CONNECTED AUTOMATION

IMPROVING SAFETY AND MOBILITY THROUGH CONNECTED VEHICLE TECHNOLOGY

Roger Berg - Vice President
North America Research and Development
DENSO Corporation
DENSO’s Global Product and R&D Focus

Fuel Efficiency, Safety, Information & Communication

- **Powertrain Products**
  - Engine management system,
    - electronically-controlled gasoline direct injection system, starter, alternator, hybrid components, etc.

- **Climate Control Products**
  - Automatic air conditioner, car heater, rear cooling unit, compressor, sensors, battery thermal, etc.

- **Body Electronics Products**
  - Instrument cluster, windshield wiper, remote keyless entry system, IC flasher, horn, etc.

- **Driving Control and Safety**
  - Cruise control system, airbag sensing system, vehicle stability control, antilock braking system, traction control system, heads-up display, active safety sensors, etc.
DOT research indicates that safety applications using V2V technology can address a large majority of crashes involving two or more motor vehicles. With safety data such as speed and location flowing from nearby vehicles, vehicles can identify risks and provide drivers with warnings to avoid other vehicles in common crash types such as rear-end, lane change, and intersection crashes. These safety applications have been demonstrated with everyday drivers under both real-world and controlled test conditions.

V2V technology does not involve exchanging or recording personal information or tracking vehicle movements. The information sent between vehicles does not identify those vehicles, but merely contains basic safety data. In fact, the system as contemplated contains several layers of security and privacy protection to ensure that vehicles can rely on messages sent from other vehicles and that a vehicle or group of vehicles would be identifiable through defined procedures only if there is a need to fix a safety problem.

In August 2012, DOT launched the Safety Pilot "model deployment" in Ann Arbor, Mich., where nearly 3,000 vehicles were deployed in the largest-ever road test of V2V technology. DOT testing is indicating interoperability of V2V technology among products from different vehicle manufacturers and suppliers and has demonstrated that they work in real-world environments.

The safety applications currently being developed provide warnings to drivers so that they can prevent imminent collisions, but do not automatically operate any vehicle systems, such as braking or steering. NHTSA is also considering future actions on active safety technologies that rely on on-board sensors. Those technologies are eventually expected to blend with the V2V technology.

"We are pleased with the direction NHTSA is taking in terms of V2V technology," said Greg Winfree, Assistant Secretary for Research and Technology. "The decision to move forward comes after years of dedicated research into the overwhelming safety benefits provided by a connected vehicle environment."

NHTSA is currently finalizing its analysis of the data gathered as part of its year-long pilot program and will publish a research report on V2V communication technology for public comment in the coming weeks. The report will include analysis of the Department's research findings in several key areas including technical feasibility, privacy and security, and preliminary estimates on costs and safety benefits. **NHTSA will then begin working on a regulatory proposal that would require V2V devices in new vehicles in a future year**, consistent with applicable legal requirements, Executive Orders, and guidance. DOT believes that the signal this announcement sends to the market will significantly enhance development of this technology and pave the way for market penetration of V2V safety applications.
Historical Background
The Transportation Problem in the USA

**Safety**
- 5,800,000 crashes & 33,963 deaths (2009)
- \(\approx\) $300 billion estimated society cost
- **$1522 for each US traveler**

**Mobility**
- 4.8+ billion hours of travel delay (2010)
- \(\approx\) $98 billion cost of urban congestion
- $590 for each US traveler

**Environment**
- 3.9+ billion gallons of wasted fuel

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**ONE KEY SOLUTION: CONNECTIVITY**

Adapted from “DSRC Workshop”, M. Schagrin, RITA JPO, May 2010 and AAA report 2011
Connected Vehicle Timeline for USA

- **US Govt. Expected Trends**
  - VIIC
  - CAMP
  - Law

- **VII Program Start**
- **VII Feasibility**
  - Equip dev. → PoC → Rev.
  - CICAS-V / VSC-A → R&D

- **Connected Vehicle Program**
  - R&D - Outreach Technical & Policy Research Tracks
  - 3000 unit FOT
  - Regional Deployments

- **Activity**
  - Device Acquisition
  - Driver Recruitment & Training
  - Vehicle Builds
  - Vehicle Deployment
  - Data Collection and Eval.
  - Safety Benefits Analysis

