NHTSA V2V Communications NPRM
Key Points and Considerations for State DOTs
(updated with webinar Q&A)

February 14, 2017
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Transportation Research Research Institute
University of Arizona
Outline/Agenda

• General Overview of NHTSA Notice of Proposed Rulemaking (NPRM) on V2V Communications
• Specific Requested Comments/Information/Feedback
• Technical Content Highlights
  • V2V Communication Advantages
  • V2V Communication Challenges/Limitations
• NPRM Justification
  • Mandate versus Consumer Decision/Option
  • Commonality and Interoperability
• Considerations for State/Agency DOTs
  • Possible Requirements, Needs, or Considerations of DOTs
  • Excluded/Unlisted Benefits for State DOTs
General NPRM Overview

• The safety need for V2V communications and approaches to advanced vehicle safety
• V2V Research and History
• Overview and Summary of ANPRM
• Proposed Rulemaking Elements
  • Proposal to Regulate:
    • Mandate for New Light Vehicles and Possible Aftermarket Devices
    • Communications: DSRC Radio Technology – Transmit, Receive, Messages
    • Communication Performance Requirements
      • Structure, Content and Requirements of Basic Safety Messages (BSMs)
      • Authentication of Incoming Messages
      • Misbehaving and Malfunctioning Devices
      • Over-the-Air (OTA) Security and Software Updates
      • Cybersecurity, Firewalls, and Device Isolation
  • Public Acceptance, Privacy, and Security
  • Device Authorization – SCMS, VBSS
  • NHTSA Authority to Regulate
  • Estimated Costs and Benefits (in-depth coverage)
  • Proposed Implementation Timing
General NPRM Overview

- Comprehensive, Extensive (Long) Document
- Focus
  - Benefits and Safety Aspects of V2V Communications
  - Reduction or Elimination of Certain/Specific Motor Vehicle Accidents
    - Multiple Vehicle Accidents (versus singular vehicle accidents)
    - Priority 10 (See supplemental slide for details)
    - Scenarios versus CV Applications
  - DSRC (Equipment, BSMs, Security, Privacy) versus CV Applications
  - V2V Communication Benefits vs. Application(s) Benefits
  - Analysis of Benefits Outweigh Costs
  - Rulemaking vs. If-Equipped or Consumer Choice

Ensures and accelerates safety benefits in a reasonable timeframe.
General NPRM Overview

What are the “Top 10 Priority” Pre-Crash Scenarios for enhancing safety?

<table>
<thead>
<tr>
<th>Pre-Crash Scenario</th>
<th>Pre-Crash Group</th>
<th>Safety Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead Vehicle Stopped</td>
<td>Rear-end</td>
<td>FCW/CFCW</td>
</tr>
<tr>
<td>Lead Vehicle Moving</td>
<td>Rear-end</td>
<td>FCW/CFCW</td>
</tr>
<tr>
<td>Lead Vehicle Decelerating</td>
<td>Rear-end</td>
<td>FCW/CFCW/EEBL</td>
</tr>
<tr>
<td><strong>Straight Crossing Path at Non-signal</strong></td>
<td>Junction Crossing</td>
<td>IMA</td>
</tr>
<tr>
<td><strong>Left-turn Across Path /Opposite Direction</strong></td>
<td>Left-turn at Crossing</td>
<td>LTA</td>
</tr>
<tr>
<td>Opposite Direction/No Maneuver</td>
<td>Opposite Direction</td>
<td>DNPW</td>
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<tr>
<td>Opposite Direction/Maneuver</td>
<td>Opposite Direction</td>
<td>DNPW</td>
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<tr>
<td>Change Lanes/Same Direction</td>
<td>Lane Change</td>
<td>BSW/LCW</td>
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<tr>
<td>Turning/Same Direction</td>
<td>Lane Change</td>
<td>BSW/LCW</td>
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<tr>
<td>Drifting/Same Direction</td>
<td>Lane Change</td>
<td>BSW/LCW</td>
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</tbody>
</table>

**Acronyms:** Blind Spot Warning (BSW), Do Not Pass Warning (DNPW), Forward Collision Warning (FCW), Intersection Movement Assist (IMA), Lane Change Warning (LCW), Left Turn Assist (LTA)

**Bold Text:** Applications considered in Cost/Benefit Analyses in NPRM
General NPRM Overview

• Effective Date(s)
  • OEM implementation within two model years after final rule is adopted
  • Three-year phase-in period to accommodate OEM product cycles
  • If rule is adopted in 2019, phase-in would begin in 2021 and all vehicles would be subject to comply in 2023.

