

# DAIMLERCHRYSLER



Vehicle IT and Services Research

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*driving connectivity*

## 2007 ITS World Congress, London, U.K. SS 59 – Communications for Vehicle Safety *Vehicle Safety Communications in the US*

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### Outline

- International V2I and V2V Support
- Vehicle Safety Communications Landscape in the U.S.
- Vehicle Safety Communications Project (VSC)
- Extended Emergency Brake Light (EEBL)
- Cooperative Intersection Collision Avoidance System (CICAS)
- Vehicle Infrastructure Integration (VII)
- Interaction between VII and CICAS
- Infrastructure Deployment (Strawman)



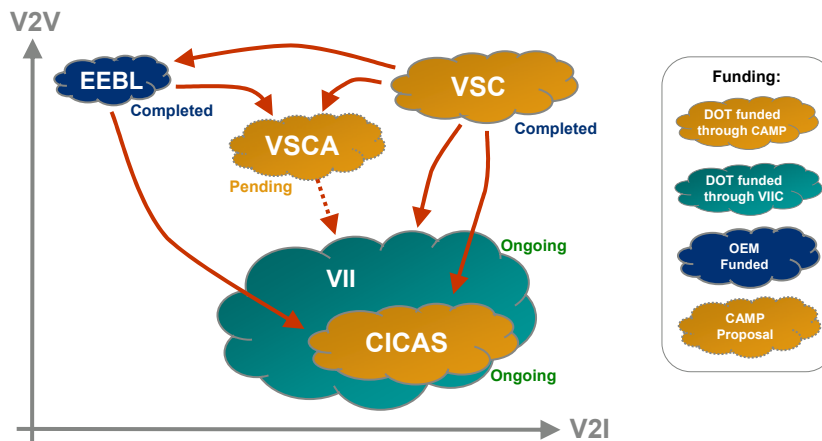
### International V2I and V2V Support

U.S., Europe and Japan all show significant activities in the area of Vehicle to Infrastructure and Vehicle to Vehicle Communications (though with somewhat different starting positions and different focus):

	<b>Focus of today's presentation</b>		
<i>RF bands</i>		20 MHz at 5.9 GHz allocation likely by 2010	20 MHz at 5.8 GHz allocated since 1997
<i>Political Environment</i>		Strong political support by the European Union and most National Governments	ETC infrastructure in place Rollout of infrastructure for vehicle safety communications ongoing
<i>Activities</i>	<ul style="list-style-type: none"> <li>• Sichere Intelligente Mobilität Testfeld Deutschland (SIM TD)</li> <li>• COM eSafety</li> <li>• Car2Car-Communications Consortium (C2C-CC)</li> <li>• CVIC, SAFESPOT</li> </ul>	<ul style="list-style-type: none"> <li>• Smartway (i.e. Vehicle Communications Infrastructure for Safety and Mobility)</li> <li>• ASV-4 (i.e. Vehicle to Vehicle Communications for Safety)</li> </ul>	



### Vehicle Safety Communications Landscape in the U.S.





## Vehicle Safety Communications Project (VSC)

VSC

2.5 year program started in May 2002, Ended in 2004

VSC Consortium Members: BMW, DaimlerChrysler, Ford, GM, Nissan, Toyota, and VW

Goals:

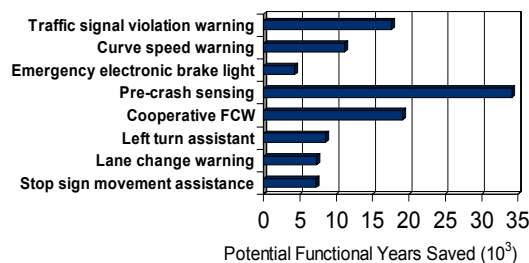
- Facilitate the advancement of vehicle safety through communication technologies
- Identify and evaluate the safety benefits of vehicle safety applications enabled or enhanced by communications
- Assess communication requirements, including vehicle-vehicle and vehicle-infrastructure modes
- Contribute to DSRC standards and ensure they effectively support safety
- Develop next generation DSRC testing system
- Test and evaluate of DSRC communications functionalities for potential vehicle safety implementations



