Deployment of Connected and Automated Vehicles

FAV Summit 2017

Tom Timcho
Program Highlights
Connected Vehicles
Automated Shuttles
Truck Platooning
SmartColumbus Program

• Multiple, Interrelated Deployment Projects
• Goals include Safety, Mobility and Environmental Benefits plus…
• Ladders of Opportunity, Customer Satisfaction, and Agency Efficiency are also a focus
• Connected / Automated Technology touches 3 Projects
  o Connected Vehicle Environment
  o Connected Electric Automated Vehicle
  o Truck Platooning
DISTRICTS

RESIDENTIAL DISTRICT

COMMERCIAL DISTRICT

DOWNTOWN DISTRICT

LOGISTICS DISTRICT
DEPLOYMENT LOCATIONS

LOGISTICS DISTRICT

RESIDENTIAL, COMMERCIAL AND DOWNTOWN DISTRICTS

LOGISTICS DISTRICT
CONNECTED VEHICLE ENVIRONMENT

175 ROADSIDE UNITS
- Signalized Intersections
- Signalized Freeway Ramps
- School Zones
- Work Zones
- Pedestrian Detection
- Multiple Vendors Planned

3000 ONBOARD UNITS
- Total of Seventeen (17) CV Apps
- Includes V2V, V2I Safety and V2I Mobility
- Deployed using Aftermarket Safety Devices (ASD)
- Multiple Vendor(s) / Configurations Expected
<table>
<thead>
<tr>
<th>Class</th>
<th>Application</th>
<th>Light-Duty Vehicle</th>
<th>Emergency Vehicle</th>
<th>Platoon Truck</th>
<th>Transit Vehicle</th>
<th>CEAV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V2V Safety</strong></td>
<td>Emergency Electronic Brake Light Warning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Emergency Vehicle Alert</td>
<td>✓</td>
<td>✓*</td>
<td>✓</td>
<td>✓*</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Forward Collision Warning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Intersection Movement Assist</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Lane Change Warning - Blind Spot Warning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓*</td>
<td>✓*</td>
</tr>
<tr>
<td></td>
<td>Transit Vehicle at Stop Warning</td>
<td>✓</td>
<td></td>
<td>✓*</td>
<td>✓*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vehicle Turning in Front of a Transit Vehicle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>V2I Mobility</strong></td>
<td>Transit Signal Priority</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Emergency Vehicle Preemption</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Freight Signal Priority</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vehicle Data for Traffic Operations</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Intent to Platoon Signal Priority</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>V2I Safety</strong></td>
<td>Pedestrian in Signalized Crosswalk Warning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Red Light Violation Warning</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduced Speed School Zone</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transit Pedestrian Indication</td>
<td>✓</td>
<td></td>
<td>✓*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Warnings about Upcoming Work Zone</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CV ENVIRONMENT – V2V Safety Apps

- Emergency Electronic Brake Light Warning
- Forward Collision Warning
- Lane Change Warning - Blind Spot Warning
- Intersection Movement Assist
- Vehicle Turning in Front of a Transit Vehicle
- Emergency Vehicle Alert
- Transit Vehicle at Stop Warning
CV ENVIRONMENT – V2I Safety Apps

- Red Light Violation Warning
- Reduced Speed School Zone
- Warnings about Upcoming Work Zone
- Pedestrian in Signalized Crosswalk Warning
- Transit Pedestrian Indication
CV ENVIRONMENT – V2I Mobility Apps

- Transit Signal Priority
- Emergency Vehicle Preemption
- Freight Signal Priority
- Intent to Platoon Signal Priority
- Vehicle Data for Traffic Operations
CV ENVIRONMENT – VEHICLE CLASSES