• Brief Acknowledgements
  • 53 USDOT CV Applications (13 CV Safety Applications) depend on V2V communications addressed in this NPRM
  • CV Mobility and Environmental (15) Applications could benefit from NPRM
  • Utility of Data by DOTs

• Reference and Supplemental Documents
  • “Implementation of the Safety Impact Methodology Tool”, June 2015
### General NPRM Overview

<table>
<thead>
<tr>
<th>Readiness / Research / Policy</th>
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<tbody>
<tr>
<td>SAE Standards Maturity</td>
<td>Completed April 2016; SAE J2735 &amp; J2945</td>
</tr>
<tr>
<td>SW Implementation on DSRC Device Performance</td>
<td>BAH Requirements and Test Procedures completed October 2015; CAMP Requirements August 2015; Test Procedures September 2015</td>
</tr>
<tr>
<td>DSRC System Performance Measures</td>
<td>CAMP Communications Completion August 2016</td>
</tr>
<tr>
<td>BSM Congestion Sensitivity</td>
<td>CAMP V2V Communications Research Project</td>
</tr>
<tr>
<td>Relative Positioning Performance Test</td>
<td>Required research for testing of GPS receivers and relative/absolute positioning</td>
</tr>
<tr>
<td>Vehicle and Receiver Positioning Biases</td>
<td>Required research on erroneous position reporting due to positional biases across GPR receiver combinations</td>
</tr>
<tr>
<td>Compliance Specifications and Requirements</td>
<td>Develop performance requirements, test procedures, and test scenarios for device evaluation</td>
</tr>
<tr>
<td>Road Side Equipment Authority Policy</td>
<td>Issuance of NPRM</td>
</tr>
<tr>
<td>V2V Device Software Updates Policy</td>
<td>Requirements Completed September 2015</td>
</tr>
<tr>
<td>Spectrum Sharing Interference</td>
<td>Test Pending (ETC: 12 months from receipt of prototypes)</td>
</tr>
<tr>
<td>Consumer Acceptance Research</td>
<td>Driver Acceptance Research Completed September 2015</td>
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<tr>
<td></td>
<td><em>Need broader public acceptance research.</em></td>
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<tr>
<td>V2V Location Tracking via BSM</td>
<td>March 2016</td>
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<tr>
<td>V2V Identification Capabilities</td>
<td>March 2016</td>
</tr>
<tr>
<td>V2V Inventory of Privacy Concerns</td>
<td>March 2016</td>
</tr>
<tr>
<td>V2V Privacy Risk Assessment</td>
<td>March 2016</td>
</tr>
<tr>
<td>Cryptographic Flexibility</td>
<td>March 2016</td>
</tr>
<tr>
<td>Independent Security Design Assessment</td>
<td>March 2016</td>
</tr>
<tr>
<td>Misbehavior Detection and Authority</td>
<td>Initial Review December 2015</td>
</tr>
<tr>
<td>Safety Application Test Metrics and Procedures</td>
<td>ETC: December 2018 (Volpe)</td>
</tr>
<tr>
<td>Safety Application Performance Measure Rationale</td>
<td>ETC: April 2019</td>
</tr>
<tr>
<td>Practicability of Non-ideal Driving Condition Testing</td>
<td>ETC: April 2019</td>
</tr>
<tr>
<td>Fused and Non-Fused V2V Safety Application Test Procedures</td>
<td>ETC: April 2019</td>
</tr>
</tbody>
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<td>Performance and Test Metric Validation</td>
<td>ETC: April 2019</td>
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<tr>
<td>False Positive Mitigation</td>
<td>ETC: April 2018 (Volpe)</td>
</tr>
<tr>
<td>DVI Minimum Performance Requirements</td>
<td>November 2016 (VTTI)</td>
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</table>
Requested Comments/Feedback

• **Comment Submission**
  • Due no later than 90 days after FR publication (1/12/17 - 4/12/2017)
  • Limited to 15 pages
  • Attachments are permitted and not counted toward 15 page limit
  • Identify Rulemaking Docket Number (Docket No. NHTSA-2016-0126)
  • Four ways to submit comments:
    • Online – [http://www.regulations.gov](http://www.regulations.gov)
    • Mail – Docket Management Facility, M-30, U.S. Department of Transportation, West Building, Ground Floor, Rm. W12-140, 1200 New Jersey Avenue, SE, Washington, DC 20590.
    • Hand Delivery or Courier – West Building, Ground Floor, Rm. W12-140, 1200 New Jersey Avenue, SE, between 9 am and 5 pm Eastern Time, Monday through Friday, except Federal Holidays.
    • Fax – (202) 493-2251