## VSC Results

VSC

- Brainstormed application scenarios enabled or enhanced by wireless communications
- Defined 45 application scenarios and their associated rough communication requirements
- Ranked Applications based on their estimated safety benefits
- Selected a subset of highest ranking applications for further research





### Basic Communications Requirements for High-Priority Application Scenarios



	Traffic Signal Violation Warning	Curve Speed Warning	Selected by the CAMP OEMs for sample Implementation	Pre-Crash Warning	Cooperative Forward Collision Warning	Left Turn Assistant	Lane Change Warning	Stop Sign Movement Assistance	
Types of Communication	one-way, point-multipoint	one-way, point-multipoint			two-way, point-point	one-way, point-multipoint	one-way, point-multipoint	one-way, point-multipoint	one-way, point-multipoint
Transmission Mode	periodic	periodic			event-driven	periodic	periodic	periodic	periodic
Minimum Frequency (Hz)	10	1			50	10	10	10	10
Allowable Latency (milliseconds)	100	1000			20	100	100	100	100
Estimated Message Size (bytes)	500	200			200	200	500	200	500
Maximum Required Range of Communication (meters)	250	200			50	150	300	150	300

Requires communication between Infrastructure & vehicles
  Requires communication between vehicles



### Extended Emergency Brake Light Project



The VSC I project established the basic technology and feasibility for Vehicle-to-Vehicle (V2V) communications but did not implement the applications

The OEMs decided to develop and evaluate the Extended Emergency Brake Light application (EEBL) as the first V2V cooperative active safety application in order to

- Develop concepts of operation, system and communication requirements
- Establish V-V EEBL message set and interoperability
- Define & perform common engineering tests to conduct preliminary benefits assessment
- Report to the industry on results
- Guide future V-V safety applications development

The project was an OEM funded effort between BMW, DaimlerChrysler, Ford, GM, Nissan and Toyota

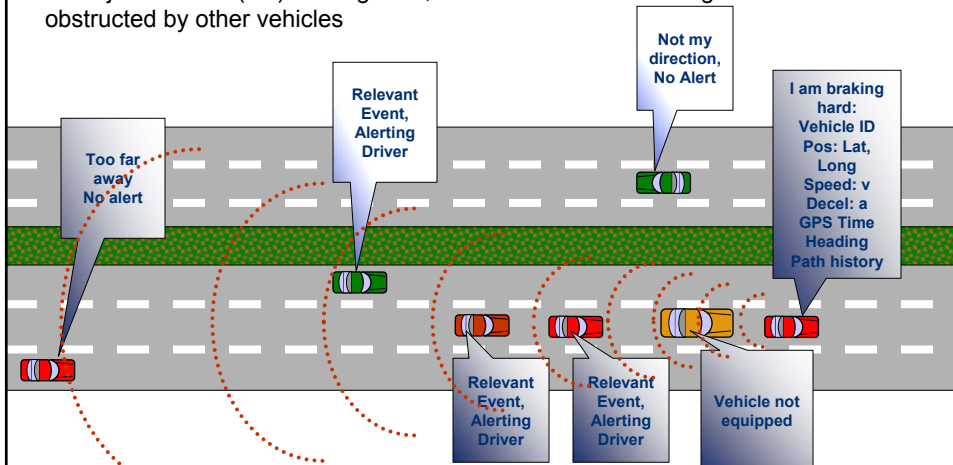
Project duration: June 2005 to March 2006



## EEBL Application Overview

**EEBL**

Objective of the application: Provide an early notification to vehicle downstream of a Subject Vehicle (SV) braking hard, even when the lines of sight to the SV are obstructed by other vehicles



## Cooperative Intersection Collision Avoidance System (CICAS)

**CICAS**

CICAS is a 4 year project to develop Cooperative Intersection Collision Avoidance Systems (CICAS) that

- Prevent crashes between vehicles due to violations of traffic signals
- Prevent crashes between vehicles due to violations of stop signs

This crash prevention applies to all types of crossing path crashes that have their origin in violations, such as Straight Crossing Path (SCP) crashes, Left Turn Across Path (LTAP) crashes, etc.

