Status of CAV Deployment and its Potential Impact on Tolling

Presented By

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Agenda

- Motivation for Automated Vehicles (AV)
- Definitions: what is CV/AV/CAV?
- Deployment Status in the U.S.
- Summary of USDOT Policy
- Impact of CAV on Tolling Industry
- Final Thoughts – how you can prepare

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Why Do We Need Automated Vehicles?

Safety

- 40,100 highway deaths in 2017
- 6.3 million crashes in 2017
- Leading cause of death for ages 16-24

Mobility

- 7 billion hours of travel delay
- 42 hours per commuter
- $160 billion cost of urban congestion

Environment

- 3 billion gallons of wasted fuel
- 56 billion lbs of additional CO_2

Source: USDOT

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Commercial Motivation

- In March 2016, General Motors paid $1B for Cruise Automation
- Ford invested the same amount in a joint venture with Argo AI
- Largest AV technology acquisition to date was Intel's $15.3 billion purchase of Mobileye, a Tier-2 automotive supplier of object-detection systems
- Uber devoted $457M to AV R&D in 2018
- Expanding mergers, acquisitions, partnerships on a daily basis
- Economic development opportunity

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Connected versus Automated

- **Connected Vehicles (CV)** use technology (e.g. DSRC, 4G, 5G) to communicate with each other (V2V) or with the roadway infrastructure (V2I) wirelessly
- **Automated Vehicles (AV)** incorporate an even broader range of technology (e.g. radar, LIDAR, etc.) to take over varying degrees of driving responsibility from the driver
- **AVs** can range from driver assistance systems such as adaptive cruise control (SAE Level 1) to fully automated systems (SAE Level 5)
- Fully automated AVs are often referred to as **Autonomous Vehicles** or **Driverless Vehicles**

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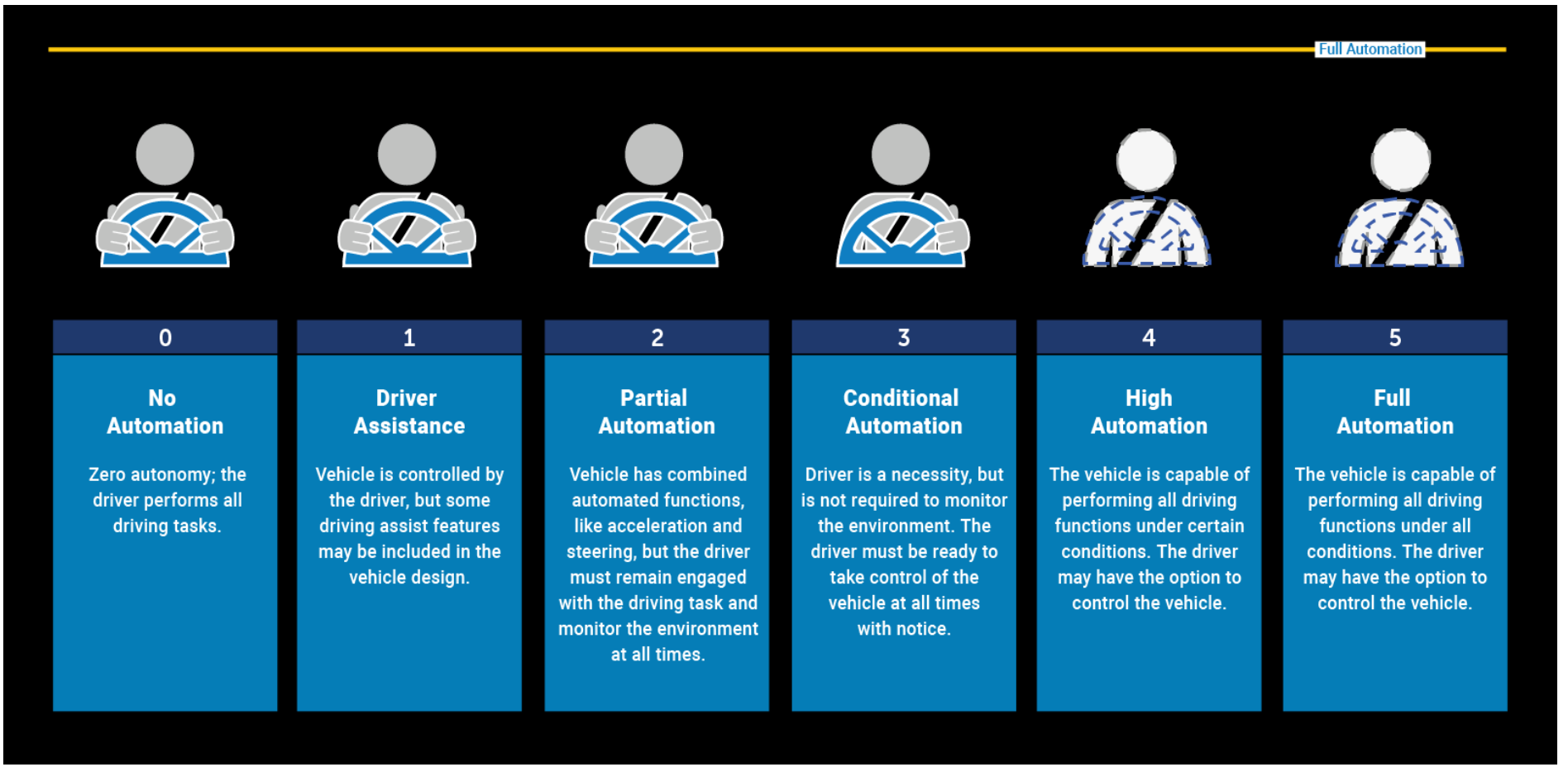
SAE Levels of Automation (0-5)



