Safely Operating in Dynamic Scenarios

ADS Demonstration Grant

Program Overview

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- This is our 31st year
- Largest transportation research institute in the U.S. by most metrics
- Safety focus
- 300+ projects, 40+ proprietary projects
- ~520 total employees on “payroll” at any given time
  - 300 full-time
  - 300 students funded for at least part of a year
- Participation from over 150 VT faculty in the last few years
## SAE Levels of Automation

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
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<tr>
<td>4</td>
<td>High Automation</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
</tr>
</tbody>
</table>

### No Automation
Zero autonomy; the driver performs all driving tasks.

### Driver Assistance
Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.

### Partial Automation
Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.

### Conditional Automation
Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.

### High Automation
The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.

### Full Automation
The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.
Gartner Hype Cycle for Emerging Technologies 2019

Plateau will be reached:
- ○ less than 2 years
- ○ 2 to 5 years
- ○ 5 to 10 years
- △ more than 10 years
- ○ obsolete before plateau

Source: Gartner, 2019 Gartner Inc. and/or its affiliates. All rights reserved.
## ADS-Equipped Light Vehicle Testing Examples

Technically, most companies are just testing, but this testing involves more than engineers monitoring ADS performance and tracking disengagements:

<table>
<thead>
<tr>
<th>Company</th>
<th>Locations</th>
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<tbody>
<tr>
<td>Waymo</td>
<td>• launched a driverless service in the <strong>Phoenix</strong> area and is testing in <strong>Atlanta, Kirkland, Detroit, Austin</strong> and <strong>Mountain View</strong></td>
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<tr>
<td>Ford/Argo</td>
<td>• is testing pizza, floral, dry cleaning delivery services in <strong>Miami</strong> with additional testing in <strong>Austin, Dearborn, DC, Palo Alto</strong> and <strong>Pittsburgh</strong></td>
</tr>
<tr>
<td>Aptiv and Lyft</td>
<td>• have a partnership “driving” riders in <strong>Las Vegas</strong></td>
</tr>
<tr>
<td>Toyota</td>
<td>• is driving safely in Michigan and California</td>
</tr>
<tr>
<td>GM/Cruise</td>
<td>• is testing a food delivery service in <strong>San Francisco</strong> and is also testing in <strong>Warren</strong> and <strong>Scottsdale</strong></td>
</tr>
</tbody>
</table>
Other ADS-Equipped Vehicle Testing Examples

Shuttles
- Easy Mile
- Local Motors
- Perrone Robotics
- Optimus Ride

Package Delivery
- Starship
- Amazon
- Nuro

Trucking
- TuSimple
- Torc & Daimler
- Kodiak
Work Zones and Crash Scenes Present Challenges for Automation

- Temporary, unconventional layout
  - Alteration of roadway
  - Level of standardization depends on operator and jurisdiction
  - Detailed data may be fragmented or unavailable
  - Real time HD maps
- Audio, visual, and gesture commands may be given onsite
- Novel pathfinding directions – driving against rules may be required
- Chaotic scenes with debris, random vehicle orientations, unexpected pedestrian activity
- Emergency lighting, fire, dust, smoke, etc. may affect sensor perception

Image Source: FHWA
FHWA ADS Demo NOFO Overview

• Focus
  – Demonstrate L3+ ADS technologies and obtain targeted deployment feedback
  – Evaluate and identify key aspects for the safe integration of ADS into the Nation’s on-road transportation

• Goals
  – Demonstrate the safe integration of ADS into the Nation's transportation system
  – Inform safety analysis and rulemaking with data
  – Create a collaborative environment that harnesses the collective expertise to advance the deployment of ADS

• Awards
  – USDOT made 8 awards, $60M total awards
  – Up to 4 year duration
USDOT Goals and Focal Areas of Program

- Improve Safety
- Foster Collaboration
- Data for rule making and system development
- Significant public benefit
- Addressing an area where the market may not develop in isolation
- Fostering economic vitality
- Developing complex technology
- Contributing to a diverse set of ADS projects at the USDOT
- Addressing transportation-challenged populations
- Developing prototype systems
USDOT Grant Funding
~$60 million to test the safe integration of automated driving systems (ADS)