The project is divided in 2 phases:

- **Phase I:** Development of the Field Operational Test (FOT) Prototype (May 1, 2006 to April 30, 2008)
- **Phase II:** Conducting the FOT and analyzing the data (May 1, 2008 to April 30, 2010)



## CICAS Partners: Public / Private / Academia

CICAS



## Project goals for Phase I

CICAS

Development of an FOT capable CICAS-V prototype that includes

- Definition of the Concept of Operations
- Development of the System Architecture
- Definition of the Performance Specifications and the test procedures to measure them
- Development of the CICAS-V message set
- Definition and development of intersection map specification
- Development of positioning correction methods
- Development of the CICAS-V application
- Development of a capable and user-friendly DVI, including warning timing
- System tests and user tests
- VII development and POC support
- FOT definition and preparation



## Project status

**CICAS**

The project has developed:

- Concept of Operations document (to be finalized after the Nov 1 public workshop)
- Systems Engineering documentation
  - Functional Requirements
  - System Requirements
  - System Architecture
  - System Interfaces
- Design of an intersection data acquisition system for intersection approach data collection
- Intersection selection for prototype development
- Drafts of Signal Phase and Timing message sets and Geometric Intersection Description (GID) definition and message set
- Analysis of Intersection approaches in the Virginia Tech 100 Car database
- Instrumentation of stop sign controlled intersection and start of data collection



## Vehicle Infrastructure Integration (VII)

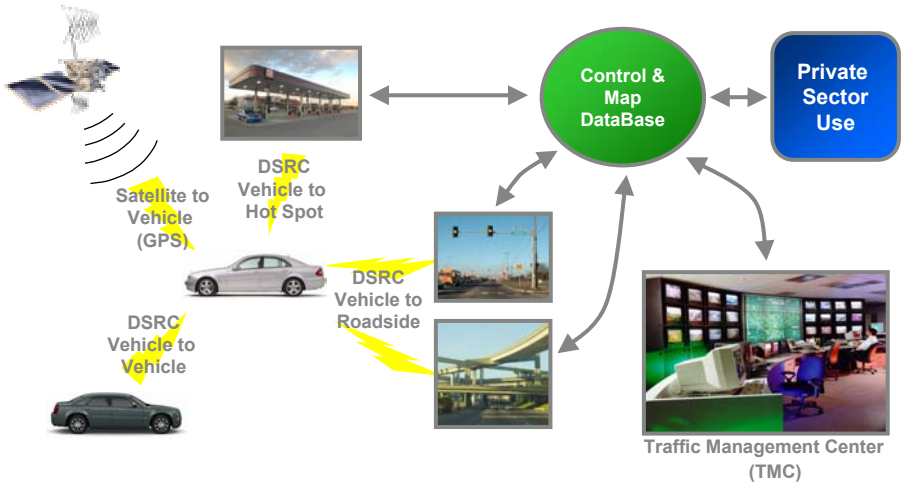
**VII**

One of nine major initiatives announced by USDOT in 2004

- **Vision:** *“Nationwide deployment of a communications infrastructure on the roadways and in all production vehicles could improve transportation and the quality of American life in ways not imagined a generation ago.”*  
(source: USDOT ITS Joint Programs Office)
- VII involves communication between individual vehicles and between vehicles and the infrastructure to enable a variety of systems to be developed to significantly improve safety, operations and maintenance, and to enable a variety of applications to support the needs of Original Equipment Manufacturers (OEMs) (i.e., the automakers) and other commercial interests.
- The VII program is a cooperative effort involving State Departments of Transportation (DOT) through the American Association of State and Highway Transportation Officials (AASHTO), local government agencies, OEMs, and the US Department of Transportation (USDOT).
- National VII Coalition established to oversee program to assess deployment feasibility