Source: NHTSA

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Connected Automated Vehicle (CAV)

Connected Vehicle
Communicates with nearby vehicles and infrastructure
Not automated (level 0)

Autonomous Vehicle
Operates in isolation from other vehicles using internal sensors

Connected Automated Vehicle
Leverages automated and connected vehicle technologies

Source: NHTSA

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Impact on Infrastructure Owner Operators

- Planning for CAVs
- Roadway Quality and Consistency
  - Pavement markings and signage
  - Traffic signal and ramp meter design
- Provision of real-time data
  - Work zones and lane closures
  - Digital mapping
  - CV data (e.g. signal phase and timing)
- Smart traffic management
  - Intersections and merges
  - Smoothing traffic flow, increasing capacity
  - Consideration of freight and transit vehicles

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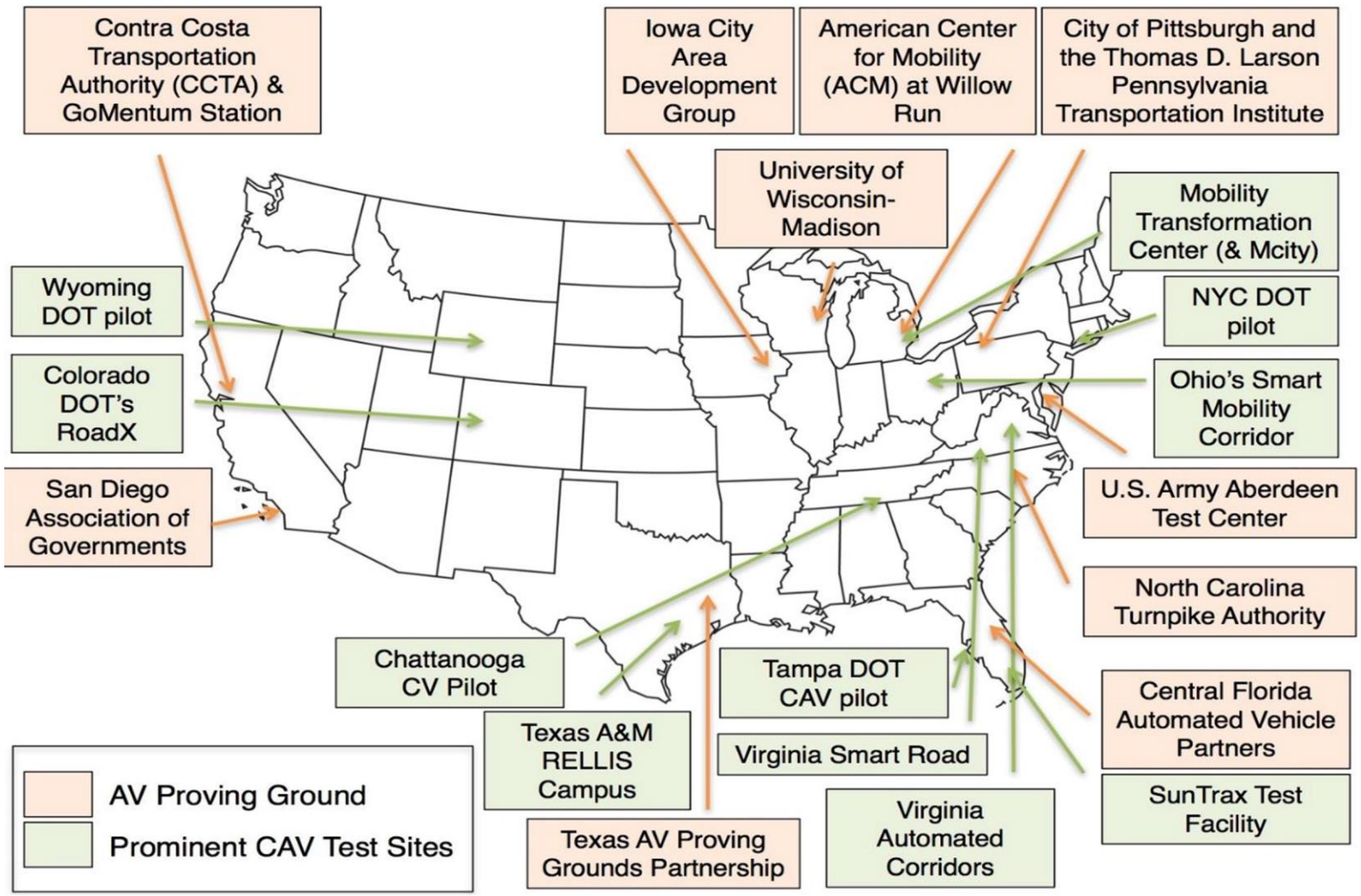
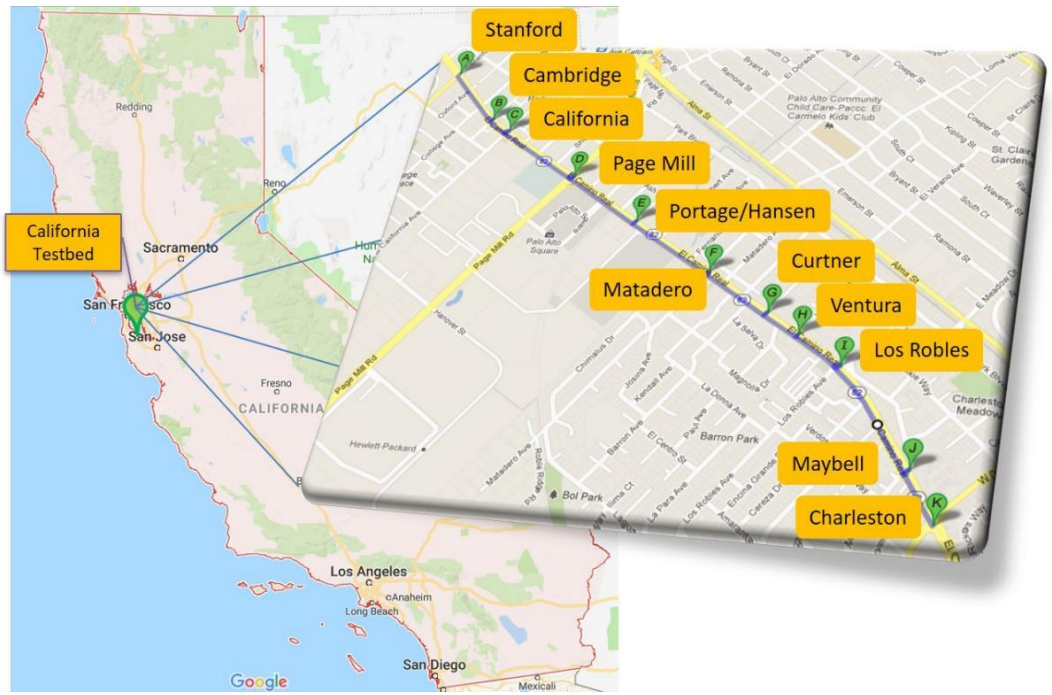
AV Proving Grounds and CAV Test Sites (source: USDOT)



