

Vehicle Safety Communications – Applications (VSC-A) Project: Communications & Standards Status

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CAMP

Vehicle Safety Communications 2

Mercedes-Benz
Research & Development North America, Inc.



TOYOTA

HONDA
Honda R&D Americas, Inc.



Intelligent Transportation Systems

A rectangular box containing logos and text for the CAMP Vehicle Safety Communications 2 project. At the top, the word 'CAMP' is written in a stylized, italicized font. Below it, the project name 'Vehicle Safety Communications 2' is also in an italicized font. The logos for Mercedes-Benz (with 'Research & Development North America, Inc.' below it), GM, and TOYOTA are arranged in a row. Below these, the logos for HONDA (with 'Honda R&D Americas, Inc.' below it) and Ford are arranged in a row. At the bottom of the box, the phrase 'Intelligent Transportation Systems' is written in an italicized font.

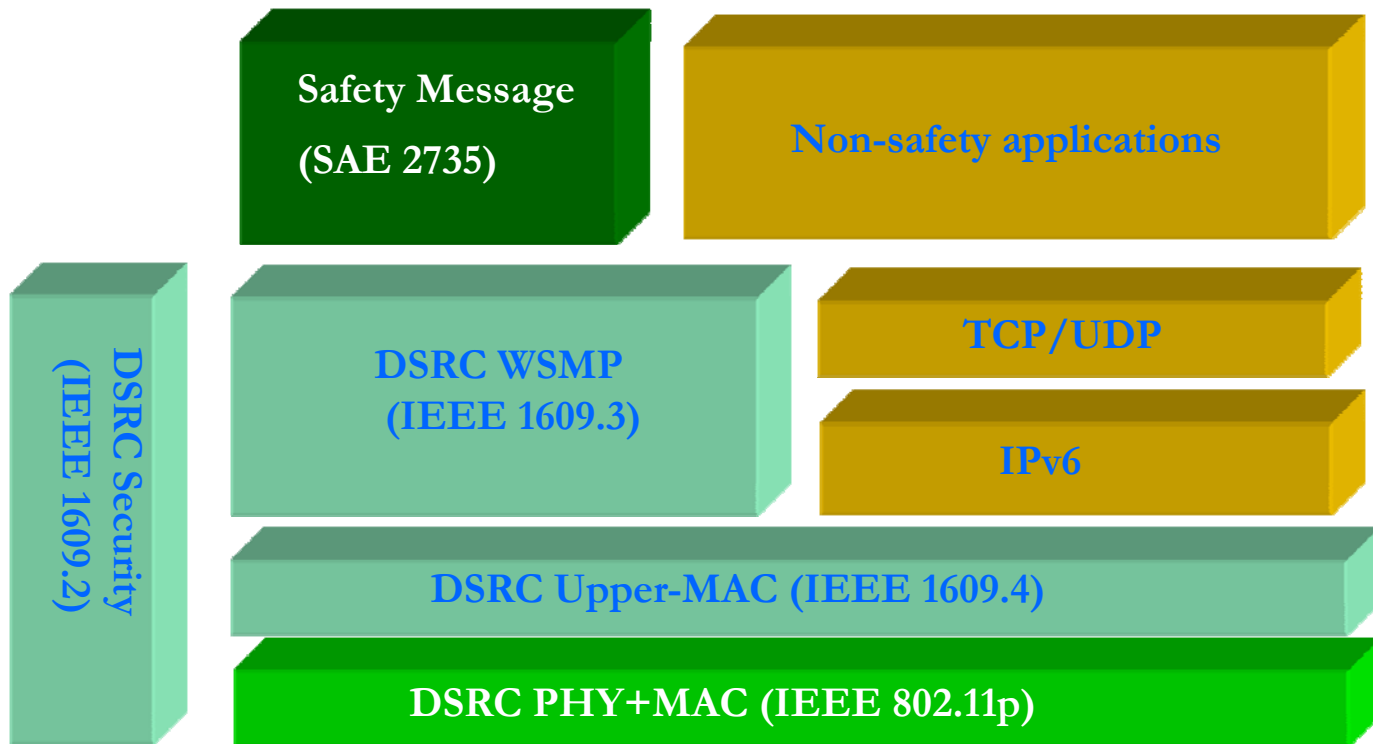
Goals of Communication Work

- Develop scalable, common vehicle safety communication architecture, protocols, and messaging framework necessary to achieve interoperability and cohesiveness among different vehicle manufacturers.
- Standardize this messaging framework and the communication protocols (including message sets) to facilitate future deployment.

