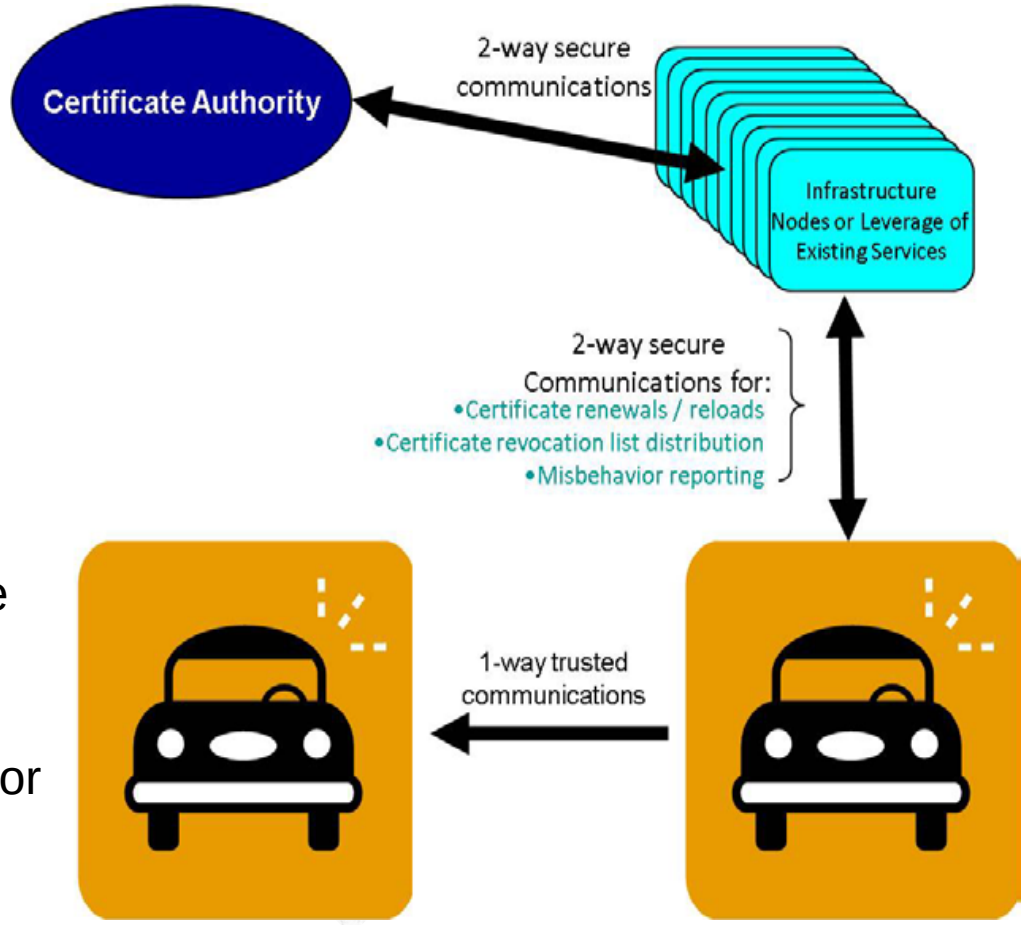
Trust

Message Validity

Defense Against Attacks

Proposed V2V Security System

- Variation of common/mature machine-to-machine Public Key Infrastructure (PKI)
- Approved system participants granted a bundle of trusted, encrypted certificates by central authority – an entity managed outside government
  - Devices receive certificate updates and “do not trust” or certificate revocation lists from central authority.
  - Devices exchange trusted basic safety messages (BSMs) by attaching certificates to each message.
  - Device-to-device messages contain no personally identifiable information (PII)
  - Devices report observed anomalous conditions in BSMs (or “misbehavior”)