Example: California CV Testbed



- Launched in 2005 by Caltrans and MTC
- First state-funded DSRC testbed in the US
- 11 intersections on SR 82 in Palo Alto

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Example: GoMentum Station

- Located at former Naval Base in Concord, CA
- 21,000 acres
- Owned and Operated by AAA of Northern CA, NV and UT
- Collaborators include:
  - Toyota, Honda, Uber, Lyft, EasyMile, Contra Costa County, City of Concord and others

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USDOT Policy on CV and AV

- NHTSA's V2V mandate seems to be on hold indefinitely while other CV technologies are emerging (C-V2X, 5G)
- Focus for CV is now on pilots and deployment (no longer research)
- AV Policy is emphasizing a light regulatory approach
  - Providing guidelines and best practices for AV safety
  - Encouraging voluntary safety self assessments
- AV 3.0 released in 2018
  - expanded scope to all modes, not just light vehicles
  - recognized the importance of connected automation (CAV)
  - added role of states, locals and MPOs
  - followed up with ADS Demonstration Grants ($50M) in 2019

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16 voluntary safety self assessments as of June 2019

- Apple
- Aurora
- AutoX
- Ford
- GM
- Mercedes-Benz/Bosch L4-L5
- Mercedes Benz L3
- Navya
- Nuro
- Nvidia
- Robomart
- Starsky Robotics
- TuSimple
- Uber
- Waymo
- Zoox

