FHWA’s GlidePath Project
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AERIS OPERATIONAL SCENARIOS & APPLICATIONS

**ECO-SIGNAL OPERATIONS**
- Eco-Approach and Departure at Signalized Intersections (similar to SPaT)
- Eco-Traffic Signal Timing (similar to adaptive traffic signal systems)
- Eco-Traffic Signal Priority (similar to traffic signal priority)
- Connected Eco-Driving (similar to eco-driving strategies)
- Wireless Inductive/Resonance Charging

**ECO-LANES**
- Eco-Lanes Management (similar to HOV Lanes)
- Eco-Speed Harmonization (similar to variable speed limits)
- Eco-Cooperative Adaptive Cruise Control (similar to adaptive cruise control)
- Eco-Ramp Metering (similar to ramp metering)
- Connected Eco-Driving (similar to eco-driving)
- Wireless Inductive/Resonance Charging
- Eco-Traveler Information Applications (similar to ATIS)

**LOW EMISSIONS ZONES**
- Low Emissions Zone Management (similar to Low Emissions Zones)
- Connected Eco-Driving (similar to eco-driving strategies)
- Eco-Traveler Information Applications (similar to ATIS)

**ECO-TRAVELER INFORMATION**
- AFV Charging/Fueling Information (similar to navigation systems providing information on gas station locations)
- Eco-Smart Parking (similar to parking applications)
- Dynamic Eco-Routing (similar to navigation systems)
- Dynamic Eco-Transit Routing (similar to AVL routing)
- Dynamic Eco-Freight Routing (similar to AVL routing)
- Multimodal Traveler Information (similar to ATIS)
- Connected Eco-Driving (similar to eco-driving strategies)

**ECO-INTEGRATED CORRIDOR MANAGEMENT**
- Eco-ICM Decision Support System (similar to ICM)
- Eco-Signal Operations Applications
- Eco-Lanes Applications
- Low Emissions Zones Applications
- Eco-Traveler Information Applications
- Incident Management Applications
The AERIS Approach

Concept Exploration
Examine the State-of-the-Practice and explore ideas for AERIS Operational Scenarios

Development of Concepts of Operations for Operational Scenarios
Identify high-level user needs and desired capabilities for each AERIS scenario in terms that all project stakeholders can understand

Conduct Preliminary Cost Benefit Analysis
Perform a preliminary cost benefit analysis to identify high priority applications and refine/refocus research

Prototype Application (GlidePath)
Develop a prototype for one of the applications to test its efficacy and usefulness

Modeling and Analysis
Model, analyze, and evaluate candidate strategies, scenarios and applications that make sense for further development, evaluation and research
GlidePath Prototype Application

Vehicle Equipped with the Eco-Approach and Departure at Signalized Intersections Application and Automated Longitudinal Control Capabilities

V2I Communications: SPaT and GID Messages

Roadside Equipment Unit

Traffic Signal Controller with SPaT Interface

Traffic Signal Head

Source: USDOT, November 2013
Project Introduction

- **Project Background**
  - Completed AERIS Proof of Concept Testing (Fall 2012)
    - University of California at Riverside (UCR) developed and tested an Eco-Approach and Departure (EAD) Trajectory Planning Algorithm that showed up to 18% fuel savings at a signalized intersection

- **Next Phase – Automated GlidePath Prototype**
  - Scope: Develop prototype for 1 vehicle at 1 intersection
  - Period of Performance: May 2014 through November 2015
Project Objectives

- Create a working prototype GlidePath application with automated longitudinal control for demonstration and future research;

- Evaluate the performance of the algorithm and automated prototype;

- Conduct testing and demonstrations of the application at TFHRC
Previous Work – AERIS EcoDrive Application

Reduce fuel consumption by providing speed guidance near signalized intersections
Previous Work – AERIS EcoDrive

Scenario 4: Slightly Reduce Speed to Avoid Red Light
## Previous Work – AERIS EcoDrive Study Results

### Reduced Fuel Consumption

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<th>Speed (mph)</th>
<th>Average Fuel Savings (ml)</th>
<th>Sigma</th>
<th>Average % Improvement</th>
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<td>20</td>
<td>13.0</td>
<td>-</td>
<td>2.5%</td>
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<td>25</td>
<td>111.0</td>
<td>10.9</td>
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<td>35</td>
<td>73.8</td>
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<td>40</td>
<td>107</td>
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GlidePath Project Partners
System Components

- High-Level System Architecture

- Component Systems:
  - Roadside Infrastructure
    - Signal Controller, Black Box and DSRC RSU
  - Automated Vehicle
    - Existing Capabilities
    - Additional Functionality
  - Algorithm
    - Objective, Input and Output
Components – Roadside Infrastructure

- Econolite Signal Controller
- SPaT Black Box
- DSRC RSU
- Fiber Backhaul
Components – Automated Vehicle

- Ford Escape Hybrid developed by TORC with ByWire XGV System
  - Existing Capabilities
    - Full-Range Longitudinal Speed Control
    - Emergency Stop and Manual Override
  - Additional Functionality
    - DSRC OBU
    - High-Accuracy Positioning Solution
    - Driver Indicators/Information Display
    - User-Activated System Resume
    - Data Logging
Components – Algorithm

- **Objective:** Optimize environmental performance of a vehicle approaching a signalized intersection

- **Input:**
  - Vehicle Location (distance to intersection)
  - Vehicle Speed
  - Signal Phase and Timing (SPaT) and MAP Messages
  - Scenario/Environmental Thresholds:
    - Maximum speed, acceleration, deceleration, jerk, etc.

- **Output:**
  - Speed Trajectory
    - Target Speed at 1Hz
    - Target Acceleration/Deceleration transitions to minimize fuel consumption and bound “jerk” \((\text{da/dt})\) for passenger comfort
Scenario Overview

Scenario 1

Scenario 2

Scenario 3

Scenario 4

Intersection of Interest

Phase 1
Accelerating

Phase 2
Cruising

Phase 3
Decelerating

Phase 4
Idling

Phase 5
Accelerating

Analysis Boundary

DSRC Range
# Schedule Overview

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<th>Finish</th>
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<td>Fri 5/30/14</td>
<td>Fri 5/29/15</td>
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<tr>
<td>+ Algorithm Integration</td>
<td>Mon 6/16/14</td>
<td>Mon 9/29/14</td>
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<tr>
<td>+ Prototype Development</td>
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<td>Mon 6/2/14</td>
<td>Mon 3/15/15</td>
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<td>Mon 6/2/14</td>
<td>Mon 4/13/15</td>
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<tr>
<td>+ Final Report</td>
<td>Mon 2/16/15</td>
<td>Fri 12/18/15</td>
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Summary

- Upgrade previous advisory system to an automated, longitudinally-controlled prototype, targeting better system performance and environmental benefits

- Serve as the basis for a larger scale AERIS demonstration
Thank You

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