Future Directions in Connected Vehicle Research

Presented by Marco Gruteser
Trend to Assisted and Automated Driving
Not a new dream
Extending the Sensing Range through Dedicated Short Range Communications

- **Automotive safety**
  - Extended Electronic Brake Light
  - Blind Spot Warning
  - Intersection Collision Avoidance

- **Efficient Pricing and Payment**
  - “Pay-as-you-drive” insurance
  - Highway tolls
  - Gas station payments

- **Entertainment**
  - Video, Web, Gaming

- **Congestion Management**
  - Real-time traffic information
  - Improved information for traffic engineering

- **Point-of-Interest Queries**
  - Finding nearby hotels, gas stations; travel guides, local entertainment

- **Fleet management**
  - Tracking fleet of company vehicles
Vehicular Networking – Past Decade

FCC Spectrum Allocation for DSRC

Demos

SAE J2735 Message Set

IEEE 802.11p

IEEE 1609.2 Security v2

SAE J2945.1 Minimum Op Req

Multi-hop Ad Hoc Nets

Security & Privacy

Reliable, Scalable Protocols (for High Density)

Channel & Mobility Models / Simulators
VSC3 - Scalability Testing

- 200 DSRC equipped vehicles transmitting BSMs
- Conducted on testing grounds with vehicles arranged / driven to model typical and extreme scenarios
Accessing Maps in the Cloud: Look-ahead region

- **Zone 1**
  - Potholes?
  - Icy patch?
  - Positions of other vehicles?

- **Zone 2**
  - Detours?
  - Maintenance Crew?
  - Traffic light timing?

- **Zone 3**
  - Traffic congestion?

- **Vehicle has standing “subscription” for lookahead zone and receives dynamic updates**
- **Should the zone be determined based on road network**
- **Developer assigns to zones based on how far in advance the vehicle needs to know**
- **Can the system optimize when to download based on expected rate of change?**
# NHTSA Levels of Automation

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>0 – No Automation</td>
<td>Driver is in complete and sole control.</td>
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<tr>
<td>1 – Function Specific Automation</td>
<td>Electronic stability control, pre-charged breaks</td>
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<td>2 – Combined Function Automation</td>
<td>Adaptive cruise control in combination with lane centering</td>
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<td>3 – Limited Self-Driving Automation</td>
<td>Vehicle has full control of all safety-critical functions under certain conditions. i.e the google car.</td>
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<tr>
<td>4 – Full Self-driving Automation</td>
<td>Vehicle is responsible for all driving functions for the entire trip.</td>
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A Mobile Entertainment Center
Roadtraffic efficiency
Research Overview

- Security and Privacy
- Traffic Management
- Pedestrian Safety
- ...

Diagram:
- Future Internet Connectivity
- Scalable V2V Communications
- Internet of Things
Thank you