• **General Recommendations for Comments/Feedback**
  • Explain why you agree or disagree.
  • Suggest alternatives
  • Offer substitute language for requested changes
  • Describe your assumptions, technical information, and/or data
  • Provide sufficient details of analysis that enable reproduction
  • Explain your views clearly and in a professional manner
Requested Comments/Feedback

- Coverage Extent of Comments/Feedback
  - V2V Communications NPRM
  - Preliminary Regulatory Impact Assessment (PRIA)
  - Draft Privacy Impact Assessment (PIA)

- Two Categories of Comments/Feedback
  - Specific questions and requests in the text of the NPRM
  - Broad comments, particularly those that are supported by relevant documentation, information, or analysis (p19)

- Possible Outcomes/Expectations
  - ANPRM resulted in over 900 comments.
  - ANPRM responses were “from a diverse set of commenters representing a wider range of perspectives than other agency safety rules.”
  - Diversity – vehicle OEMs and suppliers, trade associations, standards development organizations, safety advocacy groups, individual citizens, technology/communications companies, state/federal agencies, and privacy groups.
Requested Comments/Feedback

• **Specific Requests for Comments/Feedback**
  • **Fused Systems** – “views concerning the potential of fusing connected and vehicle-resident technologies.” (p33)
  • **If-Equipped Option** (p68) – a standard vs. a mandate
  • **Certification of Aftermarket V2V Device Installations** (p70)
  • **Alternative Interoperable Technology Provisions** – technologies satisfying performance and interoperability requirements based on DSRC-based V2V communications (p71)
  • **Applications** – “information that could inform a potential decision to mandate certain applications.” (p71, 276-277)
    • IMA and LTA used throughout NPRM as examples and premise for critical analyses (e.g., accidents presented, lives saved, and cost estimates)
  • **DSRC Performance Requirements** (p71-105)
    • Transmission Minimum Range (300m, +10/-6 degree elevation)
    • Transmission Reliability (<10% PER)
    • Test Device (-92 dBm)
    • FCC Power Restrictions (max EIRP 33dBm)
    • Data Rate (Channel 172 6Mbps)
Requested Comments/Feedback

• Specific Requests for Comments/Feedback (Cont.)
  • Proposed BSM Content (p105-123)
    “...we especially would like input on whether we have appropriately selected (1) the data elements to include/make optional/exclude, and (2) the tolerance levels for each data element.”
  • Message Packaging
    • Message ID
    • Message Count
    • Temporary ID (p107)
  • Time – accuracy of +/- 1ms of actual time
  • Location
    • Lat & long (HDOP ≤ 1.5m, abs. error < 1σ)
    • Elevation <3m
    • vehicle position reference position (WGS-84)
  • Movement
    • Speed within 0.28m/s
    • Heading (2° for speeds > 12.5m/s; 3° for speeds < 12.5m/s)
    • Acceleration (lat, long ≤ 0.3m/s², elevation ≤ 1m/s²)
    • Yaw Rate ≤ 0.5°/s
Requested Comments/Feedback

• Specific Requests for Comments/Feedback (Cont.)
  • Proposed BSM Content Continued...(p105-123)
    • Additional Event Based Information - Path History (1m), Path Prediction, Exterior Lights, Event Flags
    • Vehicle Based Motion Indicators – Transmission State and Steering Wheel Angle (5°)
    • Vehicle Size (0.2m) p121
      “However, we acknowledge that if the vehicle size information is too specific, it could potentially facilitate an effort to identify basic safety messages to a particular vehicle over time. The agency believes the performance metric (0.2m) for this data element balances not only the safety need for accurate information about the vehicle size, but also the privacy needs of the driver.”
  • Optional Data Elements p122
  • Excluded Data Elements p122-
    • Vehicle Identification Data Field – vehicle type
  • BSM Data Initialization Requirements
    • Broadcast BSMs within 2 seconds of gear selection
    • Acknowledgement of “open sky”/GPS availability in certain situations (e.g., parking garages)
Requested Comments/Feedback

