Recent Developments in CAV and Lessons Learned



Presenter

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Why use Connected **Automated** Vehicle (CAV)?

- USDOT now uses CAV (e.g. Proving Grounds 9/20/16)
- "Autonomous" is still used widely in the media and automotive industry
- "Autonomous" implies "acting independently."
- Many safety applications require connectivity
- "Automated" better describes the technology!





The Evolution of Connected and Automated Vehicles



www.its.dot.gov





PTV Microsimulation Example

https://youtu.be/Jrc3hUG4wjs?t=2191





CAV is a Mobility Paradigm Shift





ENERGY & ENVIRONMENT

Volvo, Betting on Electric, Moves to Phase Out Conventional Engines

By JACK EWING JULY 5, 2017





RELATED COVERAGE



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At the Los Angeles Auto Show, an Industry Ponders Its Digital Future NOV. 17, 2010

2019 hybrids or all electric





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500,000 Testa Model 3 Pre-orders







Home if News T Executy if Canadiscription services to take rolly aafee by 2023, Volvo GEO aays

Car subscription services to take 1 of 5 sales by 2023, Volvo CEO says



Take Us With You!





any Volio Stat

The bary Value XCap has only represents the Sweetish brand's first constant conservation by sold in the U.S. but its first shot at a new model for others to obtain cars a subscription service.

A simple alternative to car ownership.

Month-to-month car subscriptions. Now available in the San Francisco Bay Area.



We are an online platform that offers monthly subscriptions to pre-owned Ford vehicles. All of our cars come with everything you need to hit the road, like insurance, maintenance, and warranty coverage.

Browse Cars





20% ber Pool Rides as a total of all trips globally (2016)





CAV technologies impact how communities will:

- Operate
- Accommodate Growth
- Manage Congestion
- Improve the Economy
- Increase Safety
- Save Time
- Encourage Health
- Improve Quality of Life





Resiliency = Robust Automated Mobility

Sustainability = Less, smaller & safer cars Affordability = Less capital construction Equality = Accessibility to everyone Accommodating = Provide flexible capacity Influencing = Enhances transit

Broad Access to Mobility Services Seniors / Paratransit / Low Income Users/Job Search





Connectivity in motion



Vehicle to Infrastructure (V2I)





Connectivity in motion



Vehicle to Vehicle (V2V)





Connectivity in motion

Vehicle to Pedestrian (or Phone)(V2P)







Vehicle to Cloud (V2X)

Photo Source: TechRepublic





Connectivity in Motion







NHTSA Notice of Proposed Rulemaking on Vehicle to Vehicle Communication, January 12, 2017





Shared Automated Vehicles





olli

Basic Elements of a Shared Connected Automated Vehicle













How Do We Gain Confidence?

- Testbeds
- Pilot Projects
- Well planned and orchestrated
- Build on successes
- Societal Skepticism to Acceptance





USDOT CAV Proving Grounds

- 1. City of Pittsburgh and the Thomas D. Larson Pennsylvania Transportation Institute
- 2. Texas AV Proving Grounds Partnership
- 3. U.S. Army Aberdeen Test Center
- 4. American Center for Mobility at Willow Run
- 5. Contra Costa Transportation Authority & GoMentum Station
- 6. San Diego Association of Governments
- 7. Iowa City Area Development Group
- 8. University of Wisconsin-Madison
- 9. Central Florida Automated Vehicle Partners
- 10. North Carolina Turnpike Authority





Other CAV Proving Grounds

- 1. Transportation Research Center, Columbus, OH
- 2. Mcity, University of Michigan, Ann Arbor, MI
- 3. City of Tampa Pilot Project, Tampa, FL
- 4. I-80 Pilot Project, Wyoming
- 5. NYC CV Pilot Project, New York City
- 6. Active Arura, Edmonton, AB





GoMentum Station Concord, CA

#1 Largest secure testbed in the US

> 5,000+ acres with 2,100 acres available for testing

20+ miles

of paved roadways with a 7-mile long spine road for high speed testing

> 1 of 10 USDOT Designated AV Proving Grounds





A Platform for Transforming the Future

What is GoMentum Station?



...while addressing the real congestion/safety need





Key AV Partners Testing at GoMentum Station









Test Objective: Traverse Suburban Residential Streets





Test Objective: Passenger Feedback Test Objective: Navigation and Interface App

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Test Objective: At Grade RR Crossing







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EZIO

FZIO



"Transit Accessibility" will be the key





Tampa SAV Mixed Traffic Pilot

Downtown Tampa Autonomous Transit Phase I

Marion Street is a north and south running roadway in the center of downtown Tampa. Between the hours of Gam and 7pm on weekdays, the corridor is for exclusive use of buses and emergency vehicles, and therefore offers an opportunity to operate a low-speed, autonomous last-mile shuttle service out of mixed traffic. The service would address mobility needs downtown by connecting the Marion Transit Center and parking to employment, and act as a catalyst for further autonomy in transportation throughout the Tampa Bay region.

- .6 miles along Marion Street
- .2 miles circulation around Marion Transit Center
- 15 mph speed limit
- CSX rail crossing on Polk St

- · 2 blocks north on Marion, low-volume public road
- 8 signalized intersections
- At operating speed less than half of bus, could operate at 10 minute frequency with 2 vehicles









ACTIVE-AURORA Edmonton, AB

#1 Largest CV Testbed in Canada

3 Corridors

Rural Freeway Urban Expressway Urban Arterial

3 Testing Stages

Improving Safety Driver Behavior Congestion Reduction





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ACTIVE AURORA

Testing CV systems, technologies, applications and services for traffic, transit, goods movement, and active transportation.





Connected Vehicles

Stantec Design of Electrical Systems







ACTIVE-AURORA Test Bed Network

- \$3.6 million test bed for connected vehicles
- Testing both DSRC and mobile cellular environments
- Stantec's role: Project Manager and Designer
- Over 60 RSUs in multiple corridors
- 5.9 GHz developmental license







Connected Vehicles

Direct Short Range Communications Environment







CAV Testing Lessons Learned





Lessons Learned by Stantec

Issue

Lack of Content

Unlimited uses for CAV technology

Recommendation

Better Coordination with App Developers

- Do a better job collaborating across industry sectors
- Don't be afraid to put your idea out there





Lessons Learned by Stantec

Issue

Default Deceleration

- Highly automated vehicles disengage/decelerate as a default in most challenges.
 - How do they perform compared to a human driver?
 - Will we see in an increase in delay?

Technical Redundancy

• Multiple LIDAR, Sensors, Data Management





Lessons Learned by Stantec

Recommendation

Resilience

• The ability of a highly-automated vehicle to identify, respond to, and recover from a safety challenge.

Need Oppositional Testing

 Instead of collaboration to pass tests, the track owners attempt to defeat the highly-automated vehicle into a crash or unsuccessful result by introducing increasingly difficult safety challenges.







Resilience Engineering in CAV Testing





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