City of Detroit, Michigan
"Michigan Mobility Collaborative-ADS-Demonstration"

University of Iowa
"ADS for Rural America"

Pennsylvania DOT
"Safe Integration of Automated Vehicles (AV) in Work Zones"

Ohio DOT
"D.A.T.A. in Ohio: Deploying Automated Technology Anywhere"

Contra Costa Transportation Authority, California
"ADS Demonstration Program"

Texas A&M Engineering Experiment Station
"AVA: Automated Vehicles for All"

Virginia Tech Transportation Institute
"Trucking Fleet CONOPS for Managing Mixed Fleets"

Virginia Tech Transportation Institute
"Safely Operating ADS in Challenging Dynamic Scenarios: An Optimized Automated Driving Corridor Demonstration"
Our Demonstration Concept

Safe L4 ADS Interactions with Public Services

Cooperative L3+ ADS Operation on a Managed Corridor
Rationale

Interaction with public services is a key aspect to the safe integration of ADS-equipped vehicles on roadways. The mobility benefits of ADS-equipped vehicles may only be realized through cooperative operations.
Collaboration

OEMs and ADS Developers
Are there opportunities to improve ADS interaction with public safety operations?

Infrastructure Owner Operators
How can we facilitate safe ADS deployment?

Public Safety Providers
How should we interact with ADS and how will they respond?

Virginia Tech Transportation Institute
- Build consensus on requirements and technological solutions
- Leverage infrastructure data to ensure safe ADS operation
- Develop L4 ADS capabilities to demonstrate safe interactions, cooperative operation, and collect data
- Create simulations of interactions and distribute data to OEMs and ADS developers
- Develop recommendations, data, and educational materials for OEMs, IOOs, and Public Safety Providers
Task 1: Develop Solutions for Corridor Optimization

• Evaluate Express Lanes for Demo
  – Communications requirements and technology options
  – Assess signage, striping, TOC capability, etc.

• Develop spec for real time Operational Design Domain (ODD) support system
  – Investigate source data available
  – Develop messages to provide data to vehicles
  – OEM stakeholder review of messages and content
  – Spec architecture for message flow and management
  – Spec full ODD TOC-side tool

• Develop high-level CADS demo concept
  – Dynamic speed harmonization solution with CACC
  – High level vehicle-side requirements to support demo
Task 2: Dynamic Scenario Definition and Development of Technological Solutions

- Extend existing task analysis to support SSP and Work Zone use cases (VTTI)
- Candidate scenarios
- Interaction requirements
- Technological concepts
  - Scan for available technologies or development opportunities
  - Cost/feasibility/practicality/acceptance, etc.
- ADS requirements to support technological concepts
- Public safety requirements to support technological concepts
Task 3: Build Reference Demonstration Vehicles

- **Vehicle platform goals**
  - Capable of performing L4 operation within the ODD of the selected scenarios
  - Capacity for ride-along participants
  - Significant data collection capability

- **Platform selection**
  - Significant time has passed since proposal
  - New options are available
  - Evaluate CARMA to identify opportunities to incorporate

- **Build and test the vehicle(s) for selected scenarios**
Task 4: Build TOC Applications

- Build and test ODD support tool specified in Task 1
  - Traffic conditions
  - Weather
  - Work zones
  - Incidents
  - Build upon AMCD/EDCM concepts
- Dynamics speed harmonization application
- Build and test TOC side of cooperative automation applications
  - Recommended speed
  - Recommended lane selection
  - Platoon configuration
Task 5: Design and Conduct Demonstrations

• Three high profile demonstration events
  – Northern VA and possibly Smart Road in Blacksburg, VA
  – Primary stakeholder groups include IOO’s, OEM’s, Public Safety Providers
  – On-road, parking lot, and test track options
  – Staged scenarios and events

• Participation from public safety partners

• Focus group sessions
Task 6: Data Collection, Processing, and Dissemination

• Data collected during testing and demonstrations will be processed into several datasets
  – On-board DAS
  – Scenario demonstration
  – Scenario simulation
  – Infrastructure data
  – Subjective assessment

• Source data for ADS development and public safety training

• Hosted on portal for public access
Questions?
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