Source: NHTSA web site

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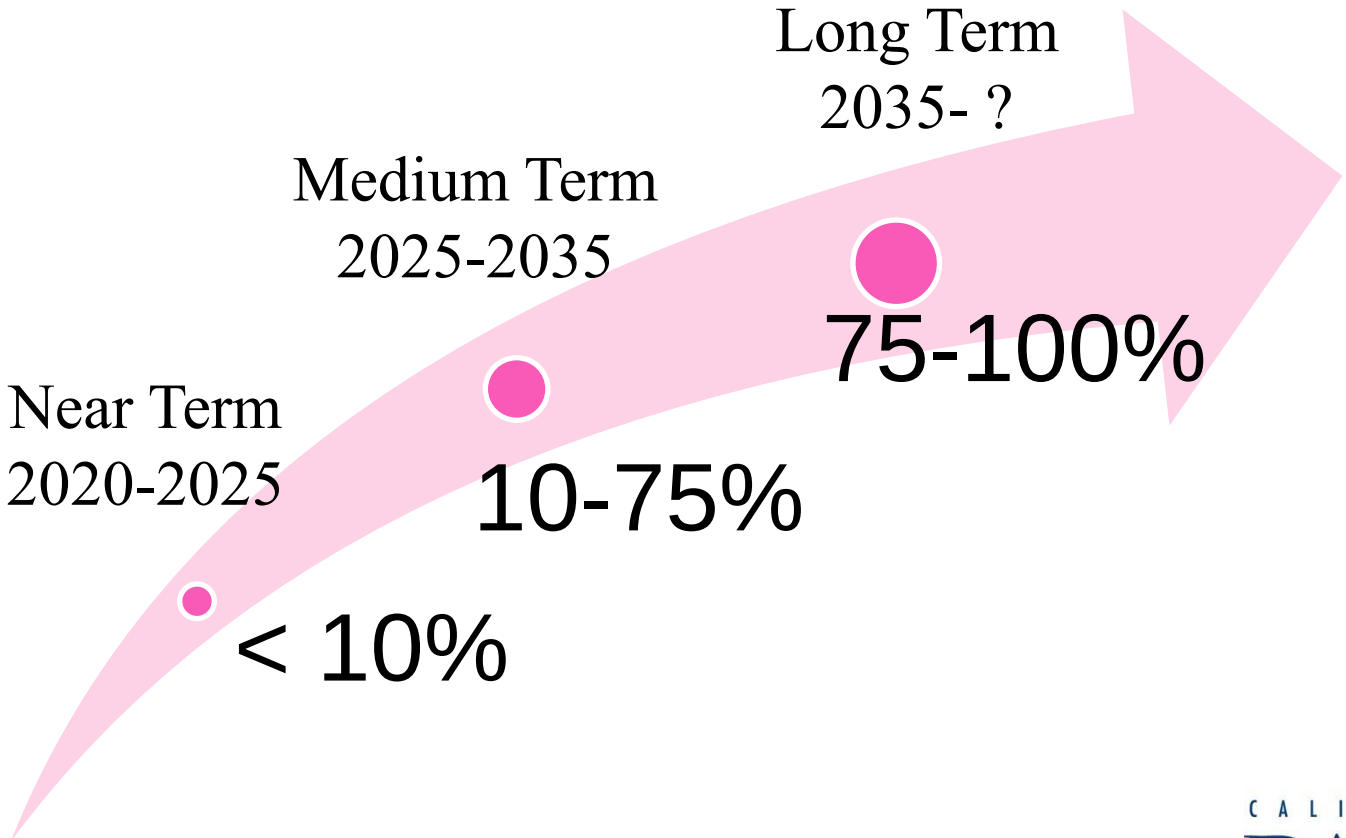
CAV Deployment Timeline (market penetration of CAVs)

- Consider that U.S. Fleet Turnover rate is ~ 20 years



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Potential Impacts on Tolling

Near Term (0-5 yrs)	Medium Term (5-15 yrs)	Long Term (>15 yrs)
DSRC or C-V2X for tolling: replaces existing readers and transponders	Dedicated AV Lanes: allows for narrower widths, closer following, increased capacity	No need for DMS and other signage
Improved lane markings and signage for AVs	Improved HOV detection	No need for gantries or traffic detection devices
Toll price information pushed to an API or CVs	Better data collection and traffic management opportunities	Policy Considerations: HOV treatment, liability for traffic and toll violations
	GPS based tolling rather than using discrete points	Impact on parking and congestion pricing?

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How Should Toll Agencies Prepare?

- Stay abreast of technological trends and developments (both CV and AV)
- Look for opportunities to pilot or demonstrate AV technologies and tolling applications on their facilities to gain hands-on experience
- Be selective and thoughtful
  - Don’t deploy technology for technology’s sake
  - Look for technologies and applications that provide the best ROI

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Examples of CAV Efforts by Tolling Agencies

Tampa Hillsborough Expressway Authority (THEA)

- AV testing on Lee Roy Selmon Reversible Express Lanes
- Can support closed or open course testing
- Starsky Robotics tested truck platooning there
- Hosting USDOT's CV Pilot

Florida Turnpike Enterprise (FTE)

- Developed SunTrax - a 2.25 mile oval test track on 475 acres
- Supports testing of AVs, CVs and high-speed tolling technologies
- Allowed truck platooning tests by Peloton on 148 mile segment of FLA Turnpike

Questions?

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