Benefits of Vehicle Safety Communications

CICAS-V and VSC-A

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Presentation Overview

- Introduction to Safety Benefits
- CICAS-V Benefits
- VSC-A Benefits
- Summary and Plans
Safety: Research Questions

• Does the safety system alter crash frequency and severity?
• Is the safety system more effective in preventing some crash scenarios?
• Are there any unintended consequences?
Safety Benefits Basic Principle

Crashes Avoided = Crashes Without – Crashes With

\[ \text{Crashes Avoided} = \text{Crashes Without} \times (1 - \text{Crashes With}) \]

\[ N_a = N_{wo} \times SE \]

Process:

1. Break down applicable crashes to the lowest level of pre-crash scenarios where system effectiveness may vary

2. Estimate system effectiveness in each pre-crash scenario
## How CICAS-V and VSC-A Safety Benefits Differ

<table>
<thead>
<tr>
<th>CICAS-V</th>
<th>VSC-A</th>
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</thead>
<tbody>
<tr>
<td>• Based on data collected from a Field Operational Test (FOT)</td>
<td>• Input data from test track and modeling</td>
</tr>
<tr>
<td>• Cooperative vehicle-infrastructure system</td>
<td>• Vehicle-vehicle based system</td>
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Breakdown of CI CAS-V Applicable Crashes

Target Crashes → Applicable Crashes → Scenario 1 → Scenario 2 → Scenario n
Estimation of CI CAS-V System Effectiveness

Crashes Avoided = Crashes Without \times \left(1 - \frac{\text{Crashes With}}{\text{Crashes Without}}\right)

System Effectiveness SE

Determine Crashes With and Crashes Without from:

Crashes = \text{Violations} \times \text{Probability}(\text{Crash} | \text{Violation time after red})

Exposure Factor
Prevention Factor
Data Flow for CI CAS-V Safety Benefits Estimation

Sample Measures

<table>
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<tr>
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<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Brake reaction time to desired signal</td>
<td>Number of near violations per total number of crossings</td>
</tr>
<tr>
<td>Average deceleration</td>
<td>Number of violators</td>
</tr>
</tbody>
</table>

P(V | Performance)  
(Model)  

P(V | Conflict)  
(Model)  
P(C | V time after red)

Performance  
Every time

Conflicts/Near Violations  
Sometimes

Violations  
Once in a while

Crashes  
Once in a life time
VSC-A Safety Benefits Approach

OEMs will:

- Equip 10 vehicles with DSRC
- Develop vehicle relative positioning algorithms
- Develop warning algorithms
- Test vehicles and algorithms (no FOT!)

US DOT will:

- Help plan tests
- Receive and analyze test data
- Estimate safety benefits
Safety Benefits Model - VSC-A

$$B = \sum_{i} N_{\text{woi}} \times D(MP)_i \times \left(1 - \frac{\sum_{j} p_j x_{i,j}}{x_{i,0}}\right),$$

Parameterizing the model is the key to estimating the VSC-A safety benefit

$B$ = number of crashes avoided

$N_{\text{woi}}$ = Number of crashes in each scenario (from crash statistics)

$D(MP)_i$ = Deployment effectiveness (higher is better, max = 1)

$p_j$ = probability of a specific driver response

$x_{i,j}$ = probability of a crash with specific driver response

$x_{i,0}$ = probability of a crash without specific driver response
Summary and Plans

Discussed safety benefits estimation for two DSRC-enabled systems: CICAS-V and VSC-A

Safety benefits begins with a model, which must be parameterized

CICAS-V parameterization will use FOT and additional data
  • Acquire additional data to link violations and severity to crashes
  • Identify violations, near violations and performance events in FOT data
  • Analyze driver response to situation and CICAS-V alert

VSC-A parameterization will use test data
  • Analyze test data
  • Develop representative set of crash initial conditions
  • Simulate driver/vehicle response to alert following these initial conditions
Questions/ Comments?

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