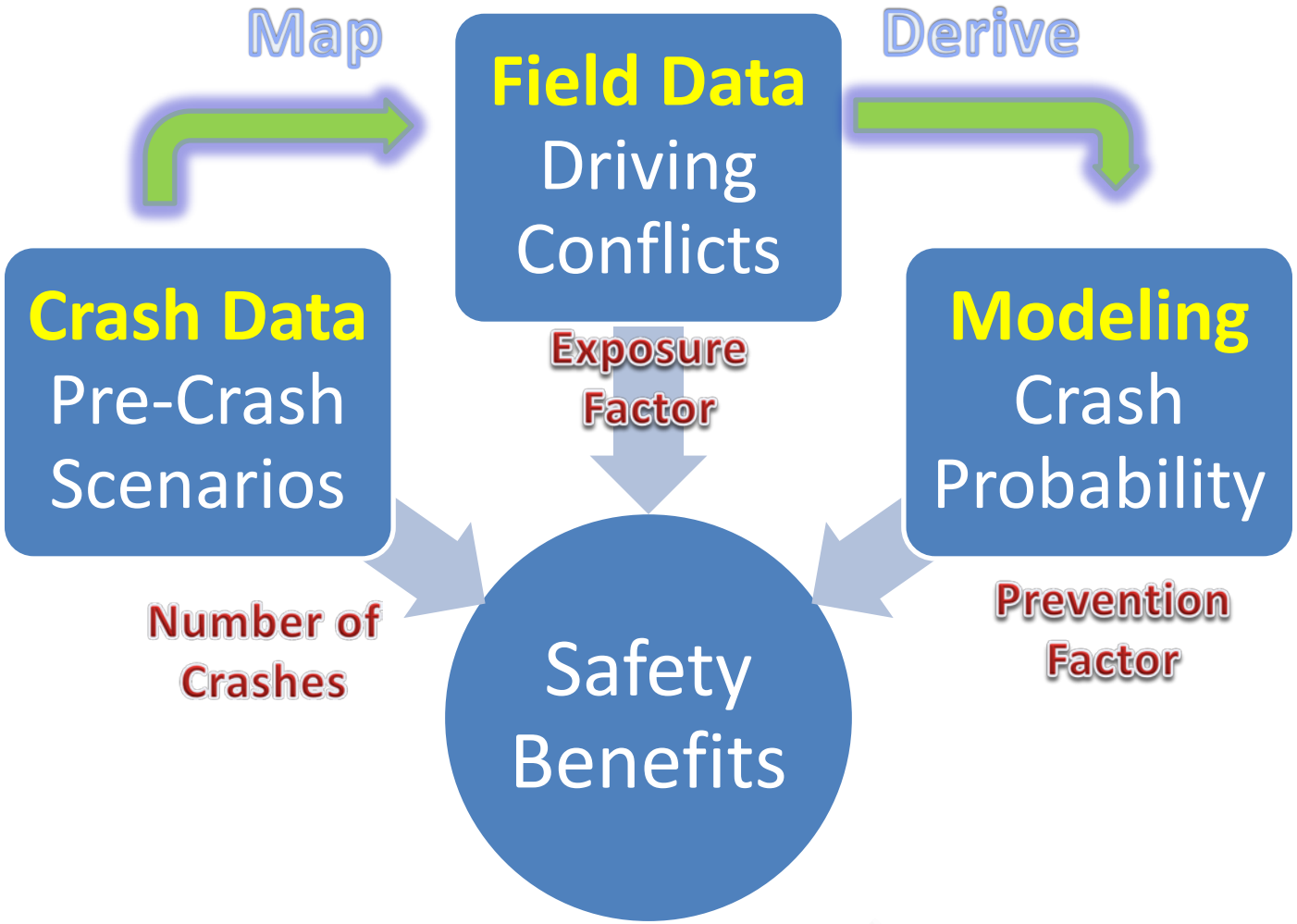
Plan for Maturing and Implementing an SCMS

- Early, limited functionality, version tested in Safety Pilot (Complete)
- Finalize Design (Complete)
- Build and Test a Prototype
  - In process: led by CAMP with support from telecommunication industry partners.
  - End-to-End testing to be completed by late 2015
- Operate a fully functional SCMS to service Connected Vehicle Pilot environments being established by USDOT.
- Issued a Request for Interest to build/operate an SCMS
  - Over 20 responses from variety of auto, telecom and IT industry stakeholders and suppliers.