## VII High Level Overview

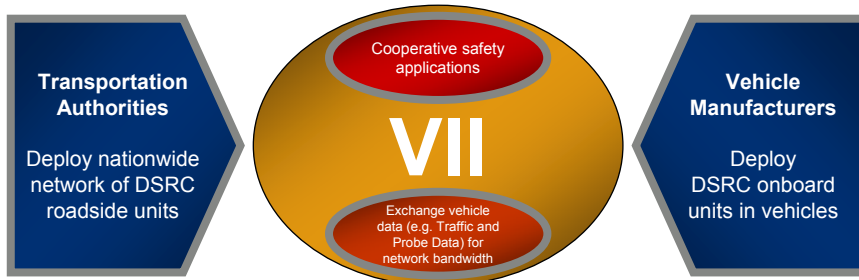


## VII Business Case



VII stakeholders are vehicle OEMs, the Federal Department of Transportation (DOT), and State and Local DOTs.

Deployment model is a nationwide rollout of roadside infrastructure, followed by large scale deployment in the new vehicle fleet.

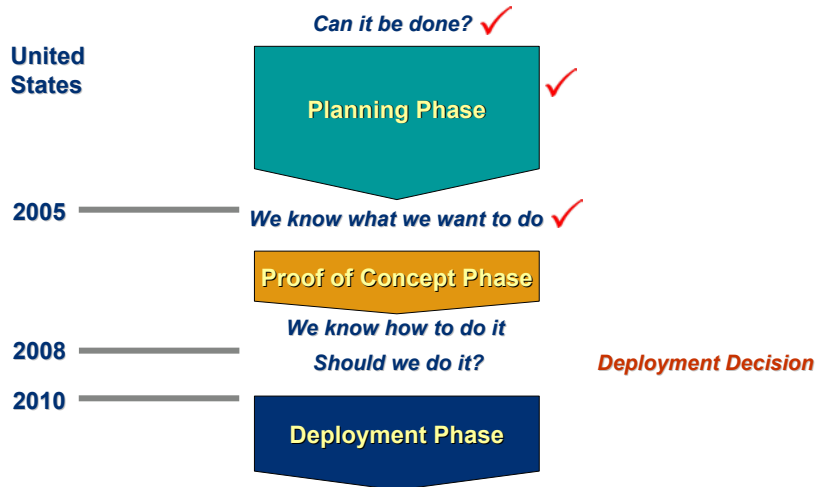






## VII Rollout Plan

VII



## Goals of the Proof Of Concept (POC)

VII

1. Testing and validation of technologies and functions for vehicle-to-vehicle and vehicle-to-infrastructure communications in a setup that exceeds a demonstrator status (scalability, proof of market suitability)
2. Preparation of the deployment decision for a country-wide introduction of vehicle-to-infrastructure- and vehicle-to-vehicle-communication-technologies.
3. Investigation of some categories of applications enabled by vehicle-to-infrastructure- and vehicle-to-vehicle-communications.



## VII POC Applications

VII

### Safety

- Extended Emergency Brake Light
- Traffic Signal Violation Warning

### Present Traffic Information

- Off-board navigation
- Dynamic traffic information
- Optimized routing
- Incident information
- Estimated travel times
- Weather information

### In-Vehicle Signage

- Work zone warning
- School zone warning
- Speed limit
- Icy bridge ahead
- Icy road
- Clearance height
- Wrong way
- Curve ahead
- Next exit services

### Make Payments

- Toll road
- Gasoline purchases
- Parking fees



## Criteria for VII POC Application Selection

VII

Likely to be the first VII production applications

Applications support diverse interests (safety, mobility, and consumer)

