Experimental Design

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Volpe The National Transportation Systems Center
Advancing transportation innovation for the public good

U.S. Department of Transportation
Research and Innovative Technology Administration
John A. Volpe National Transportation Systems Center
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

Moving Towards an Operation Model
- Data Collection
- Data Evaluation & Analysis
- Establishing an Operational Environment
- Results
Connected Vehicle Environment

- Full deployment – all vehicles capable of communicating with each other

- Model Deployment – subset of all vehicles capable of communicating with each other

How do we know that the Model Deployment will obtain enough data for evaluation?
Scoping the Model Deployment

- Question: What should be the scope of the Model Deployment to gather enough data?

- Conducted analysis using prior field test results
  - 3 Forward Collision Warning alerts during treatment period
Results of Scoping Analysis

- Requires careful selection of test area
- Requires careful selection of test participants as well to ensure interactions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Recommended</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Subjects</td>
<td>108</td>
<td>128</td>
</tr>
<tr>
<td>Duration</td>
<td>5 months</td>
<td>6 months</td>
</tr>
<tr>
<td>Integrated Vehicles</td>
<td>55</td>
<td>64</td>
</tr>
<tr>
<td>Equipped Vehicles</td>
<td>2,500 – 3,000</td>
<td>2,772</td>
</tr>
</tbody>
</table>
Experimental Design – Recruitment

- Approaches for Recruiting Participants
  - UoM Medical Center
  - Ann Arbor city school system

- Variety of Interactions
  - Following
  - Adjacent
  - Crossing
Simulating the Experimental Design

- Ann Arbor Trip Tables
  - Provided by Washtenaw Area Transportation Study

- TRANSIMS Model
  - Ran model for 24 hour period
  - Output included second-by-second positioning of vehicles
Post Processing to Obtain Interactions

- Forward collision
  - Same direction, same lane

- Lane change
  - Same direction, adjacent lanes

- Intersection assist
  - Crossing paths
Interactions by Time of Day

- 64 light vehicles equipped with safety applications
- 2,500 Vehicle Awareness Devices deployed
- Hourly estimates of interactions in a typical weekday
Estimates of Daily V2V Interactions

- Assumptions for V2V interactions
  - 2,500 Vehicle Awareness Devices are deployed
  - Vehicle speeds > 25 mph
  - Vehicles are within 30 meters of each other

<table>
<thead>
<tr>
<th>Host Vehicle</th>
<th>Daily Interactions</th>
<th>Monthly Interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Light Vehicles</td>
<td>250</td>
<td>5,000</td>
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</tbody>
</table>
Total Safety Alerts Estimated

- How do the interactions relate to safety alerts generated by the applications?
- Developed estimates of the relationship between interactions and safety alerts.
- Estimated that over 6 months, each driver would experience ~3 alerts / safety application

The estimated volume of alerts per driver are consistent with scoping analysis!
Interaction Results from Month 1

- Devices Deployed
  - 64 Integrated light vehicles are deployed
  - 738 Vehicle Awareness Devices are deployed

<table>
<thead>
<tr>
<th>Integrated Light Vehicles Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Measure</td>
</tr>
<tr>
<td>Interactions (30 meters)</td>
</tr>
<tr>
<td>All Safety Alerts</td>
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</tbody>
</table>

Thru Month 1, the observed results are comparable to the estimates from the traffic simulation model!
Conclusion

- Observed results from the field are comparable with the simulated estimates.
- Simulation Model estimated that the Model Deployment will generate sufficient data for evaluation.

The results so far indicate that enough data will be collected for the evaluation!