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 CO_2

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, protoyping, 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


Fulle
DODGE
DAKOTA
4x4

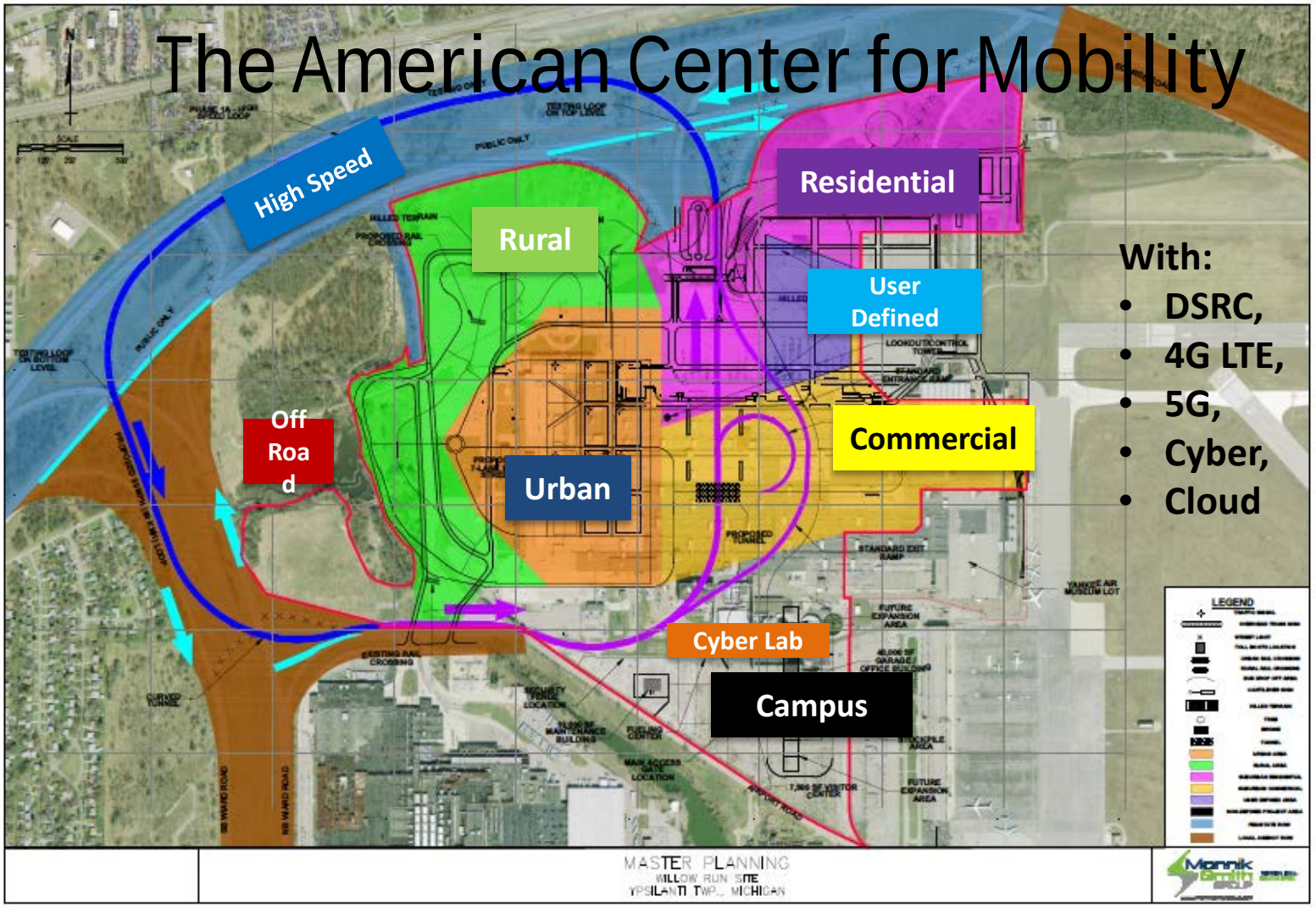
Mcity: opened by U-M and MDOT July 20, 2015