<table>
<thead>
<tr>
<th>Activity</th>
<th>2012</th>
<th>2013</th>
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<tbody>
<tr>
<td>Device Acquisition</td>
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<tr>
<td>Driver Recruitment &amp; Training</td>
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<td>Vehicle Builds</td>
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<td>Vehicle Deployment</td>
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<td>Data Collection and Eval.</td>
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<tr>
<td>Safety Benefits Analysis</td>
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</table>

- **Transportation Act of 2012**
- **☆ NHTSA decision to move towards regulation**
- **☆ ITS WC (NY)**
- **☆ ITS WC (FL)**
- **☆ ITS WC (MI)**
CAMP V2V Safety Program

DENSO demonstrated proven capability for successful V2X design and implementation.
## 2012 - 2014 Model Deployment

### SAFETY PILOT

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Vehicle Type</th>
<th>Vehicle Source</th>
<th>Number of Units</th>
<th>% of total</th>
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<tbody>
<tr>
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<td>CAMP</td>
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<td>2.3%</td>
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<tr>
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<td>Battelle</td>
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<tr>
<td>VAD</td>
<td>Light</td>
<td>UM employees</td>
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<tr>
<td>VAD</td>
<td>Commercial Trucks</td>
<td>Conway, Sysco</td>
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<td>1.8%</td>
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<td>University Fleet</td>
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<td>3.5%</td>
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<tr>
<td>VAD</td>
<td>Transit Vehicles</td>
<td>AATA, UM buses</td>
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<td>3.5%</td>
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<tr>
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<td>Light Vehicles</td>
<td>UM employees</td>
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<tr>
<td>TSP</td>
<td>Transit Vehicles</td>
<td>AATA, UM buses</td>
<td>3</td>
<td>0.1%</td>
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</table>

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Vision for Today
What Can Connected Vehicle Technology Do?
What is Connected Vehicle Technology?
How does it improve vehicle safety?

Sample V2X Info & Safety Applications

- Emergency Vehicle Advisor
  - Locate First Responders

- Blind Intersection Warning
  - Blocked Field of View
  - Stopped Vehicles in Roadway

- Intersection Collision Avoidance
  - Red Light Violation

- Blind Spot / Lane Change Warning
  - Blocked Field of View

- Forward Collision Warning
  - Hard Brake

- Electronic Brake Lights

- Control Loss Warning
  - Slick Roadway Skid

- Do Not Pass Warning
  - Oncoming Vehicle
V2V Safety Application – Intersection Alert
V2V Safety Application – Stopped Car Alert
A V2X Service Deployment Scenario

1) Use V2X safety messages and content to provide day one benefits
   - Focus on information and warning functions as new and retrofit devices deploy
   - Cooperate with infrastructure systems providers for integrated V2V/I2V approach

2) Expand to more advanced (safety) services as deployment penetration increases
   - Building on a mature system, use of effective safety features can proliferate
   - Achieve improved functional integration to lower system cost
One configuration option (opportunity)

- Antennas
- V2V & GPS
- Audio alert

Kit certified by USDOT and/or auto maker

Dealer or mobile electronics installer

Enhanced applications via wireless tether
Application Implementation (opportunity)

Safety processor, radio, GPS mounted in vehicle

Application(s) and HMI contained on carry-in device

5.9 GHz DSRC

Wi-Fi

Drive Assist - Map view

Drive Assist

Received CAMs: 101

Received DENMs: 1850

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Vision for the Future
Internal Conn/Auto Sensors
How Do We Get there

- Sensors
- HMI
- Lab
- Driver monitor
- V2X

Color HUD

Driver Workload Indicator
- Workload Meter
- Driving Workload
- Accident prevention
- Task Workload

Haptic

Center Display

Blocked Field of View
Vehicle with radar and V2V approaches intersection

Gray car slows to let truck pass intersection

Truck moves at constant speed (example)

Blue car slows because gray one did
Blue car accelerates back to original speed
One Idea - Connected Automation City

- Less restrictive operational constraints
- May coexist with pedestrians & bikes
- Safety is absolute must
Summary

- V2X is effective at cooperative crash avoidance
- Retrofit installs may play a large role in deployment
- Road to automation includes connectivity to driver
- Future flows to alternative transport vehicles and must include technology for pedestrian environment operation