2012 DOE Vehicle Technologies Program Review Presentation

Next Generation Environmentally-Friendly Driving Feedback Systems Research and Development

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This presentation does not contain any proprietary, confidential, or otherwise restricted information
Project Overview

• **Timeline**
  – Start 10/1/2011
  – End 9/30/2014
  – 10% complete

• **Budget**
  – Total project funding
    • DOE – $1,210,235
    • Contractor – $665,472
  – Funding received in FY11
    • $0
  – Funding for FY12
    • $556,267

• **Barriers**
  – Barriers addressed
    • Public acceptance
    • Safety concern

• **Partners**
  – ESRI
  – NAVTEQ
  – Beat the Traffic
  – Earthrise Technology
  – Automatik
  – Riverside Transit Agency
  – Caltrans
  – U. of California Berkeley
Project Objective

• To design, develop, and demonstrate a next-generation driving feedback system with four advanced modules:
  – Eco-Routing module
  – Eco-Driving Feedback module
  – Eco-Score and Eco-Rank module
  – Algorithm Updating module

• Success criteria:
  – Improve fuel efficiency of the fleet of passenger cars and commercial vehicles by at least 2%
  – Comply with federal safety and emissions regulations
  – Deployable across existing vehicle fleets
# Milestones for FY12

<table>
<thead>
<tr>
<th>Month/Year</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 2011</td>
<td>Complete an upgrade of Dynamic Roadway Network (DynaNet) database with 3D digital road map and real-time traffic data feed</td>
</tr>
<tr>
<td>Jul 2012</td>
<td>Complete the design of eco-driving feedback user interfaces and algorithms</td>
</tr>
<tr>
<td>Sep 2012</td>
<td>Complete Eco-Routing Navigation module that incorporates intersection delays in route calculations</td>
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</table>
Approach – Vision

- Eco-Routing Navigation Module
- In-Vehicle Device
- Route Planning and Scheduling Module
- Algorithm Updating Module
- Eco-Score and Eco-Rank Module
- Server
- Eco-Driving Feedback Module

- Trip Start: Excessive idling. Please start driving or turn off the engine.
- En Route: Excessive acceleration episode.
- Trip End: Excessive idling. Please start driving or turn off the engine.
Approach – Eco-Routing

• Create routes and schedules for day-to-day fleet operation that are optimized for fleet average fuel consumption
• Use real-time traffic data in route calculations
• Account for intersection delays and road topology when finding optimal routes
Approach – Eco-Driving Feedback

- Simple user interfaces
- Supplement visual feedback with auditory feedback to reduce distracted driving and improve effectiveness
- Convey monetary messages in addition to fuel economy messages
Approach – Eco-Score and Eco-Rank

• Track vehicles and monitor driving behavior, vehicle performance, and fuel consumption in real-time
• Periodically assess driving behavior of drivers and provide recommendations for improvements
• Provide platform for performance comparison against oneself over time as well as against other drivers
Approach – Algorithm Updating

- Continuously update Eco-Routing algorithms based on real-world vehicle performance and fuel consumption
Approach – System Testing

- Test individual modules and the integrated system in testbed vehicle before field operational test in fleets
Technical Accomplishments

• Eco-Routing module
  – Upgraded DynaNet with 3D street map and new traffic data
  – Developing methods for estimating intersection delays from smartphone-based GPS data with 20-second interval
Estimating Intersection Delays

Example log for path segment at intersection 1

<table>
<thead>
<tr>
<th>To Node</th>
<th>Total distance Traveled (m)</th>
<th>Base Speed Limit (mph)</th>
<th>Expected Time (s)</th>
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<tr>
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<td>152.50</td>
<td>20</td>
<td>17.06</td>
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<tr>
<td>1378570</td>
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<td>End (mid link)</td>
<td>82.96</td>
<td>28</td>
<td>6.63</td>
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Estimated delay at intersection 1 = 14.30 seconds

Actual delay = 14.35 seconds
Collaborations (1)

- University of California Riverside (university)
  - Prime contractor assuming leadership role
  - Conduct system research & development
  - Lead system testing & evaluation, reporting

- ESRI (industry)
  - Provide route planning & scheduling and GIS software packages
  - Provide technical support in the integration of its software products with other system components

- NAVTEQ (industry)
  - Provide 3D digital map and real-time & historical traffic data
  - Provide technical support in the integration of its products with other system components
Collaborations (2)

• Beat the Traffic (small-business enterprise)
  – Provide GPS data from its smartphones app users
  – Develop methods to detect and model intersection delays on arterial and local roads using these GPS data

• Earthrise Technology (small-business enterprise)
  – Provide vehicle on-board diagnostics and telematics devices
  – Provide software development and technical support services related to its devices

• Automatiks (small-business enterprise)
  – Provide system development, configuration, and installation of the in-vehicle device and its wireless connectivity with the system server
Collaborations (3)

• Riverside Transit Agency (local government)
  – Allow a subset of its paratransit fleet to be equipped with the system technology
  – Provide staff support during the field operation test of the system

• California Department of Transportation (state government)
  – Allow selected passenger cars from its extensive vehicle fleet to be equipped with the system
  – Provide staff support during the field operation test of the system

• University of California Berkeley (university)
  – Provide input into the design of the system through a series of expert interviews
  – Evaluate drivers’ perception towards the system through before-and-after surveys
Proposed Future Work (FY12)

• Eco-Routing Module
  – Calibrate Energy Operational Parameter Set (EOPS) for vehicles in the test fleets
  – Integrate EOPS with route planning/scheduling software
  – Perform system module testing

• Eco-Driving Feedback Module
  – Design types, properties, and media of feedback
  – Design feedback algorithms
  – Implement Eco-Driving feedback software
  – Integrate the software with OBD firmware
  – Perform system module testing
Proposed Future Work (FY13)

• Eco-Score and Eco-Rank Module
  – Design Eco-Score and Eco-Rank calculation algorithms
  – Design module’s user interfaces
  – Implement Eco-Score and Eco-Rank module software
  – Perform system module testing

• Algorithm Updating Module
  – Design algorithm updating methodologies
  – Design module’s user interfaces
  – Implement algorithm updating module software
  – Perform system module testing

• System Integration
  – Set up system server and communication links
  – Perform full system testing
Summary

• The proposed driver feedback system are designed to improve fuel efficiency of vehicles in multiple processes of trip-making, from planning to routing to driving.

• The research team possesses strong collaborations between academic institutions, corporations, small-business enterprises, and state and local governments.

• The research team is well positioned for work planned next year.
Technical Back-Up Slides
Dynamic Roadway Network (DynaNet)

- Google Earth or Google Maps interfaces
- Real-time probe vehicle data (for freeways and surface streets)
- Real-time data from other sources
- Real-time PeMS data (for freeways)
- Historical data from travel demand or traffic simulation models
- Underlying digital roadway network with speed limit info
Energy Operational Parameter Set (EOPS)

\[
\ln(f_k) = \beta_0 + \beta_1 v_k + \beta_2 v_k^2 + \beta_3 v_k^3 + \beta_4 v_k^4 + \beta_5 g_k
\]

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