Connected and Automated Vehicles: How Do We Prepare?

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CAVita
Giving life to transformational technology in transportation
Agenda

• A technological tipping point
  – Brought about by CAV

• Imposed on a century-old transportation system
  – The rate of change has changed

• The process of deployment

• The road(s) to “connected automation”

• Moving forward with public-private collaboration around CAV use cases
A technological tipping point

• Connected vehicles and infrastructure (CV)
• Automated vehicles (AV)
  – Including highly-automated vehicles (HAV’s)
• Surrounded by:
  – Shared Use Services, Big Data, Smart Cities, Cybersecurity, Internet-of-Things
• Enabled by:
  – Sensors, software, cloud services, computation, robotics, artificial intelligence, consumer electronics
Century-old transportation system

- Drivers, vehicles and infrastructure
- Tremendous incremental progress
  - For example, crash rates continue to decline
- But not sustainable for another century
- New technologies cut right across the old silos
  - Safety, traffic efficiency, emissions, energy, economics
- The 21st Century mobility system is connected, automated and shared
Key transformational metrics

- Fatalities and injuries
- Delay in traffic
- Energy consumption
- Carbon emissions
- Customer satisfaction
Today’s Transportation Challenges

Safety
- 32,675 highway deaths in 2014
- 6.1 million crashes in 2014
- Leading cause of death for ages 11, 16-24

Mobility
- 6.9 billion hours of travel delay
- $160 billion cost of urban congestion

Environment
- 3.1 billion gallons of wasted fuel
- 56 billion lbs of additional CO₂

Data Sources:
Quick Facts: 2014 Data, National Highway Traffic Safety Administration (January 2016); 2015 Annual Urban Mobility Report, Texas Transportation Institute (Aug 2015); Centers for Disease Control
The rate of change has *changed*

- Conventional R&D model is linear: research, prototyping, testing, modification, deployment
- We now need rapid learning cycles based on large deployments
  - This has been the successful model of the auto industry
  - Commercially successful products require multiple cycles of deployment with increasingly large groups of users
- The same model applies to CAV; in addition it becomes a public-private activity, or set of activities
  - There is no rule book for “public-private learning cycles”
  - Current examples include pilots, demos, model deployments, field operational tests, challenges, etc
The process of deployment

- Model deployments (eg. Safety Pilot, Ann Arbor)
- Fake cities
  - Mcity
  - Willow Run (MI), RELLIS (Tx), GoMentum (CA)
- CV pilots
  - NYC, Tampa, Wyoming
- Advanced Transportation and Congestion Management Technologies Deployment Program (ATCMTD)
  - Marysville OH
- Public-private consortia
  - Safety Pilot, Mobility Transformation Center (MTC), American Center for Mobility, RELLIS (Tx), GoMentum, Virginia Automated Corridors, I70 Mountain Pilot
- Smart City Challenge
  - $50M prize
  - One winner out of 78 cities: Columbus
Streetscape in Downtown Mcity
The American Center for Mobility

With:
- DSRC,
- 4G LTE,
- 5G,
- Cyber,
- Cloud
RELLIS Campus at Texas A&M
CV and AV can proceed independently on parallel paths but will converge to produce “connected automation”
Path to CV

**Connected Vehicles**
- Voluntary fitment of V2V and I2V by OEMs
- Aftermarket fitment
- Introduction of V2V rule
  - NPRM released December 2016
- Significant penetration by 2025

**Connected Infrastructure**
- V2I guidance from FHWA
  - Anticipated December 2016
- V2X pilots (NYC, Tampa, Wyoming)
- AASHTO SPAT challenge
- Actions by State DOT’s, MPOs and cities
- Significant penetration of signalized intersections by 2025
Continuing issues for CV

• Exclusive access to 5.9 GHz spectrum
  – FCC will decide whether to allow multiple uses and to auction part or all of the spectrum (currently reserved for safety applications)

• Cybersecurity & privacy
  – Authority for issuing security certificates
  – Monitoring of security breaches
    • The auto industry has created an Auto ISAC (Information Sharing and Analysis Center) under the Alliance of Automotive Manufacturers
Connected Vehicles

- Voluntary: 0.5 M
  - 2017 - 2021

- Aftermarket: 30 M
  - 2019 - 2024

- Initial mandate: 90 M
  - 2021 - 2024

- Full mandate: 150 M
  - 2024 - 2026

Target: 150 M in 2030
Roadside Equipment (RSEs)