Test provides good coverage of VII capabilities

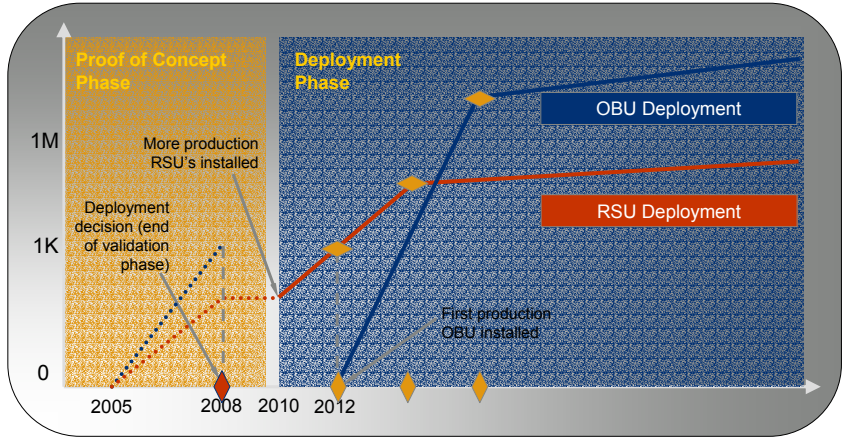
Important to have near term benefits even without high populations of VII-equipped vehicles

Test multiple concurrent applications to determine system reliability and performance

Starting point for evaluation of initial production deployments



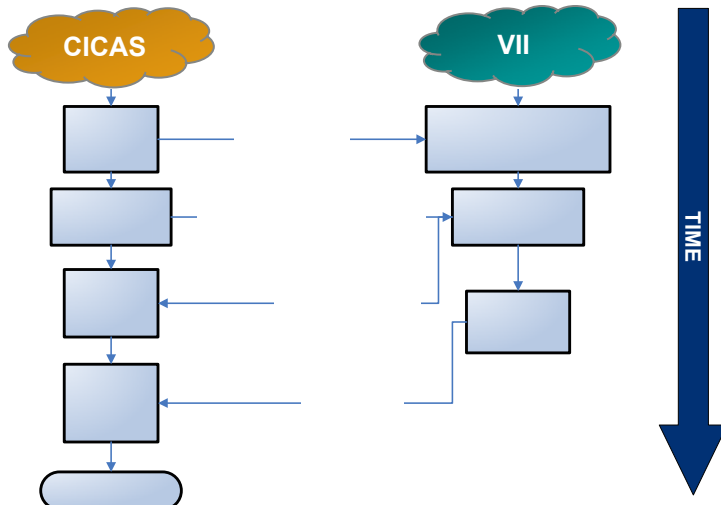
### VII Timeline (Conceptual)



**OBU:** On-Board Unit (vehicle)      ◆ Deployment Decision      ◆ Key agreement quantity  
**RSU:** Road-Side Unit (infrastructure)      ◆ Key agreement date



### Interaction between VII and CICAS





## Infrastructure Deployment (Strawman)

### Phase 1:

- 50% of all signalized intersections in urban areas containing 50% of the population
- All freeways and interstates in same urban areas (<2 minute delay)
- Every interstate interchange (<10 min delay)
- 131,800 total road side units
- Complete by 2011



### Phase 2:

- 70% of all signalized intersections in 454 urban areas
- Extra 10,000 road side units for smaller communities
- Additional 14,000 on interstates
- 239,000 total road side units
- Installation for 2012 to 2017



## Thank You!

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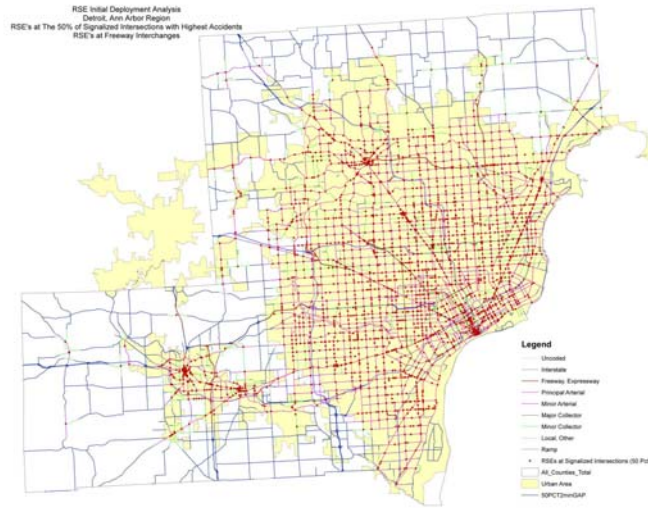
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## Infrastructure Deployment (Phase 1)



## Infrastructure Deployment (Phase 2)