Communication Focus Areas

- Message Composition
- Power Testing
- Message Dissemination
- Multi-channel Operation
- Standards Coordination and Validation

DSRC Standards Landscape



VSC-A team is working actively in green tinted areas (SAE, IEEE 1609, IEEE 802.11)

Message Composition

- One common message supports all safety applications.
- Exchange with neighboring vehicles.
- Send periodically (heartbeat) or event-triggered.

SAE J2735 Basic Safety Message (BSM)	
Part I	Basic Vehicle State Message Part I (Veh. ID, Seq. #, time, position, motion, control, veh. size) <i>Part I is mandatory in BSM</i>
Part II	Vehicle Event Object (hard braking, control loss, etc.)
	Vehicle Path History Object
	Vehicle Path Prediction Object
	Relative Positioning RTCM 1002 data

Power Testing Objectives

- Characterization of relationship between distance and packet reception probability as a function of
 - Transmission Power
 - Propagation Environment
 - Modulation Technique
- Explore utility of:
 - high power (> 20 dBm) for enhanced safety application performance,
 - low power (< 20 dBm) for congestion control

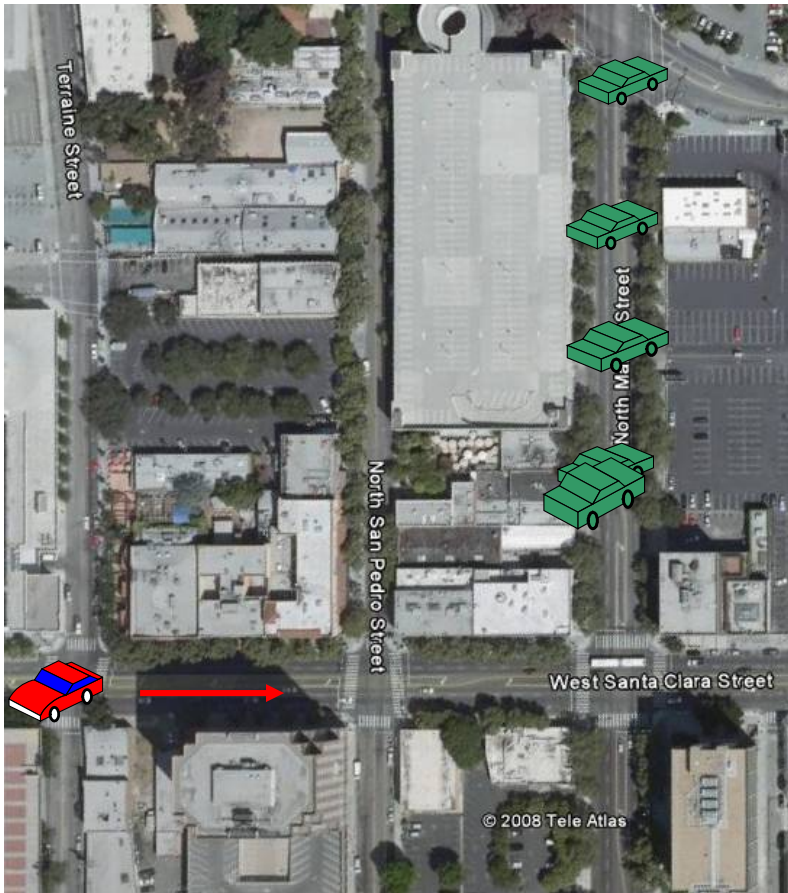
Test Scenarios Performed

- Baseline Line of Sight
- Baseline Shadowing
- Urban Straight Line
- Freeway Line of Sight
- Freeway Shadowing
- Residential Line of Sight
- Expressway Shadowing
- Arterial Shadowing
- Curved Track
- Urban Closed Intersection
- Urban $\frac{3}{4}$ Open Intersection
- Suburban Closed Intersection
- Suburban $\frac{3}{4}$ Open Intersection
- Rural Closed Intersection
- Rural Open Intersection
- Rural Highway Line of Sight
- Rural Highway Shadowing

