LIGHT VEHICLE DRIVER ACCEPTANCE CLINICS

USDOT ITS Connected Vehicle Workshop

Mike Lukuc, NHTSA Research
September 25, 2012
# V2V Safety Framework

## Maturing the V2V Research
- Initial Crash Problems
- Performance Measures
- Testing Procedures
- Interoperability Requirements
- Initial Security Models
- Driver Vehicle Interface Guidance

## Model Deployment
- Benefits Framework
- Driver Clinics
- Performance Testing
- Model Deployment
- Experimental Design

## Evaluation
- Evaluation Plan
- Data
- Conduct Evaluation
- Run Simulations

## Supporting Policy Elements
- Implementation
- Technical
- Legal

## Moving Towards a Decision
- Safety Benefits
- Performance Requirements
- Test Procedures
- Driver Acceptance

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**Moving Towards an Operation Model**
- Data Collection
- Data Evaluation & Analysis
- Establishing an Operational Environment

**Results**
Objectives:

- Obtain feedback on connected vehicle technology and safety applications from a representative sample of drivers

- Assess the performance and reliability of 5.9 GHz DSRC communications and GPS in diverse geographic locations and environmental conditions…and

- Promote V2V-based safety technology and potential safety benefits
DAC PROJECT TEAM

Vehicle Safety Communications

Mercedes-Benz
GM
TOYOTA

HONDA
Ford
NISSAN

HYUNDAI·KIA MOTORS
VOLKSWAGEN

Intelligent Transportation Systems

NHTSA

U.S. Department of Transportation
Federal Highway Administration

RITA
Research and Innovative Technology Administration
Volpe National Transportation Systems Center

AUTOMOTIVE EVENTS
Alameda Naval Air Station
Alameda CA (Jan 2012)

Brainerd International Raceway
Brainerd, MN (Sept 2011)

VTTI Smart Road
Blacksburg VA (Nov “11)

Texas Motor Speedway
Fort Worth TX (Dec ’11)

Walt Disney World Speedway
Orlando, FL Oct 2011

Michigan International Speedway
Brooklyn, MI (Aug 2011)
DAC Vehicle Resources

- 16 V2V equipped vehicles
  - 2 from each OEM
  - 8 for use by participants (host vehicles)
  - 8 for use by AE professional drivers during scenario execution (remote vehicles)

- 8 additional V2V equipped “template” vehicles
  - Available as spares for DAC if needed
  - Intended for performance testing (have additional instrumentation)

- DAC vehicles are 16 of the 64 integrated vehicles that will be deployed in Safety Pilot Model Deployment (Ann Arbor, MI)
V2V SAFETY APPLICATIONS…

- EEBL: Emergency Electronic Brake Lights
- FCW: Forward Collision Warning
- BSW/LCW: Blind Spot Warning/Lane Change Warning
- LTA: Left Turn Assist
- IMA: Intersection Movement Assist
- DNPW: Do Not Pass Warning
### Safety Applications by OEM

- **V2V Applications & Scenarios**
  - Run the following applications (# of scenarios)
    - EEBL (1); FCW (4); BSW/LCW (2); DNPW (2); IMA (2); LTA (1)

<table>
<thead>
<tr>
<th>Applications</th>
<th>Ford</th>
<th>GM</th>
<th>Honda</th>
<th>Mercedes</th>
<th>Toyota</th>
<th>Hyundai-Kia</th>
<th>Nissan</th>
<th>VW-Audi</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEBL</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCW</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>BSW/LCW</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>(BSW)</td>
</tr>
<tr>
<td>DNPW</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMA</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>LTAP/OD</td>
<td></td>
<td></td>
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<td></td>
<td>X</td>
</tr>
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</table>
**DRIVER VEHICLE INTERFACE (DVI) EXAMPLES**

- OEM specific DVIs
  - Audible, visual and/or haptic
PARTICIPANT EXPERIENCE

- Arrival
- Registration
- Pre-drive questionnaire
- Briefing
- Orientation to vehicle and station
- Safety Feature Exposure
- Questionnaire (after each application)
- Post Drive Questionnaire
- Focus Group (if applicable)
SAFETY APPLICATION EXPOSURE

- 112 participants over a 4 day period
- Typically, 4 sessions per day at 8 participants each
- Participants are:
  - Equally split by gender
  - Equally split into three age categories (20-30, 40-50, 60-70)
- Participants experience each V2V safety feature
- After each exposure the experimenter asks a series of questions
  - Captures their immediate impressions
  - Safety Application Effectiveness
  - Relevance of Driver Vehicle Interface (DVI)
- Focus Groups
## Demographic and Application Exposure Breakdowns