- 2000+ Light Duty Vehicles
- Aftermarket Safety Device with HMI
- Includes City fleets
  - Public Safety (police cruisers)
  - Public Service
  - COTA supervisor vehicles
- Balance from private citizens
• Truck Platoon (~10 tractors)
  o V2V platooning (via DSRC) and other V2V apps
  o Intent-to-platoon and Freight Signal Priority
• Connected Electric Autonomous Vehicle (6)
  o Signal priority and basic safety message (BSM) broadcast
  o Signal phase and timing (SPAT) also desired for use in navigation algorithm
CV ENVIRONMENT – OTHER VEHICLE CLASSES

- COTA CMAX bus rapid transit (BRT) buses (15)
  - Transit signal priority (TSP)
  - Transit CV Applications
- COTA Fixed Transit Fleet (335)
  - Transit CV Applications
- Emergency vehicles (qty. TBD)
  - Emergency Vehicle Preempt and Emergency Vehicle Alert
  - Other V2X Apps
<table>
<thead>
<tr>
<th>Class</th>
<th>Application</th>
<th>Light-Duty Vehicle</th>
<th>Emergency Vehicle</th>
<th>Platoon Truck</th>
<th>Transit Vehicle</th>
<th>CEAV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V2V Safety</strong></td>
<td>Emergency Electronic Brake Light Warning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Emergency Vehicle Alert</td>
<td>✓</td>
<td>✓*</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Forward Collision Warning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Intersection Movement Assist</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Lane Change Warning - Blind Spot Warning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Transit Vehicle at Stop Warning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓*</td>
<td>✓*</td>
</tr>
<tr>
<td></td>
<td>Vehicle Turning in Front of a Transit Vehicle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>V2I Mobility</strong></td>
<td>Transit Signal Priority</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Emergency Vehicle Preemption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Freight Signal Priority</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vehicle Data for Traffic Operations</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Intent to Platoon Signal Priority</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>V2I Safety</strong></td>
<td>Pedestrian in Signalized Crosswalk Warning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Red Light Violation Warning</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reduced Speed School Zone</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transit Pedestrian Indication</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓*</td>
</tr>
<tr>
<td></td>
<td>Warnings about Upcoming Work Zone</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Emergency Vehicle Alert

- Warns Driver of Approaching Emergency Vehicle
- 2000+ Private Vehicles and Fleets will be equipped with this warning
- Will be activated when EV is on run (lights and/or siren)
SMART COLUMBUS CV APPS

Transit Vehicle at Stop Warning

• Warns Approaching Driver of Slowing or Merging Transit Vehicle
• 2000+ Private Vehicles and Fleets will be equipped with this warning
• Considering geo-fence and door close as event trigger
SMART COLUMBUS CV APPS

Pedestrian in Signalized Crosswalk

• Warns Transit Vehicle Driver of Pedestrian in Crosswalk

• Infrastructure-based detection at 10 Locations

• 350+ Transit Vehicles will be equipped with this warning
Transit Pedestrian Indication

- Warns Transit Vehicle Driver of Pedestrian at Bus Stop
- Infrastructure-based detection at TBD locations
- 350+ Transit Vehicles will be equipped with this warning
Intent to Platoon Signal Priority

- Signal Priority for Freight Vehicles intending to Platoon
- Six (6) intersections and 10 Heavy Trucks to be equipped
Connected Electric Automated Vehicles

- Addresses first/last mile challenges in dense, urban environment
- Extension of local transit service provided by COTA
- ADA-compliant, 10+ passenger shuttles
- Intended to operate on public roadway with mixed pedestrian / vehicle traffic
Peloton is technology vendor

Working with 2 local firms / movement types

Local drayage from RCK to L-Brands

Intrastate route between westside multi-modal terminal and destination in Byesville, OH
SMART COLUMBUS SUMMARY

- CV spans EAV, Platoon Freight, Emergency Vehicles, Transit and Light Duty
- 175 DSRC Locations
- 3000+ DSRC-equipped vehicles
- 17 CV Applications
- Six (6) CEAVs deployed to support first/last mile
- 10 Platoon Capable tractors
Thomas Timcho, PMP
Principal – C/AV Projects
Smart Columbus CV Technical Lead
614.893.7744
tom.timcho@wsp.com