Streetscape in Downtown **Mcity**

MDOT Michigan Department of Transportation

MTC

The American Center for Mobility



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

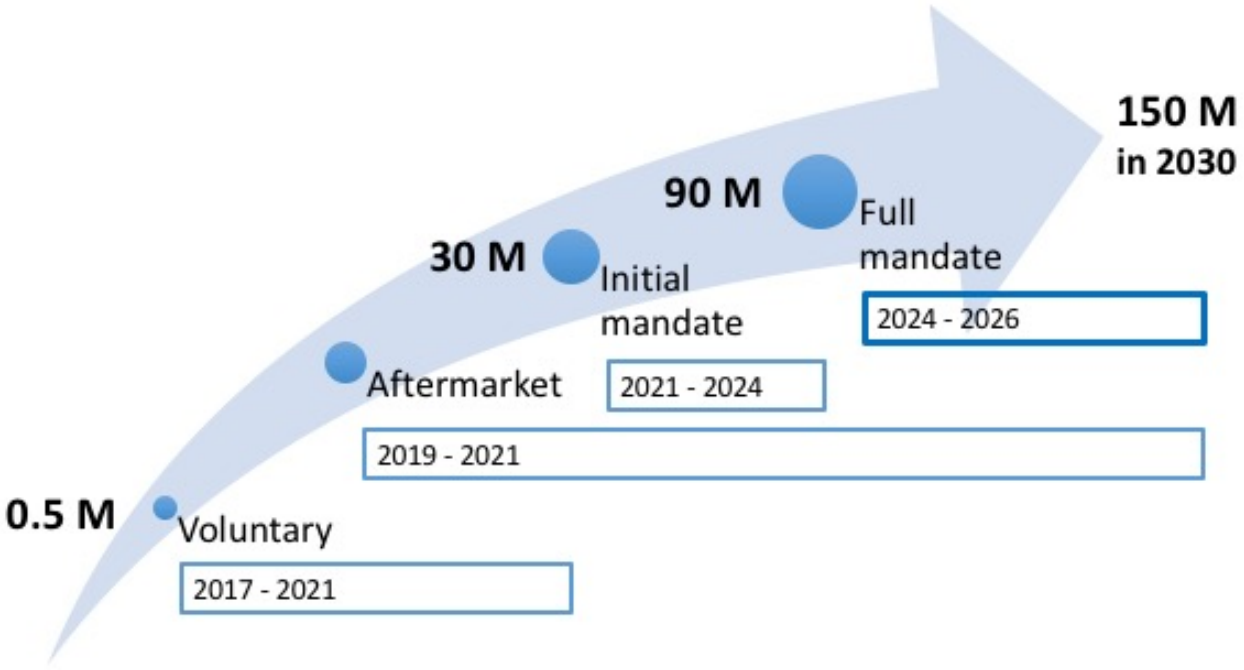
Connected Infrastructure

- 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

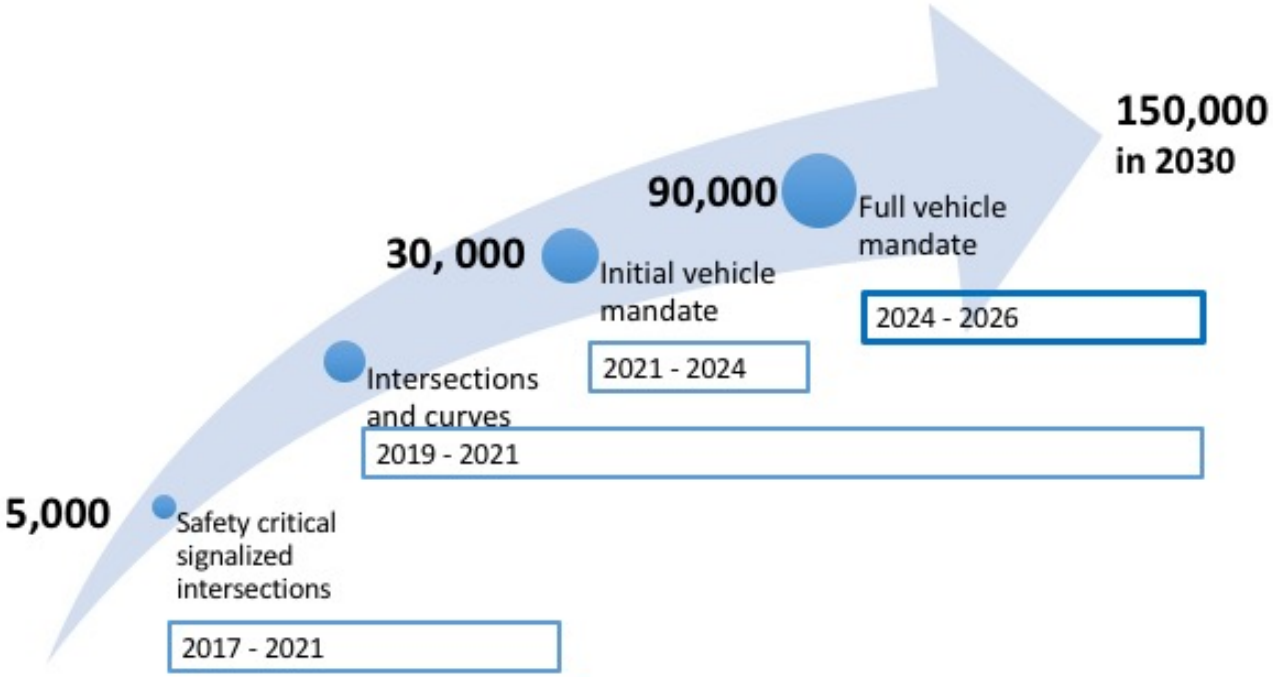
Continuing issues for CV

- 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



Roadside Equipment (RSEs)