• Specific Requests for Comments/Feedback
  • Public Key Infrastructure (PKI) Proposal (p14, 133)
    • Alternative Approach – Performance-based Only
    • Alternative Approach – No Message Authentication (p141)
  • Primary Misbehavior Detection and Reporting Proposal
    • Security Credential Management System, SCMS (p15, 237, 241)
    • Misbehavior Reporting (p142-144)
    • Alternative Approach – No Reporting Requirement, but tamper detection (p15, p142)
      • Malfunction Indication Requirements (p149-150)
      • Tampering (p156)
  • Software and Security Certificate Updates (p151-152)
  • Cybersecurity PKI-SCMS Requirements (p154-165)
Requested Comments/Feedback

• Specific Requests for Comments/Feedback (Cont.)
  • **Cost Estimates** – DSRC Equipment and Cost per Vehicle (p276-340)
    • Quantified Costs
      • Approach 1: One DSRC radio dedicated to V2V safety and one secondary communication platform (cellular, Wi-Fi, or satellite)
      • Approach 2: Two DSRC radios – one dedicated to V2V safety and one for secondary communications such as SCMS.
    • Component Costs – OEMs, Consumers, Installation, GPS Installation
    • Communication Costs – RSU deployment on three different roadways
    • Fuel Economy Impact – Due to weight (omitted HP/Wattage usage, Eco Apps, and travel efficiencies)
    • Overall Annual Costs
    • Overall Model Year Costs – Fuel economy impact
  • Non-Quantified Costs
    • Health Insurance Costs, Perceived Privacy Loss, Opportunity Cost of Spectrum, Increased Litigation Costs
  • Estimated Benefits
    • Injury and Property Damage Benefit
    • Monetized Benefits
  • Non-Quantified Benefits
    • Effect for Enhancing Vehicle-Resident Safety Systems
    • Incremental Benefits of V2V Apps
    • Impact of Next Generation V2V Apps
    • Impact of Enabling V2P and V2I Apps
    • Impact on Automation and Autonomous Vehicles
  • Breakeven Analysis
  • Cost Effectiveness and Positive Net Benefits Analysis
  • Estimated Costs and Benefits of V2V Alternatives
Technical Content Highlights

• V2V Communication Advantages
  • Offers Crash-Avoidance in contrast to Crash-Mitigation (vehicle-resident sensor systems)
  • Not line-of-sight restricted
  • Provides additional information not available from traditional sensors
  • Long-range detection – almost double vehicle-resident sensors
  • Critical information available sooner (Crash-Avoidance)
  • Environmentally and situationally robust (weather, sunlight, shadows, cleanliness, calibration, aging effects, etc.)
  • Can be fused with vehicle-resident sensors and capabilities for even greater benefit
  • Not limited/restricted to new vehicles
  • Collaborative, situational-awareness environment that improves with number of vehicles participating
Technical Content Highlights

- **V2V Communication Challenges/Limitations**
  - **Interoperable communications** are required (messages, protocols, language, etc.)
  - **Critical Mass** – “V2V can only begin to provide significant safety benefits when a significant fraction of vehicles comprising the fleet can transmit and receive the same information in an interoperable fashion.” (p11, 67)
  - **If-Equipped Standard vs. Mandate** – From ANPRM, it was suggested that a standard could be issued “if a new vehicle is equipped with devices capable of V2V communications, then it should meet the following requirements.”
  - **Safety Improvement** – Dependent on the fraction of vehicle fleet communicating/participating.
  - **Application Dependency** – This NPRM does not specify any specific safety application, but uses IMA and LTA as examples to demonstrate benefits.
NPRM Justification

• Mandate versus Consumer Decision
  • Holistic benefit (safety and efficiency) from collaborative participation
  • Consumer cost-benefit is dependent on other consumers/purchasers
  • Historic Precedence – Seat belts, air bags, tire pressure monitoring

• Commonality and Interoperability
  • If each OEM had a proprietary offering, the collective benefit would be reduced/impacted.
  • Critical Mass – “Without government intervention, the resulting uncertainty could undermine manufacturer plans or weaken manufacturers’ incentive to develop V2V technology to its full potential” (p12)
Considerations for State DOTs