Key Cost Elements

- **Vehicle equipment**
  - DSRC radio(s)
  - GPS
  - Operating system
  - Antennas and wiring
- **Security system**
  - Capital (IT equipment; facilities; land; etc.)
  - Operating (labor, rents, utilities, etc.)
- **Communications**
  - Between SCMS and vehicles
  - DSRC, cellular, or other (baseline costs to be estimated on DSRC network)

Safety Benefits Estimation



Primary Data Sources For Benefits Estimation

- **Heavy Truck - Driver Acceptance Clinics**
  - Experience of approximately 100 truck drivers using V2V in realistic driving scenarios in a closed course environment
- **Safety Pilot - Model Deployment**
  - Data from 19 equipped V2V trucks driven by participating fleets in an 18-month naturalistic field study
- **Heavy Truck V2V Performance Testing**
  - VRTC test track evaluation of heavy truck V2V systems
- **National Advanced Driving Simulator Heavy Truck V2V Study**
  - Simulator study to measure truck drivers' reactions to V2V warnings in crash imminent driving scenarios
- **IVBSS**
  - Field data on truck driver's reaction to safety warnings

Research on General V2V Issues

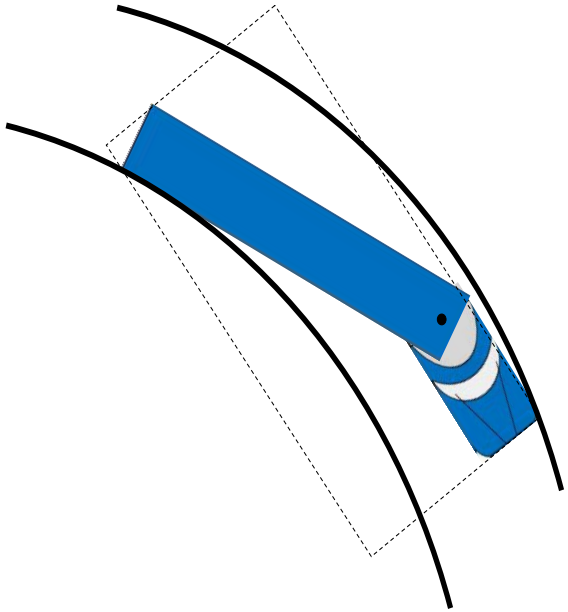
- Additional research continues through 2015
  - Specifications and objective test procedures for mandatory DSRC devices
  - Finalize security system design and end-to-end testing
  - Mitigating communications congestion
  - Detailed privacy risk assessment and security review
  - Public Acceptance Research
  - Performance metrics for safety applications
- Spectrum: to share or not to share?
- Security system: who will operate?

Heavy Vehicle Specific V2V Research

- Basic Safety Message for Truck Trailers
  - Develop changes to the BSM to accommodate articulated trailers
  - Demonstrate this fall on prototype tractor-trailer and submit to SAE technical committees for standards review
- Objective test procedures for heavy vehicle applications for V2V systems
- Complete safety benefits for heavy vehicles
  - Estimates of crash, fatality, and injury reductions
  - System costs

Basic Safety Message (BSM) for Articulated Vehicles

- Current BSM reflects only single-bodied vehicle
- Special considerations for articulated vehicles in BSM
- Need more accurate vehicle position and vehicle type information for trailers
  - On a straight path, a single, simple BSM adequately describes the vehicle
  - On a highway curve or ramp at low to moderate speed, the trailer tracks inside the tractor
- Recommendations for SAE J2735 and J2945 committees to update standards



ANPRM on Light Vehicle V2V Communications

- NHTSA released an Advance Notice of Proposed Rulemaking (ANPRM) in August 2014
  - Require V2V communication capability for light vehicles (passenger cars and light truck vehicles (LTVs))
  - Create minimum performance requirements for V2V devices and messages for new vehicles in a future year.
- ANPRM will Includes an analysis of research findings in a report: ***Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application***
  - Technical feasibility
  - Privacy and security
  - Preliminary estimates on costs and safety benefits.
- **http://www.safercar.gov/ConnectedVehicles/index.html**

Next Steps

- Continue research on heavy vehicle specific V2V issues
- Prepare heavy vehicle decision document
- Announce NHTSA Heavy Vehicle V2V Decision by early 2015
- Issue a request for expressions of interest in establishing and running the security system
- Complete research for proposed LV rule
- Draft NPRM for LV in 2016

Contact Information

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For more information on the U.S. DOT Connected Vehicles Program, visit the websites:

http://www.safercar.gov/ConnectedVehicles/index.html

http://www.its.dot.gov