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

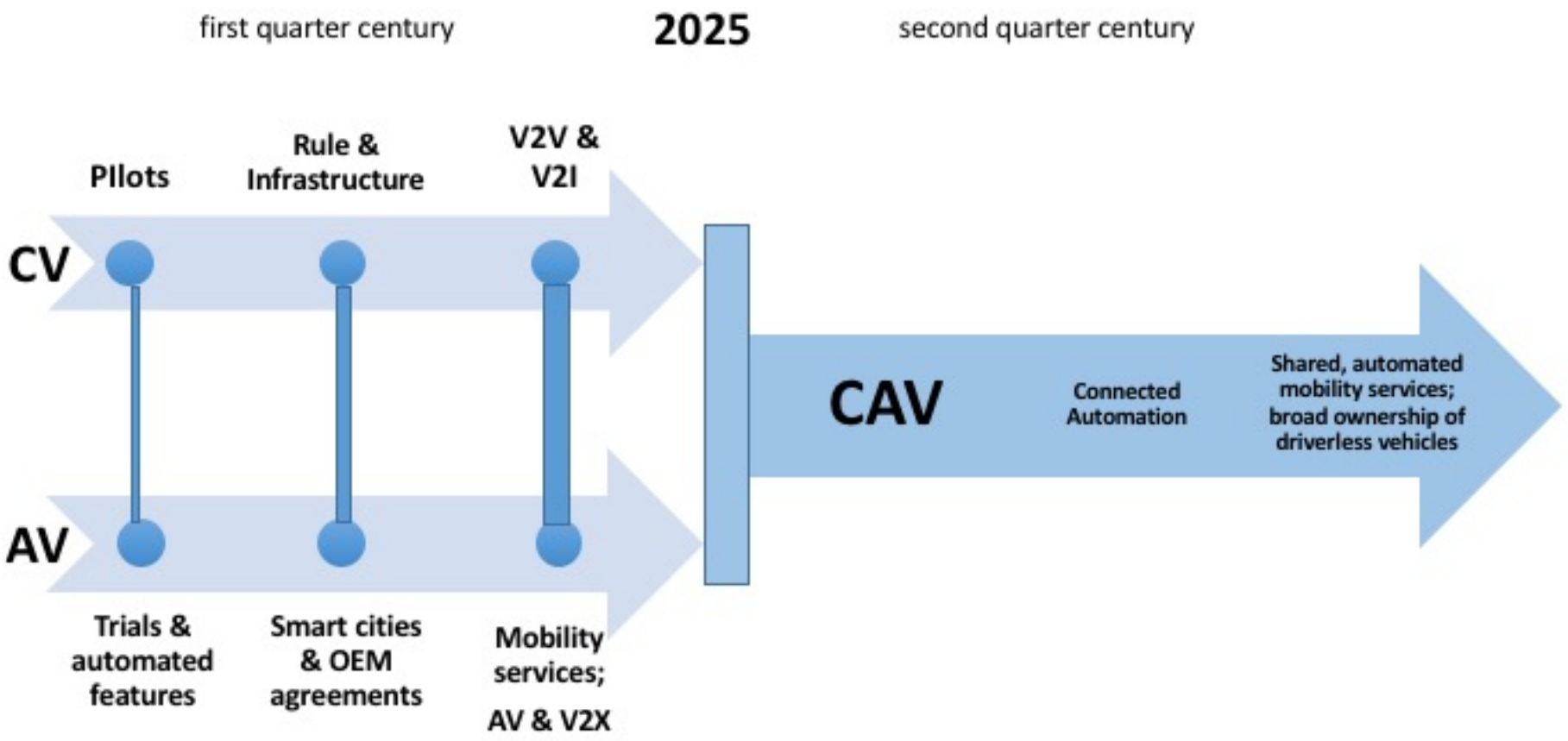
- No national roadmap to HAV deployment
- Too many questions, inhibiting collaboration
- Shared mobility accelerates deployment, but brings more questions

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



Driver Assistive Truck Platooning

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

North American Council for Freight Efficiency (2013). *CR England Peloton Technology platooning test Nov 2013.*

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

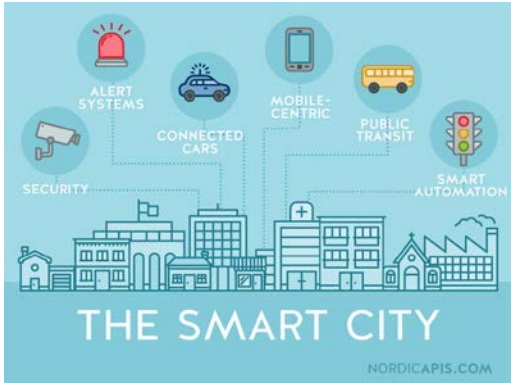
Use Case 1

Freeway Platooning: Moderately Automated Highway Operation

Source: USDOT

Use Case 2

Automated City Center: Highly Automated Urban Operation



Source: NORDICAPIS.COM

Use Case 3

Urban Chauffeur: Fully Automated Tailored Mobility Service

Source: http://www.citymobil2.eu/en/Downloads/Pictures/

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