The Future of Transportation and the Impact of Connected and Automated Vehicles on States

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VDOT and Connected Vehicles

• Lead state for the Connected Vehicle Pooled Fund Study

• Provided support for the Connected Vehicle University Transportation Center

• Developed the VCC for application development and testing

• Moving towards integration with TOC operations
Connected Vehicle Pooled Fund Study

• The Pooled Fund Study (PFS) is a partnership of transportation agencies who have established a program to facilitate the development and evaluation of Connected Vehicle applications.

• The program will prepare state and local transportation agencies for the deployment of Connected Vehicle technologies.

• The program will result in the following outcomes:
  – Development and demonstration of connected technology, algorithms, tools and applications
  – Preparation for field deployments
  – Development and deployment documentation
  – Lessons learned and identification of challenges from field deployments
Current PFS Membership

Fifteen Core Members:
Virginia, California, Florida, Michigan, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Texas, Utah, Washington, Wisconsin, Maricopa County and FHWA

Associate Members
Palm Beach Co, FL; Oakland Co, MI; MTC (Bay Area), San Diego’s Regional Planning Agency, Los Angeles County Metropolitan Transportation Authority (Metro), Transport Canada, Arizona DOT, Rijkswaterstaat and North Texas Toll Authority

Liaisons
NCHRP/SHRP 2; AASHTO (strategic and deployment plans)
Virginia Connected Corridors
### Transportation Needs

<table>
<thead>
<tr>
<th>Need</th>
<th>Details</th>
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<tbody>
<tr>
<td>Reduce recurring congestion</td>
<td>I-66 corridor currently experiences average travel speeds of approximately 40 mph during the peak periods</td>
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<td>Increase travel reliability</td>
<td>I-66 has a PTI value over 3 during both the morning and evening peak periods</td>
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<td>Reduce non-recurring congestion</td>
<td>Incident duration in the Northern Region has averaged 52 minutes over the last year</td>
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<td>Reduce crashes</td>
<td>Facilities within the VCC experienced 2961 crashes (5 fatal and 70 severe injury crashes) in 2014</td>
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### VDOT Performance Measures & Goals

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<tr>
<th>Goal</th>
<th>Measure/Indicator</th>
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<tr>
<td>Delay</td>
<td>Vehicle Hours of Delay (GOAL: Reduce this)</td>
</tr>
<tr>
<td>Reliability</td>
<td>Planning Time Index (GOAL: Reduce PTI)</td>
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<tr>
<td>Duration</td>
<td>Incident Duration (GOAL: Reduce Incident duration by 5 min in 5 years)</td>
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<tr>
<td>Safety</td>
<td>Number of crashes (GOAL: Reduce fatal &amp; injury crashes by 3% per year from 2010 baseline)</td>
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### CV Applications

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<tr>
<th>Application</th>
<th>Description</th>
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<tr>
<td>Advanced Traveler Information</td>
<td>V2V – Forward Collision Warning</td>
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<tr>
<td>Work Zone Alerts for Drivers and Workers</td>
<td>Parking Availability</td>
</tr>
<tr>
<td>Incident Scene Alerts for Drivers</td>
<td>Probe Enabled Traffic Monitoring</td>
</tr>
<tr>
<td>Red Light Violation Warning System</td>
<td>Integrated Traffic Signal System</td>
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<tr>
<td>Queue Warning</td>
<td>Transit Signal Priority</td>
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Traveler Information Message App

• DSRC or Cellular only option
• Statewide deployment for cellular users
• Speech recognition and reporting
- VCC Cloud builds dynamic traveler messages and pushes them to drivers via DSRC or Cellular
- Work Zone app clusters multiple workers together if necessary
- When close, locations of individual workers or clusters are streamed to VCC Mobile for higher precision display
- Layout status is updated every 10 seconds
Virginia’s Automated Corridor

- Partnership between VDOT, DMV, Here, Transurban and led by VTTI to enable advanced automated vehicle technologies in Virginia

- VDOT has committed to maintaining standards for completeness of marking and retro-reflectivity properties
Connected/Automated Vehicles Provide Opportunity to Reduce Infrastructure

- VDOT wants to understand feasibility of eliminating certain high-dollar infrastructure through connected vehicle applications.
  - Overhead Guide Signs
    - 1,000 signs x $100,000 per sign structure = $100 M
  - Overhead Changeable Message Signs
    - 550 signs x $200,000 per sign = $110 M
  - Traffic Signals
    - 3,200 signals x $250,000 per signal = $800 M

- VDOT issued an RFI for innovative and cost effective strategies to transition from traditional assets and infrastructure to CV technology and applications
  - Key milestones and timelines
Automated Vehicle Integration
Initial Discussion Draft

Figure 1: Existing Signalized Intersection Network

Features:
1. Current method of traffic control at signalized intersections.
2. Intersection traffic controlled by signal controller.
3. No communication between vehicles and infrastructure.

Challenges:
1. High initial cost of signal construction.
2. Annual operational and maintenance costs.
3. Limited optimization of traffic flow.
Automated Vehicle Integration
Initial Discussion Draft

Figure 2: Vehicle to Infrastructure (V2I) Network
Anticipated Implementation Date: 1 year

Features:
1. Immediate future for technology improvements.
2. Connected vehicles transmit data to signal controller and receives signal and sign data.
3. Allows for gradual growth of connected vehicle fleet.
4. Accommodates unconnected vehicles, including bicycles and pedestrians.

Challenges:
1. Redundant signals and signs required until all vehicles are connected.
2. Improvements to traffic flow will be limited by traffic signals.
Automated Vehicle Integration
Initial Discussion Draft

Figure 3: Vehicle to Vehicle (V2V) Network

Anticipated Implementation Date: 10 - 15 years

Features:
1. Connected vehicles communicate directly with each other to control traffic.
2. Requires 100% participation of vehicles.
4. Allows for the removal of physical traffic signals and reduction of associated operational and maintenance costs.

Challenges:
1. Assignment of vehicular right-of-way is undetermined.
2. Challenges on how to integrate bicycles and pedestrians.
3. Cyber security for vehicles and infrastructure will be required.
Automated Vehicle Integration
Initial Discussion Draft

Figure 4: Fully Automated Vehicle Network

Anticipated Implementation Date: 20 years

Features:
1. Fully automated vehicles communicating with network to optimize traffic.
2. Requires 100% participation of vehicles.
3. Network will assign vehicular right-of-way.
4. No physical traffic signals will be required.
5. Enhanced operations will result in reduced congestion and higher capacity.

Challenges:
1. Cyber security for cloud-based network will be required.
2. Will require public support for technology
Questions?