### DAC - Overall

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>20-30</td>
<td>117</td>
<td>111</td>
<td>228</td>
</tr>
<tr>
<td>40-50</td>
<td>115</td>
<td>117</td>
<td>232</td>
</tr>
<tr>
<td>60-70</td>
<td>115</td>
<td>113</td>
<td>228</td>
</tr>
<tr>
<td>Total</td>
<td>347</td>
<td>341</td>
<td>688</td>
</tr>
</tbody>
</table>

### EEBL, FCW, BSW-LCW*, DNPW, IMA, LTA

<table>
<thead>
<tr>
<th></th>
<th>EEBL</th>
<th>FCW</th>
<th>BSW-LCW*</th>
<th>DNPW</th>
<th>IMA</th>
<th>LTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acura</td>
<td>91</td>
<td>88</td>
<td>85</td>
<td>85</td>
<td>91</td>
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</tr>
<tr>
<td>Cadillac</td>
<td>88</td>
<td>87</td>
<td>86</td>
<td>86</td>
<td>88</td>
<td>---</td>
</tr>
<tr>
<td>Ford</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>84</td>
<td>85</td>
<td>---</td>
</tr>
<tr>
<td>Hyundai</td>
<td>---</td>
<td>172</td>
<td>87</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Infiniti</td>
<td>---</td>
<td>87</td>
<td>173</td>
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<td>---</td>
<td>173</td>
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<tr>
<td>Mercedes</td>
<td>87</td>
<td>87</td>
<td>87</td>
<td>---</td>
<td>87</td>
<td>---</td>
</tr>
<tr>
<td>Toyota</td>
<td>172</td>
<td>---</td>
<td>85</td>
<td>---</td>
<td>172</td>
<td>---</td>
</tr>
<tr>
<td>VW-Audi</td>
<td>165</td>
<td>82</td>
<td>---</td>
<td>---</td>
<td>165</td>
<td>---</td>
</tr>
<tr>
<td>Total</td>
<td>688</td>
<td>688</td>
<td>688</td>
<td>255</td>
<td>688</td>
<td>173</td>
</tr>
<tr>
<td>% of Overall</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>37%</td>
<td>100%</td>
<td>25%</td>
</tr>
</tbody>
</table>

*LCW was not available on the Infiniti
A Single Example Showing The “Big-Picture”

DRIVERS TEND TO DESIRE V2V TECHNOLOGY
DESIRABILITY - ACROSS ALL FACTORS

I would like to have this Vehicle-to-Vehicle Communication safety feature on my personal vehicle.

- 1: Disagree (n = 5)
- 2: Neutral (n = 59)
- 3: Agree (n = 620)

U.S. Department of Transportation
DESIRABILITY
ACROSS ALL FACTORS AND PARSED BY AGE

I would like to have this Vehicle-to-Vehicle Communication safety feature on my personal vehicle.

- **60-70**
  - Agree: 91.6%
  - n = 227

- **40-50**
  - Agree: 90%
  - n = 230

- **20-30**
  - Agree: 90.3%
  - n = 227

Percentage response (%)
A Few Examples Demonstrating

DRIVER ACCEPTANCE AS A FUNCTION OF SAFETY FEATURE
OVERALL IMPRESSIONS - USEFULNESS

How useful do you think a safety feature that alerted you to the presence of a (specific threat) would be in terms of improving driving safety in the real world?

<table>
<thead>
<tr>
<th>Safety Features</th>
<th>Percentage Response (%)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSWLCW</td>
<td>90.9%</td>
<td>683</td>
</tr>
<tr>
<td>DNPW</td>
<td>88.6%</td>
<td>254</td>
</tr>
<tr>
<td>EEBL</td>
<td>91.4%</td>
<td>684</td>
</tr>
<tr>
<td>FCW</td>
<td>90.5%</td>
<td>686</td>
</tr>
<tr>
<td>IMA</td>
<td>95.5%</td>
<td>685</td>
</tr>
<tr>
<td>LTA</td>
<td>83.8%</td>
<td>173</td>
</tr>
</tbody>
</table>

Legend:
- Green: Positive
- Yellow: Neutral
- Red: Negative
I would like to have a safety feature that alerted me to the presence of a (specific threat) on my personal vehicle.