Test scenarios motivated by specific VSC-A Safety Applications

Urban Closed Intersection

Satellite Image of Urban Closed Intersection

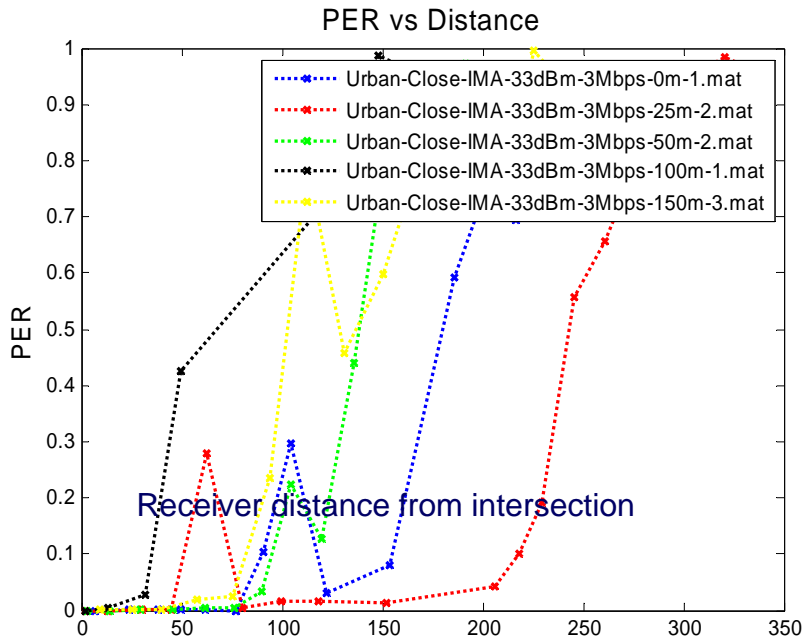


- Market and Santa Clara Street
- Downtown San Jose
- Buildings on all four corners of intersection
- Transmitter at 5 fixed locations (0 to 150 meters)

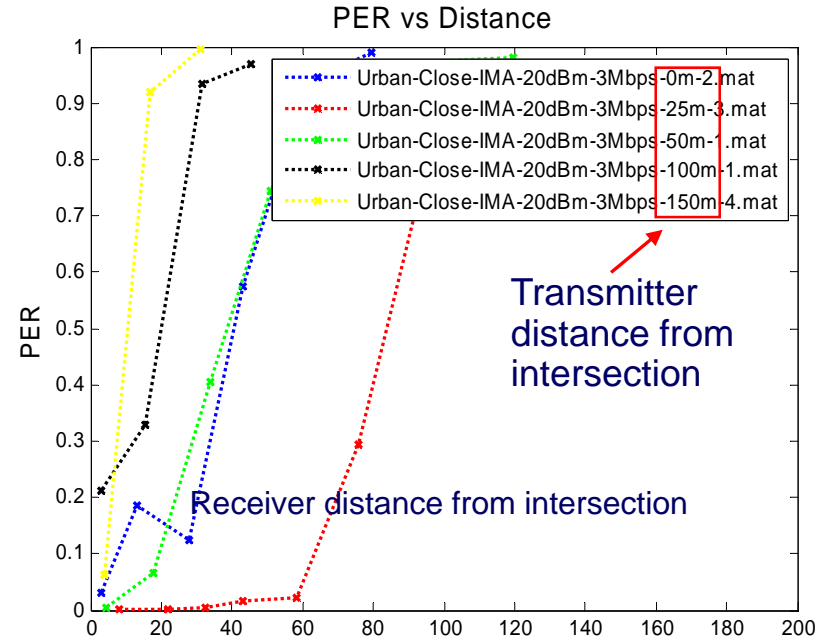
Test Results for Urban Closed Intersection

Extra range at 33 dBm could be important for safety applications targeting intersection crashes (e.g. IMA)

Packet Error rate (PER) Versus distance for Urban Closed Intersection



33dBm Transmissions



20dBm Transmissions

Message Dissemination

Objective: Use power, rate, and other controls to mitigate network congestion and improve message delivery

Approach:

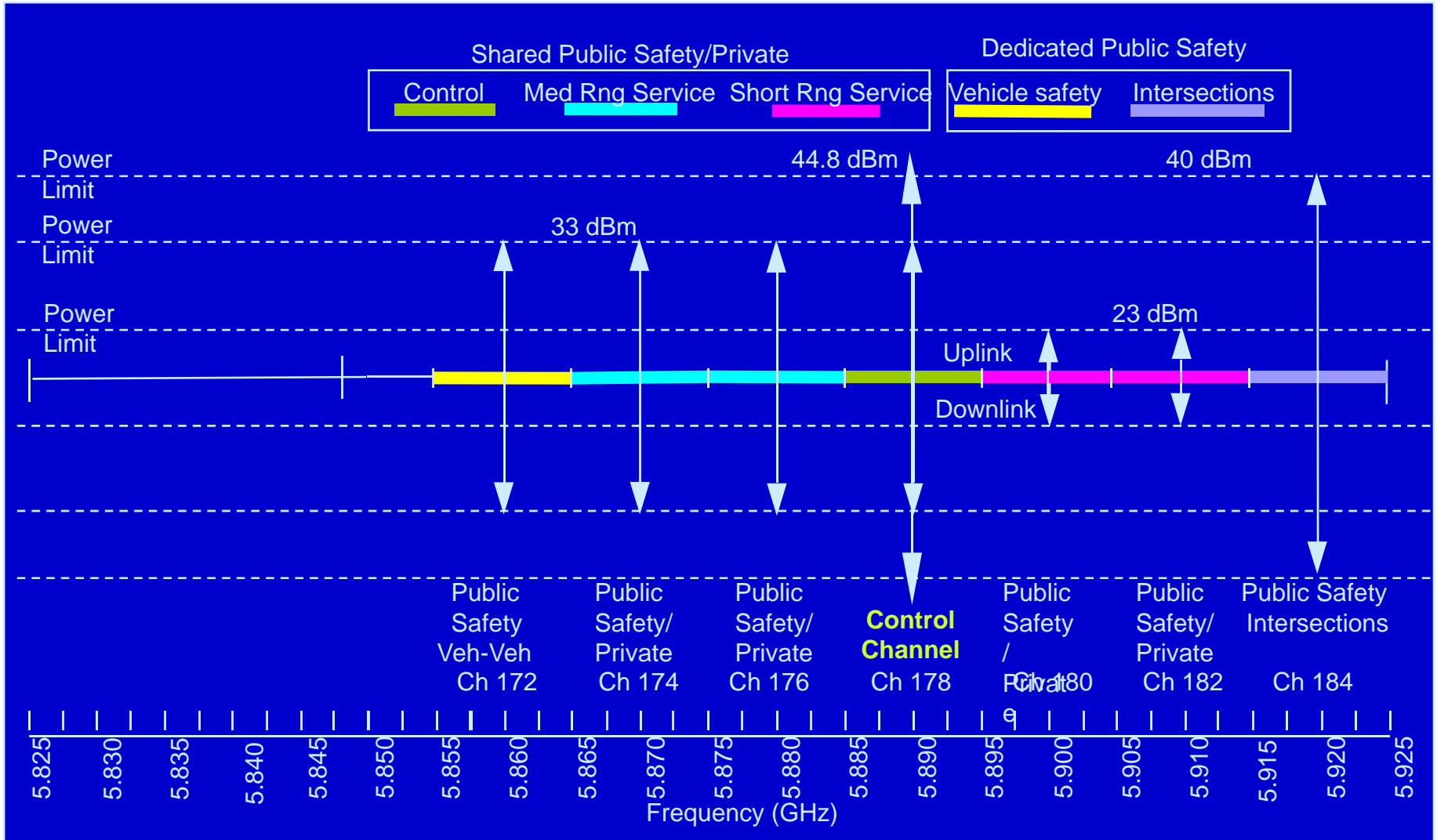
- Define Message Dissemination Framework
 - Cooperative, distributed action
 - Distinguish between important and routine messages
- Define appropriate channel load metric
- Develop specific controls
- Validate and refine via simulation
- Test in vehicles