- 5,000 Safety critical signalized intersections (2017 - 2021)
- 30,000 Intersections and curves (2019 - 2024)
- 90,000 Initial vehicle mandate (2024 - 2026)
- 150,000 Full vehicle mandate in 2030
# Path to AV

## Automated Vehicles
- Voluntary fitment of automated features by OEMs
- Fitment of automated features under NHTSA agreements
- Significant penetration by 2025

## Driverless Vehicles
- Rules of the road at state level
- NHTSA issuing AV interpretations of FMVSS
- USDOT field operational tests (FOTs) – to be announced
- Low-speed trials
- Smart cities deployments
- On-demand fleets in precincts and cities
- **NHTSA guidance on highly-automated vehicles (HAV’s)**
- Readiness for on-demand mobility services by 2025
Continuing issues for AV

- Occasional engagement of human driver
- Liability
- Cybersecurity & privacy
- Compliance with federal motor vehicle standards

- No national roadmap to HAV deployment
- Too many questions, inhibiting collaboration
- Shared mobility accelerates deployment, but brings more questions
Technology and Policy Driving Mobility

TRB Partners in Research Symposium: Transformational Technologies

Detroit, Michigan – October 31 – November 1, 2016
Convergence of CV and AV paths

CV
- Pilots
- Rule & Infrastructure
- V2V & V2I

AV
- Trials & automated features
- Smart cities & OEM agreements
- Mobility services; AV & V2X

CAV
- Connected Automation
- Shared, automated mobility services; broad ownership of driverless vehicles

First quarter century
2025
Second quarter century
Driver Assistive Truck Platooning

- Fuel savings at 60 mph, 11m gap:
  - following truck: 10.0%
  - lead truck: 4.5%

The tipping point for CAV
2025 – 2030 timeframe

• V2V and V2I are widely deployed
  – Cybersecurity and privacy issues are settled
• Privately-owned vehicles with automated features (such as AEB) are widely used
  – Many of these vehicles have the additional benefit of V2V and V2I connectivity
• Driverless vehicle standards and operating rules are available
  – Cybersecurity & privacy measures are proven adequate for AVs on a large scale
  – Experience with mobility services using tailored driverless vehicles
  – Sufficient connected infrastructure is available
CAV scenarios and roadmap for private and public action
Towards Road Transport Automation: Opportunities in Public–Private Collaboration
Third EU–U.S. Transportation Research Symposium

April 14-15, 2015
National Academy of Science Building
Washington, D.C.

Peter Sweatman, U-M/CAVita & Maxime Flament, ERTICO
By the numbers

• 245 research questions
• 50 experts
• 11 constituencies
• 8 key topics
• 3 use cases

*use cases* enable us to get our arms around an almost overwhelming set of issues
EU-US use case scenarios

**Use Case 1**
Freeway Platooning: Moderately Automated Highway Operation

**Use Case 2**
Automated City Center: Highly Automated Urban Operation

**Use Case 3**
Urban Chauffeur: Fully Automated Tailored Mobility Service

Source: USDOT

Source: NORDICAPIS.COM

# Use cases considered by Volpe/NHTSA

Review of Federal Motor Vehicle Safety Standards (FMVSS) for Automated Vehicles

**Automated Vehicles**

- Highway automation
- Driverless valet
- Truck platooning
- Aftermarket highly-automated driverless vehicle kit
- Conventional vehicle with highly-automated OEM kit
- Highly-automated, conventionally designed vehicle

**Driverless Vehicles**

- Highly-automated vehicle with advanced design
- Highly-automated vehicle with novel design
- Riderless delivery motorcycle
- Driverless delivery vehicle (light duty/heavy duty)
CAV partners and activities

- AASHTO, ITE & ITS-A
  - V2I Deployment Coalition (V2I-DC)
  - Chair: Shailen Bhatt
- NHTSA, FHWA & CAMP
  - Many technical, standards, regulatory and advisory activities
- USDOT & AASHTO
  - V2I Footprint Analysis
- AASHTO CAV Executive Leadership Team
  - Chair: Kirk Steudle
  - Policy positioning for AV
- TRB/NCHRP CAV research roadmap
  - November 2016 symposium on transformational technologies (Detroit)
  - Anticipated formation of TRB research roundtables
Policy issues for public-private collaboration

• Nationally-applicable guidelines for the introduction of AV – based on use cases
• Solutions to early-stage risks
  – Spectrum, security & privacy
• Interoperability of CV and AV across state borders
• Playing field for information exchange between industry and government
• Data streams and data access provisions
• Comprehensive public outreach program for CAV
• Common set of planning assumptions, scenarios and tools