Presentation Outline

- Today’s Transportation Challenges
- Connected and Automated Vehicle Overview
- CV Pilot Deployment Program
- Smart City Challenge Program
- Challenges to Our Profession
The car as we know it, and how it’s used in people’s lives, is going to change really dramatically and it’s going to change fast..

Bill Ford Jr., Executive Chairman (April 2013)

- The next revolution of our transportation system since the Interstate Highway System
- Major enhancements to improve safety, mobility, and environment
- Impacts to our lives, careers, and industries
Connected and Autonomous Vehicles

EARLY GM AUTOMATED VEHICLES

ADVANTEC Consulting Engineers
Connected and Autonomous Vehicles
Connected and Autonomous Vehicles

- National Automated Highway System Consortium (NAHSC)
- Highlight was the 1997 Demo on I-15 in San Diego
- Passenger car automation demonstrated
Connected and Autonomous Vehicles

- 2004 Defense Advanced Research Projects Agency (DARPA) Grand Challenge – No winners
- 2005 DARPA Grand Challenge - 5 vehicles completed the course
- 2007 DARPA Urban Challenge – 6 vehicles completed the course
- Created another push for development of AV
Connected and Autonomous Vehicles

- **2011**: Defined V2V Apps
- **2012**: Defined Safety (V2I), Mobility (V2V & V2I), AERIS and Weather Apps
- **2013**: Application Development
- **2014**: Pilots/Early Deployments
- **2015**: NHTSA Decision Heavy Vehicle
- **2016**: FHWA Deployment Guidelines

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Connected and Autonomous Vehicles

**Autonomous Automated Vehicle**
Operates in isolation from other vehicles *using internal sensors*

**Connected Vehicle**
Communicates *with nearby vehicles and infrastructure*

**Connected Automated Vehicle**
Leverages autonomous automated and connected vehicles

https://www.youtube.com/watch?v=YxmLkqVrg4c
Connected and Autonomous Vehicles

NHTSA defines vehicle automation as having five levels:

- **Level 0**: No automation. Driver is in complete and sole control of brakes, steering, throttle, and motive power at all times.
- **Level 1**: Function-specific automation. Automation of one or more functions: electronic stability control or pre-charged brakes.
- **Level 2**: Combined function automation. Automation of at least two functions, for example adaptive cruise control and lane centering steering.
- **Level 3**: Limited self-driving automation. Automation that takes over all safety-critical functions under certain traffic conditions. Driver is available for occasional control.
- **Level 4**: Full self-driving automation. Vehicle can perform all safety-critical driving functions for an entire trip. Driver is not expected to be available for control any time during the trip.

**Connected Vehicles** - we will see a connected fleet with level 1-3 automation in the next 10-15 years.

**Automated Vehicles** - estimated that up to 30 percent of the fleet will be automated by 2030.
### SAE Levels of Automation

<table>
<thead>
<tr>
<th>SAE Level</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>Execution of Steering/Acceleration/Deceleration</th>
<th>Monitoring of Driving Environment</th>
<th>Fallback Performance of Dynamic Driving Task</th>
<th>System Capability (Driving Modes)</th>
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<td>0</td>
<td>No Automation</td>
<td>the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems</td>
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<td>Driver Assistance</td>
<td>the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
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<td>Partial Automation</td>
<td>the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
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<td>High Automation</td>
<td>the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene</td>
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<td>Full Automation</td>
<td>the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>All driving modes</td>
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Connected and Autonomous Vehicles

- Connected Vehicles use **wireless technology** to “connect” vehicles to each other and/or to infrastructure (for example, cell tower, roadside equipment, hand-held device)
  - Dedicated short-range communication (DSRC)
  - Cellular

- Vehicle-to-Vehicle (V2V) Communications
- Vehicle-to-Infrastructure (V2I) Communications
- Vehicle-to-Vehicle and Vehicle-to-Infrastructure (V2X) Technology
- Vehicle-to-pedestrian (V2P) Communications

latitude, longitude, time, heading angle, speed, lateral acceleration, longitudinal acceleration, yaw rate, throttle position, brake status, steering angle, headlight status, wiper status, external temperature, turn signal status, vehicle length, vehicle width, vehicle mass, bumper height
Autonomous Vehicles

Sense their surroundings with such techniques as radar, sensor technologies (LiDAR), GPS, and computer vision.

Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage, traffic signals, etc.

Some autonomous vehicles update their maps based on sensory input, allowing the vehicles to keep track of their position even when conditions change or when they enter uncharted environments.
Connected and Autonomous Vehicles

CV: V2V and V2I Communications Overview

Figure 1. Wireless communications between the infrastructure and vehicles using Dedicated Short Range Communication (DSRC) network.
## CV / AV Applications

### V2I Safety
- Red Light Violation Warning
- Curve Speed Warning
- Stop Sign Gap Assist
- Spot Weather Impact Warning
- Reduced Speed/Work Zone Warning
- Pedestrian in Signalized Crosswalk Warning (Transit)

### V2V Safety
- Emergency Electronic Brake Lights (EEBL)
- Forward Collision Warning (FCW)
- Intersection Movement Assist (IMA)
- Left Turn Assist (LTA)
- Blind Spot/Lane Change Warning (BSW/LCW)
- Do Not Pass Warning (DNPW)
- Vehicle Turning Right in Front of Bus Warning (Transit)

### Agency Data
- Probe-based Pavement Maintenance
- Probe-enabled Traffic Monitoring
- Vehicle Classification-based Traffic Studies
- CV-enabled Turning Movement & Intersection Analysis
- CV-enabled Origin-Destination Studies
- Work Zone Traveler Information

### Environment
- Eco-Approach and Departure at Signalized Intersections
- Eco-Traffic Signal Timing
- Eco-Traffic Signal Priority
- Connected Eco-Driving
- Wireless Inductive/Resonance Charging
- Eco-Lanes Management
- Eco-Speed Harmonization
- Eco-Cooperative Adaptive Cruise Control

### Mobility
- Advanced Traveler Information System
- Intelligent Traffic Signal System (I-SIG)
- Signal Priority (transit, freight)
- Mobile Accessible Pedestrian Signal System (PED-SIG)
- Emergency Vehicle Preemption (PREEMPT)
- Dynamic Speed Harmonization (SPD-HARM)
- Queue Warning (Q-WARN)
- Cooperative Adaptive Cruise Control (CACC)
- Incident Scene Pre-Arrival Staging
- Guidance for Emergency Responders (RESP-STG)
- Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
- Emergency Communications and Evacuation (EVAC)
- Connection Protection (T-CONNECT)
- Dynamic Transit Operations (T-DISP)
- Dynamic Ridesharing (D-RIDE)
- Freight-Specific Dynamic Travel Planning and Performance
- Drayage Optimization

### Road Weather
- Motorist Advisories and Warnings (MAW)
- Enhanced MDSS
- Vehicle Data Translator (VDT)
- Weather Response Traffic Information (WxTiINFO)

### Smart Roadside
- Wireless Inspection
- Smart Truck Parking
Traffic Incident Management Applications

Incident Ahead
Reduce Speed
Move to left Lane

INCIDENT ZONE WARNING
Traffic Incident Management Applications
Traffic Management Applications
Traffic Management Applications

- Connected Signals
  - EnLighten

- Traffic Technology Services
  - Personal Signal Assistant
Weather Management Applications
Other Applications

- Automated Transit (2014 – 14 pilot projects)
- Automated Taxis (UBER?)
- Automated Parking
Other Applications

- Connecting Trucks - Truck Platooning

Networked
  Finds Other Trucks
  Safety Approval
  Geo-fencing

Data
  Analytics
  Event Capture
  Diagnostics

Safety
  Collision Avoidance
  Always-On

V2V Wireless Link
Radar
SAVINGS
Network Operations Center
**FHWA CV Pilot Deployment Program**

- Awarded $42 million in Next Generation Connected Vehicle Technologies
- **NY City** - install V2V technology in 10,000 city-owned vehicles
  - Upgrading traffic signals to V2I
- **Wyoming** - efficient and safe movement of freight using V2V and V2I
- **Tampa, Florida** - solve congestion and safety issues; equipping smart phones to provide V2P
- Proposed FHWA Rulemaking (2016)
  - It will require installation of V2V communications in all new light vehicles

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**Connected Vehicle Pilot Deployment (up to 50 months)**

- **PHASE 1** (up to 12 months)
  - Concept Dev.

- **PHASE 2** (up to 20 months)
  - Design/Deploy/Test

- **PHASE 3** (minimum 18 months)
  - Maintain/Operate Pilot

- Routine Operations (ongoing)
  - Post-Pilot Operations

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Opportunity to highlight the role of public-private partnerships in addressing our transportation challenges

USDOT ($40 million) will partner with Vulcan Philanthropy for this competition

Vulcan is offering up to an additional $10 million to support the deployment of electric vehicles and other carbon emission reduction strategies

Winning city will view Intelligent Transportation Systems (ITS), connected vehicles, and automated vehicles as the next logical step in its existing, robust transportation infrastructure

It should also aim to have critical systems in vehicles and infrastructure that communicate with each other, allow for active citizen participation, and integrate new concepts that leverage the sharing economy
USDOT Beyond Traffic: The Smart Transportation Challenge

Grant Application

DOT Smart City Challenge

1,400 local officials, companies, academics and non-profits joined our webinars

800 people participated in our Smart City Forum

300 companies have expressed interest in partnering

78 applications received for the Smart City Challenge

5 Smart City Challenge Finalists to be announced in March at SXSW

1 Smart City Challenge Winner announced in June

#DOTSmartCity

www.transportation.gov/smartcity

U.S. Department of Transportation
USDOT Beyond Traffic: The Smart Transportation Challenge
Grant Application

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CITY OF RIVERSIDE
CALIFORNIA

Application For
US Department of Transportation
Beyond Traffic: The Smart Transportation Challenge
Grant Application - PART 1
February 4, 2016
### USDOT Beyond Traffic: The Smart Transportation Challenge
Grant Application

#### BEYOND TRAFFIC: THE SMART CITY CHALLENGE
CITY OF RIVERSIDE, CALIFORNIA

**SHARED MOBILITY**

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**ADVANTEC Consulting Engineers**
USDOT Beyond Traffic: The Smart Transportation Challenge
Grant Application

### BEYOND TRAFFIC: THE SMART CITY CHALLENGE
CITY OF RIVERSIDE, CALIFORNIA
TECHNOLOGY COMPANIES

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<td>Traffic Jam Assist (Lane Keeping + Adaptive Cruise Control) tested</td>
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<td>Steering Assist (Lane Keeping + Adaptive Cruise Control) in U.S. production vehicles</td>
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<td>Researching a semi-autonomous vehicle designed to keep the driver in the control loop and takeover in case of an imminent accident</td>
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Connected and Autonomous Vehicles

How Google will put self-driving cars on the road in four years

Google is taking a different approach to developing self-driving cars than the many automakers and auto parts providers that are also developing them. Auto companies plan to roll out automated functions — like automatic braking and lane departure warning — to their cars piecemeal over the next few years. These automated functions will help prevent accidents and make driving safer, and (automakers hope) train consumers to trust their cars to drive themselves. That trust will build a viable market for self-driving cars down the road.

Google isn’t concerned with taking these stepping-stones to habituate consumers to self-driving technology. It’s going directly to a self-driving car, and plans to have a completely autonomous vehicle available for the public in four years, according to WIRED.

Cadillac to Introduce Advanced ‘Intelligent and Connected’ Vehicle Technologies on Select 2017 Models

Super Cruise and V2V technologies slated for production in about two years

Detroit — Cadillac will begin offering advanced “intelligent and connected” vehicle technologies on certain 2017 model year vehicles, General Motors CEO Mary Barra said Sunday during her keynote address at the Intelligent Transport System (ITS) World Congress in Detroit.

In about two years, an all-new 2017 Cadillac vehicle will offer customers an advanced driver assist technology called Super Cruise and in the same timeframe the 2017 Cadillac CT6 will be enabled with vehicle-to-vehicle (V2V) communication technology.

“A side of innovation has invigorated the global auto industry, and we are taking these giant leaps forward to remain a leader of new technology,” Barra said. “We are not doing this for the sake of the technology itself. We are doing it because it’s what customers around the world want. Through technology and innovation, we will make driving safer.”
Volvo: We will be responsible for accidents caused by our driverless cars

By Alistair Charlton
October 9, 2015 12:22 BST

Volvo has become one of the first car companies to confirm that it will accept full responsibility for any accidents caused by its future driverless cars. The carmaker’s stance is an effort to speed up regulations which currently fail to fully recognise how autonomous cars and their manufacturers should be liable.

Mercedes and Google have made similar claims, as they and the industry as a whole work to develop autonomous features which take control and responsibility away from the driver. Volvo has described current US and European law regarding self-driving cars and liability as “a patchwork of rules and regulations.”

Reality is Here!
The Washington Post

Business

General Motors invests $500m in Lyft, forms partnership

By Dee-Ann Durbin | AP  January 4

DETROIT — The automotive industry is placing its biggest bet yet that using a device to hail a ride — with or without a driver — is the future of transportation.

General Motors Co. said Monday it is investing $500 million in ride-hailing company Lyft Inc. and forming an unprecedented partnership that could eventually lead to on-demand, self-driving cars. It’s the largest investment yet by a traditional automaker in a new mobility company, and is an acknowledgement by GM that the transportation landscape is changing fast.

“We see the world of mobility changing more in the next five years than it has in the last 50,” GM President Dan Ammann told The Associated Press.
Challenges to Our Profession

Understanding CV/AV Challenges

- Incorporating CV/AV in Transportation Planning, Design, O&M, Funding Process and Policies
- Public Policy Challenges
- Agency Indemnification
- Cyber Security
- Wireless Connectivity
- Truck Automation/Platooning
- First and Last Mile (transit)
- Electrification
- Vehicle Insurance Challenges
- Human Factors in Automated Vehicles
Challenges to Our Profession

City of Vancouver, Canada

3. Driverless or autonomous vehicle technology is now progressing so rapidly that Ontario has permitted testing of such vehicles in 2016 and may allow regular use in the near future;

4. This new technology poses new challenges to protection of privacy in its collection of data, and offers new margins of safety, dramatic improvements in efficiency and the potential to free large areas of urban land for better use;

MOTION ON NOTICE

4. Preparing Vancouver for Autonomous and Driverless Cars

MOVER: Councillor Meggs
SECONDER:

WHEREAS

Vancouver’s Transportation 2040 plan, adopted in 2012 and now is already showing important progress in supporting the transportation goals, particularly in shifting the share of mobile to transit and active transportation, especially

automous or driverless vehicles was then virtually unknown or present stages, with only a single jurisdiction in the world with the use of such technology;

uous vehicle technology is now progressing so rapidly that Ontario has permitted testing of such vehicles in 2016 and may allow regular use in the near future;

4. This new technology poses new challenges to protection of privacy in its origins of safety, dramatic improvements in urban areas of urban land for better use;


to technology, which several ey expect to have fully automated recast to reach as much as 75 percent of
rect staff to report back on:

negative, of this technology on the City’s transportation and sustainability plans, as well as the steps

the views of the City’s planning, transportation and technology experts on the best ways to maximize the benefits of this technology for the city and its economy while mitigating potential negative impacts.

THEREFORE BE IT RESOLVED THAT Council direct staff to report back on:

- the implications, both positive and negative, of this technology on the City’s transportation, land use, economic and sustainability plans, as well as the steps necessary to update those plans; and

- the views of the City’s planning, transportation and technology experts on the best ways to maximize the benefits of this technology for the city and its economy while mitigating potential negative impacts.
Challenges to Our Profession

Funding Policies
- Investment in **Smart Roadway Technologies**
- **Installation, Maintenance, and Operations**
- Educate our DOTs, MPOs, cities, agencies
- Educate agency management team
- California is always the leader!

Changes to Our Workforce
- Traffic Engineering
- Electrical Engineering
- ITS and communication networks
- IT
- Cyber security
- System engineering

- Driverless Bus – Switzerland, Spring 2016
Challenges to Our Profession
Challenges to Our Profession

TRANSPORTATION PLANNERS AND ENGINEERS

- ASCE
- ITE
- ITS AMERICA
- ITS CALIFORNIA
- SAE
- TRB
- AASHTO
- ASSOCIATION OF UNMANNED VEHICLE SYSTEMS INTERNATIONAL (AUVSI)

Google and ITE: The Road Ahead for Self-Driving Cars

ADVANTEC Consulting Engineers
CONTACT INFORMATION:

Carlos A. Ortiz, PE, TE, PTOE
- 949-861-4999 (Office)
- 949-636-0646 (Cellular)
- cortiz@advantec-usa.com
- LinkedIn
- Twitter: @CAOrtiz2121
QUESTIONS?