Multi-Channel Operation

Objectives:

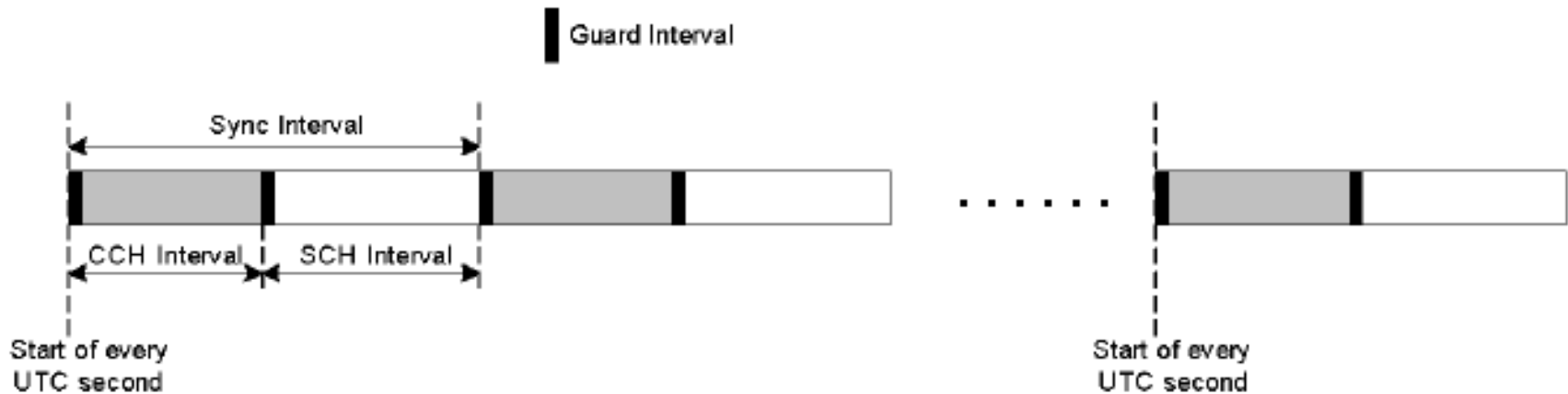
- Analyze IEEE 1609.4 Channel Switching
- Develop alternatives and evaluate
- Consider effect of FCC ruling on Channel 172

US DSRC Bandplan



IEEE 1609.4 Channel Switching

- Defines channel switching between control and service channels
- Safety messages sent on Control Channel during CCH Interval



CCH: Control Channel

SCH: Service Channel

Multi-channel issues to consider

- Performance (safety, general DSRC services)
- Efficiency
- FCC designated Channel 172 exclusively for V2V safety communications – July 2006
- Single-radio and optional dual-radio systems

VSC-A is exploring a wide range of potential solutions

DSRC Standards Status

- IEEE 802.11p (PHY and MAC): passed Letter Ballot May 2008. Planning to complete in 2009.
- IEEE 1609.x (Middle layers): 1609.2, 1609.3, and 1609.4 planning to move from Trial Use status to Full Use status in 2009.
- SAE J2735 (Message Set Dictionary): Planning to start ballot process Dec. 2008, will move from Recommended Practice to Standard

Thank You