# 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
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>Performance Measure</th>
<th>Estimated</th>
<th>Observed</th>
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</thead>
<tbody>
<tr>
<td>Interactions (30 meters)</td>
<td>1,400</td>
<td>1,196</td>
</tr>
<tr>
<td>All Safety Alerts</td>
<td>24</td>
<td>110‡</td>
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</tbody>
</table>

‡ The number of alerts indicates the system triggered a warning; however, the specifics of the warning (i.e. repeat warnings) have not been analyzed yet.

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!