Example CV Pilot Deployment Concepts:
Downtown Sunnyside

Ben McKeever (FHWA)
Downtown Sunnyside

Sunnyside’s central business district:
- Busy signalized network in Southern U.S.
- Complex, congested intersections
- Limited parking options
- Transit corridor
- High pedestrian traffic
- Poor localized “hot spot” air quality
Stakeholders Convene and Identify Key Transportation Challenges

- **Mobility**
  - Heavy congestion at peak times
  - Transit vehicles schedule reliability

- **Safety**
  - Pedestrian-vehicle conflicts
  - Crashes in unprotected left hand turns

- **Environment**
  - Emissions/Air Quality hot spots
  - Poor progression results in wasted fuel
Stakeholder Set Three Key Improvement Targets

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase transit reliability</td>
<td>Transit vehicles on schedule 90% of the time</td>
</tr>
<tr>
<td>Improve pedestrian safety</td>
<td>Reduce pedestrian-vehicle conflicts by 50%</td>
</tr>
<tr>
<td>Improve hot spot air quality</td>
<td>Reduce emissions by 20%</td>
</tr>
</tbody>
</table>
## Applications Considered for Improving Transit Reliability

### V2I Safety
- Red Light Violation Warning
- Curve Speed Gap 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)

### 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

### 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)

### 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

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

### Smart Roadside
- Wireless Inspection
- Smart Truck Parking
## Applications Considered for Improving Pedestrian Safety

<table>
<thead>
<tr>
<th>V2I Safety</th>
<th>Environment</th>
<th>Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Light Violation Warning</td>
<td>Eco-Approach and Departure at Signalized Intersections</td>
<td>Advanced Traveler Information System</td>
</tr>
<tr>
<td>Curve Speed Gap Warning</td>
<td>Eco-Traffic Signal Timing</td>
<td>Intelligent Traffic Signal System (I-SIG)</td>
</tr>
<tr>
<td>Stop Sign Gap Assist</td>
<td>Eco-Traveler Information</td>
<td>Signal Priority (transit, freight)</td>
</tr>
<tr>
<td>Spot Weather Impact Warning</td>
<td>Eco-Mobility</td>
<td>Mobile Accessible Pedestrian Signal System (PED-SIG)</td>
</tr>
<tr>
<td>Reduced Speed/Work Zone Warning</td>
<td>Eco-Ramp Metering</td>
<td>Emergency Vehicle Preemption (PREEMPT)</td>
</tr>
<tr>
<td><strong>Pedestrian in Signalized Crosswalk Warning (Transit)</strong></td>
<td>Low Emissions Zone Management</td>
<td>Dynamic Speed Harmonization (SPD-HARM)</td>
</tr>
<tr>
<td><strong>Intersection Movement Assist (IMA)</strong></td>
<td>AFV Charging / Fueling Information</td>
<td>Queue Warning (Q-WARN)</td>
</tr>
<tr>
<td>Left Turn Assist (LTA)</td>
<td>Eco-Smart Parking</td>
<td>Cooperative Adaptive Cruise Control (CACC)</td>
</tr>
<tr>
<td>Blind Spot/Lane Change Warning (BSW/LCW)</td>
<td>Dynamic Eco-Routing (light vehicle, transit, freight)</td>
<td>Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)</td>
</tr>
<tr>
<td>Do Not Pass Warning (DNPW)</td>
<td>Eco-ICM Decision Support System</td>
<td>Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)</td>
</tr>
<tr>
<td>Vehicle Turning Right in Front of Bus Warning (Transit)</td>
<td></td>
<td>Emergency Communications and Evacuation (EVAC)</td>
</tr>
<tr>
<td><strong>Road Weather</strong></td>
<td></td>
<td>Connection Protection (T-CONNECT)</td>
</tr>
<tr>
<td><strong>Motorist Advisories and Warnings (MAW)</strong></td>
<td></td>
<td>Dynamic Transit Operations (T-DISP)</td>
</tr>
<tr>
<td>Enhanced MDSS</td>
<td></td>
<td>Dynamic Ridesharing (D-RIDE)</td>
</tr>
<tr>
<td>Vehicle Data Translator (VDT)</td>
<td></td>
<td>Freight-Specific Dynamic Travel Planning and Performance</td>
</tr>
<tr>
<td>Weather Response Traffic Information (WxTINFO)</td>
<td></td>
<td>Drayage Optimization</td>
</tr>
<tr>
<td><strong>Agency Data</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probe-based Pavement Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probe-enabled Traffic Monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Classification-based Traffic Studies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV-enabled Turning Movement &amp; Intersection Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV-enabled Origin-Destination Studies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Zone Traveler Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Smart Roadside</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wireless Inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smart Truck Parking</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Applications Considered for Improving the Environment