<table>
<thead>
<tr>
<th>Safety Features</th>
<th>Percentage Response (%)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSWLCW</td>
<td>89.4%</td>
<td>682</td>
</tr>
<tr>
<td>DNPW</td>
<td>84.5%</td>
<td>252</td>
</tr>
<tr>
<td>EEBL</td>
<td>89.2%</td>
<td>685</td>
</tr>
<tr>
<td>FCW</td>
<td>89.1%</td>
<td>682</td>
</tr>
<tr>
<td>IMA</td>
<td>93.9%</td>
<td>685</td>
</tr>
<tr>
<td>LTA</td>
<td>79.8%</td>
<td>173</td>
</tr>
</tbody>
</table>
OVERALL IMPRESSIONS - INTUITIVENESS

How effective was this particular safety feature at alerting you to the presence of a (specific threat)?

- BSWLCW: 86.2% positive, 13.8% other, n = 679
- DNPW: 91.7% positive, 8.3% other, n = 253
- EEBL: 91.1% positive, 8.9% other, n = 684
- FCW: 87.4% positive, 12.6% other, n = 683
- IMA: 92.8% positive, 7.2% other, n = 685
- LTA: 84.8% positive, 15.2% other, n = 171
An Example of

DRIVER’S ASSESSMENT OF SYSTEM LIMITATIONS
What percentage of vehicles would need to be similarly equipped before you believe the benefits would be noticeable? (select one)
An Example Demonstrating Demographic Relationship to
SELF-REPORTED UNDERSTANDING OF V2V
OVERALL IMPRESSIONS

After experiencing these vehicle-to-vehicle safety features first hand, please tell us how well you think you understand this technology and how it works. (select only one)

- I don't understand it: n = 0
- I understand it, but still have some questions: n = 153
- I fully comprehend how this technology works: n = 530
OVERALL IMPRESSIONS

After experiencing these vehicle-to-vehicle safety features first hand, please tell us how well you think you understand this technology and how it works. (select only one)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Percentage Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-70</td>
<td>71.4%</td>
</tr>
<tr>
<td>40-50</td>
<td>78.3%</td>
</tr>
<tr>
<td>20-30</td>
<td>83.2%</td>
</tr>
</tbody>
</table>

n = 227
n = 230
n = 226
A Willingness to Pay Example Indicating

DRIVER’S VALUE V2V
At what price level might you begin to feel this collective group of safety applications (Vehicle-to-Vehicle communications safety feature) is too expensive to consider purchasing? (select one)

Raw Response Cumulative Percentage of Participants Willing to Spend Indicated Amount
A Couple Examples Asking Drivers About

UNINTENDED CONSEQUENCES
Monitoring or interpreting information provided by these safety features is no more distracting than using my car's radio.

- Brooklyn, MI: 71.9% Agree, 7.6% Neutral, 16.7% Disagree (n = 114)
- Brainerd, MN: 76% Agree, 10% Neutral, 14% Disagree (n = 96)
- Orlando, FL: 76.5% Agree, 8.1% Neutral, 15.4% Disagree (n = 119)
- Blacksburg, VA: 74.8% Agree, 8.4% Neutral, 16.8% Disagree (n = 119)
- Fort Worth, TX: 76.5% Agree, 7.4% Neutral, 16.1% Disagree (n = 119)
- Alameda, CA: 71.8% Agree, 11.5% Neutral, 16.7% Disagree (n = 117)

Percentage response (%)
Availability of these safety features would cause drivers to pay less attention to the driving environment.

- **60-70**
  - Agree: 10
  - Neutral: 50
  - Disagree: 47.6%
  - n = 227

- **40-50**
  - Agree: 10
  - Neutral: 50
  - Disagree: 47%
  - n = 230

- **20-30**
  - Agree: 10
  - Neutral: 50
  - Disagree: 32.3%
  - n = 226
Executive Summary

FOCUS GROUP
FOCUS GROUP OVERVIEW

- 12 focus groups were conducted

- Each group was comprised of **eight participants** (for a total of 96) who had just completed the driving portion of the study.

- **Mix of gender and ages** in each group, randomly assigned to participate in each focus group.

- Each participant per focus group had driven one of the eight OEM vehicles, and had experienced the majority of scenarios.
The illustration below demonstrates respondents’ most common reactions to this technology ... that saving a life or many lives, far outweighs the potential drawbacks:
NEXT STEPS

Publish the Results

- Draft Final Report due from CAMP VSC3 in Sept 2012
  - Must be subjected to NHTSA review process prior to publication
  - Published report will be available on NHTSA and RITA ITS websites:
    - RITA ITS: [http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm](http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm)