Stan Caldwell, Executive Director
Connected Vehicles

Dedicated Short Range Communication (DSRC)
Connected Bicycle Technology: PI
Anthony Rowe
Connected Vehicle Testbeds

- Pittsburgh’s East End, is a USDOT Affiliated Test Bed for connected vehicle technology.
- Additional connected vehicle infrastructure in Cranberry Township, Ross Township and Harrisburg.
CV Technical Challenges

- **Ensuring Interoperability**
  - Finalizing communication standards
  - Managing congestion and available spectrum
  - Detecting “bad actors” (misbehavior) and limiting impacts of anomalous messages

- **Ensuring security of messaging** (authenticity, trust) between vehicles...and between vehicles and infrastructure

- **Protecting Privacy**

- **Efficient data delivery system** (to support necessary V2I and I2V communications)
V2V: USDOT/NHTSA Decision

• Issue a regulatory proposal within this Administration
• Intend to require an onboard DSRC-based V2V communications technology
• Potential to address 80% of crashes involving non-impaired drivers!
Connected and Autonomous Vehicles

Connectivity
- Includes all types of communication with vehicles and infrastructure (Wi-Fi, DSRC, Cellular, etc.)

Connected Vehicle
Communicates with nearby vehicles and infrastructure
Connected and Autonomous Vehicles

Connectivity
- Includes all types of communication with vehicles and infrastructure (Wi-Fi, DSRC, Cellular, etc.)

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

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

- Includes all types of communication with vehicles and infrastructure (Wi-Fi, DSRC, Cellular, etc.)

Autonomous Vehicle

Operates in isolation from other vehicles using internal sensors

Connected Vehicle

Communicates with nearby vehicles and infrastructure

Connected Automated Vehicle
ROAD TO AUTOMATED DRIVING

John Capp, Director
Electrical & Controls Research

Increasing Capability

Today's Driver Assist Package
“SuperCruise” Concept
Limited On-Demand Automation (Monitored Control)
Emergency Intervention (Limited Control)
Driver Info & Alerts (No Control)
Complex On-Demand Automation (Transferred Control)
Autonomous Driving (Chauffeured Driving)

TECHNOLOGY ENABLERS:
Perception & Algorithms
Integrated Sensing with Maps, GPS, V2X
Driver State Knowledge

Today
Future
Autonomous Vehicles

2007 GM Lab

2012 GM Lab
Why Now?

- Revolutionary Time in Transportation Through Disruptive Technology
  - Big Data
  - Information and Communications Technology
  - Internet of Things
  - Cyber Physical Systems
Challenges

- **Exogenous:** The complexity & uncertainty of the real world
  - Weather, lighting, and road conditions; construction; accidents; obsolete information, loss of GPS.
- **Endogenous:** Online and safe recovery from failures of sensors, actuators, computing or communications.
  - Sensors and actuators
    - Calibration, wear and tear, outright failure.
- **Assurance:** How to verify and validate safety & correctness?
- **Interactions:** Vehicular Networks
  - Communicate securely and coordinate carefully
- **Reliability**
  - Cost and maintenance, customer acceptance
- **Incremental deployment**
  - Semi-autonomy → on-demand autonomy → full autonomy
- **Legal implications**
Connected & Autonomous Vehicles – 2040 Vision

• Infrastructure investment and design
• Communication devices / real time data use
• Driver licensing
• Workforce training needs
• Freight movement
Proposed PennDOT Actions for 2040 Vision

• Evaluate planned capacity enhancements.
• Collaborate with private sector to convert data into information.
• Begin deployment of V2I applications at key locations.
• Reconfigure and repurpose lanes.
• Dedicate highway lanes to autonomous vehicle use.
New CAV Policies

- NHTSA and FHWA moving on national vehicle policies.
- Pennsylvania moving to enact Autonomous vehicle testing legislation and policy.
- Multi State Smart Mobility Initiative
- Carnegie Mellon Study finds positive social benefits for partial (Level 1) automation: Cost and benefit estimates of partially-automated vehicle collision avoidance technologies, CD Harper, CT Hendrickson, C Samaras - Accident Analysis & Prevention, 2016.
# CMU Observed Insurance Data – First Generation Warning Systems

## Observed Changes in Crash Frequency and Cost and Collision Exposure By Crash Avoidance Technology ($2012)

<table>
<thead>
<tr>
<th>Crash Avoidance Technology</th>
<th>Change in Collision Claim Frequency</th>
<th>Change in Collision Claim Severity</th>
<th>Collision Exposure$^c$</th>
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</thead>
<tbody>
<tr>
<td>Blind Spot Monitoring</td>
<td>-0.53%</td>
<td>-$80</td>
<td>439,600</td>
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<tr>
<td>Forward Collision Warning$^b$</td>
<td>-3.97%</td>
<td>-$221</td>
<td>272,900</td>
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<tr>
<td>Lane Departure Warning</td>
<td>-1.21%</td>
<td>-$147</td>
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<tr>
<td>Weighted Average</td>
<td>-1.90%</td>
<td>-$149</td>
<td>N/A</td>
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</tbody>
</table>
“Not your father’s US Department of Transportation”

- Beyond Traffic Report
- Smart City Challenge
- Reconnecting Cities
- Long Term Opportunities with FAST Act
Why Pennsylvania

- Progressive leadership at PennDOT and Turnpike (SITC)
- Bi-partisan and Bi-cameral Legislative Support
- Support from the Governor and Multiple Departments
- Forward Thinking MPOs and Municipalities
- Growing Industry Cluster
- Cutting Edge University Research
- Long Term Transportation Funding