## V2I Safety
- Red Light Violation Warning
- Curve Speed Gap 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)

## 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
  - Eco-Traveler Information
  - Eco-Ramp Metering
  - Low Emissions Zone Management
  - AFV Charging / Fueling Information
  - Eco-Smart Parking
  - Dynamic Eco-Routing (light vehicle, transit, freight)
  - Eco-ICM Decision Support System

## Mobility
- Advanced Traveler Information System (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)
- CV-enabled Turning Movement & Intersection Analysis
- CV-enabled Origin-Destination Studies
- Work Zone Traveler Information
- Dynamic Eco-Routing (light vehicle, transit, freight)
- Eco-ICM Decision Support System

## Emissions
- Connection Protection (T-CONNECT)
- Dynamic Transit Operations (T-DISP)
- Dynamic Ridesharing (D-RIDE)
- Freight-Specific Dynamic Travel Planning and Performance
- Drayage Optimization

## 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

## Smart Roadside
- Wireless Inspection
- Smart Truck Parking

---

[Image: U.S. Department of Transportation ITS Joint Program Office]
## Connected Vehicle Applications Selected in Performance-Driven Approach

<table>
<thead>
<tr>
<th>Improve Transit Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Connection Protection (T-CONNECT)</td>
</tr>
<tr>
<td>- Transit Signal Priority</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Improve Pedestrian Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Mobile Accessible Pedestrian Signal System (PED-SIG)</td>
</tr>
<tr>
<td>- Pedestrian in Signalized Crosswalk Warning</td>
</tr>
<tr>
<td>- Intersection Movement Assist (IMA)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Improve Hot Spot Air Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Eco-Approach and Departure at Signalized Intersections</td>
</tr>
<tr>
<td>- Eco-Traffic Signal Timing</td>
</tr>
</tbody>
</table>
Projected Synergies and Impacts from Transit Applications in the Deployment Concept

**Addition of Transit Apps**
- Connection Protection (T-CONNECT)
- Transit Signal Priority

**Projected Impacts:**
- Fewer missed transit connections
- Transit vehicles on schedule 90% of the time; better transit reliability
- Reduced emissions from transit vehicles
- Higher transit ridership
Projected Synergies and Impacts from Pedestrian Safety Apps in the Deployment Concept

Projecte Impact:
- 50% decrease in pedestrian-vehicle conflicts
- Improved mobility for pedestrians and vehicles
- Reduced emissions due to better traffic flow

Addition of Pedestrian Safety Apps:
- Mobile Accessible Pedestrian Signal System (PED-SIG)
- Pedestrian in Signalized Crosswalk Warning
- Intersection Movement Assist (IMA)
Projected Synergies and Impacts from Environmental Apps in the Deployment Concept

Addition of Environmental Apps

- Eco-Approach and Departure at Signalized Intersections
- Eco-Traffic Signal Timing or Intelligent Traffic Signal System (I-SIG)

Project Impacts

- 20% decrease in vehicle emissions
- Improved overall intersection throughput
- 10% reduction in vehicle delay
- Sunnyside can optimize for mobility or environment depending on need
Integrated Concept for Downtown Sunnyside

Integration of a suite of applications results in additional benefits

Messages support several applications

Information from BSM generating devices and other vehicles

Integrated data from sensors and new technologies