- Possible Requirements, Needs, or Considerations from State DOTs
  - GPS replication/rebroadcasting in long tunnels, long bridges (e.g., Overseas Highway in Key West, FL), enclosed garages, and other occlusion areas
  - Certification/Authorization/Licensing of Aftermarket Device Installation (similar to certified ignition interlock devices?)
  - (p11, 67) States could contribute to “Critical Mass” by outfitting existing fleet vehicles with Aftermarket Devices.
  - (p63) In the ANPRM, “AASHTO also mentioned that interference-free spectrum is critical and commented that supporting future upgrades to the system through software rather than hardware changes would be important for state agencies.”
  - (p192-195) State and local government reliance or interpretation of health and safety concerns (e.g., EHS) of wireless devices.
  - (p195-196) Licensing/registration of FCC-covered wireless devices (e.g., repeaters, data loggers)
Considerations for State DOTs

- Possible Requirements, Needs, or Considerations from State DOTs
  - (p211, 215) Possible revenue sources/needs include: CME license fees, certificate subscription fees, and yearly service fees that might be aligned with vehicle licensing or annual license plate renewal.

  - (p223) State support/compliance with SCMS that might be administered by the Federal government (i.e., ANPRM input from Ford and Volkswagen).

  - (p276-340) Quantified Costs used in the cost/benefit analyses considered two different approaches (see slide 16). “Approach 1” could have greater cost implications to States, since two types of communication capabilities would need to be maintained in contrast to “Approach 2”.

  - (p363) Consultation or approval from state and local governments beyond the NPRM is not mandated (Executive Order 13132, August 4, 1999).

  - (p390) “States and localities may deploy roadside equipment that enables connectivity between your vehicle, roadways and non-vehicle roadway users (such as cyclists or pedestrians).”
Considerations for State/Agency DOTs

• Excluded/Unlisted Benefits for State DOTs
  • Improved Roadway Situational Awareness from use of "aggregate V2V safety messages for traffic monitoring, road maintenance, transportation research, transportation planning, truck inspection, emergency and first responder, ride-sharing, and transit maintenance purposes." (p182, 390)
    • Vehicle Data Counts
    • Performance Metrics – Throughput, Travel Time, Speeds, ...
    • Enforcement Needs/Issues
  • Congestion Relief
    "Further, V2V technology is expected to speed-up the deployment of various V2I technologies, which could have significant safety and congestion-relief applications." (p277)
  • Criticality of MAP/GID information of intersections and roadway infrastructure.
  • Emergency Vehicle Safety and Participation
    • Advanced Awareness of Approaching EVs
    • EV Routing based on current traffic conditions
  • Work Zone Safety Improvements
  • Wrong Way Driving Detection/Monitoring Capability
Webinar Q&A

• Q2: Will a copy of the presentation be provided?
  • A2: An updated copy of the technical presentation will be made available that includes the relevant Q&A.

• Q3: Can you discuss the relationship for cellular communication with the DSRC?
  • A3: The NPRM presented two approaches (Approach 1 and Approach 2 referenced in Slide 16). In Approach 1, there would be one DSRC radio dedicated to V2V safety and one secondary communication platform (cellular, Wi-Fi, or satellite) for receiving SCMS and updates. The NPRM regulates the messages, data elements, performance requirements and similar metrics that the secondary communication platform would have to meet to be in compliance with the regulation. On Slide 21, we mention the additional maintenance cost considerations that would be imposed on states for Approach 1 in comparison to Approach 2.

• Q4: You had page numbers listed in the slides. Which version of the NPRM do these map to?
  • A4: The page numbers referenced in our slides map to the version dated December 13, 2016. The PDF version of this NPRM can be obtained from this link: http://www.safercar.gov/v2v/pdf/V2V%20NPRM_Web_Version.pdf

• Q7: Was there discussion on accuracy of the vehicle position in the NPRM?
  • A7: Yes. On Slide 13, we show the positioning of 1.5 meters, which corresponds to half a vehicle-lane width. This is the accuracy for V2V. But, in developing this NPRM, they may not have considered the accuracy requirements of the various CV applications. Postscript: The NPRM was explicit about setting performance criteria as part of the regulation. They were intent on not specifying how OEMs and manufacturers will design the systems to meet these criteria.

• Q8: Did the NPRM include GPS correction?
  • A8: The NPRM did not prescribe GPS correction or any specific design approach to meeting the regulated performance of the proposed rulemaking. Details on the research roadmap (Slides 7-9) show concern about testing relative positioning performance across different GPS receivers (p44). Other details on GPS positioning effects include the impacts of improper GPS antenna installation (p70), GPS impacts at heading determination at low speeds (p114), and GPS positioning at vehicle initiation (p124).
Contact Information

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