Vehicle Connectivity/Automation and Prospects for Energy

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Applications
- V2V
- V2I

Mobility
- Real-Time Data Capture
- Dynamic Mobility Apps

Environment
- AERIS
- Road Weather Apps

Harmonization of International Standards & Architecture

Human Factors

Systems Engineering

Certification

Test Environments

Deployment Scenarios

Financing & Investment Models

Operations & Governance

Institutional Issues
AERIS Research Objectives

**Vision** – Cleaner Air through Smarter Transportation

- Encourage the development and deployment of technologies and apps that support a more sustainable relationship between surface transportation and the environment through fuel use reductions and more efficient use of transportation services.

**Objectives** – Investigate whether it is possible and feasible to:

- Identify connected vehicle applications that could **provide environmental impact reduction benefits via reduced fuel use, improved vehicle efficiency, and reduced emissions.**

- **Facilitate and incentivize “green choices”** by transportation service consumers (i.e., system users, system operators, policy decision makers, etc.).

- **Identify vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-grid (V2G) data (and other) exchanges** via wireless technologies of various types.

- **Model and analyze connected vehicle applications** to estimate the potential environmental impact reduction benefits.

- **Develop a prototype for one of the applications** to test its efficacy and usefulness.
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/HOT 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 strategies)
- 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)
- Multi-Modal 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
Eco-Signal Operations

**OPERATIONAL SCENARIO DESCRIPTION**

- Uses connected vehicle technologies to **decrease fuel consumption** and decrease GHG and criteria air pollutant emissions by reducing idling, the number of stops, unnecessary accelerations and decelerations as well as improving traffic flow at signalized intersections.

**POTENTIAL BENEFITS**

- A number of traffic signal coordination projects have documented emissions savings.
  - Syracuse, New York | Emissions reductions ranging from 9 to 13%.
  - Los Angeles, California | Emissions reductions of 14% and a reduction of fuel by 13%.
- Eco-Approach and Departure at Signalized Intersections
  - Initial modeling results showed 5% to 10% fuel savings for individual vehicles with 100% penetration rate, without significantly increasing travel time. At lower penetration rates, there were still positive network benefits.

**OPERATIONAL SCENARIO VISUALIZATION**

- Source: Noblis, July 2013
Eco-Lanes

OPERATIONAL SCENARIO DESCRIPTION

• Dedicated freeway lanes – similar to HOV lanes – optimized for the environment that encourage use from vehicles operating in eco-friendly ways.
• Variable speed limits are optimized for the environment based on data collected from vehicles.
• Drivers may opt-in to eco-cooperative adaptive cruise control (ECACC) and vehicle platooning applications.
• Wireless (inductive) charging infrastructure embedded in the roadway allows electric vehicles to charge their batteries while the vehicle is moving.

POTENTIAL BENEFITS

• Variable Speed Limit (VSL) systems reduce congestion, provide more reliable journey times, reduce the frequency of accidents, reduce carbon emissions, and reduce driver stress.
• University of Texas at Austin research found that reducing speed limits on a freeway from 65 mph to 55 mph on a “Code Red Air Quality Day” resulted in a 17% reduction in NOx over a 24 hour period.
• The Safe Road Trains for the Environment (SARTRE) Project in Europe estimates that vehicle platooning has the potential to reduce CO2 emissions by 20%.

OPERATIONAL SCENARIO VISUALIZATION

Source: Noblis, July 2013
Low Emissions Zones

OPERATIONAL SCENARIO DESCRIPTION

- Geographically defined areas that seek to incentivize “green transportation choices” or restrict specific categories of high-polluting vehicles from entering the zone to improve the air quality within the geographic area.
- Incentives may be based on the vehicle’s engine emissions standard or emissions data collected directly from the vehicle using V2I communications.
- Geo-fencing the boundaries of the Low Emissions Zone allows the possibility for these areas to be responsive to specific traffic and environmental conditions (e.g., pop-up for a Code Red Air Quality Day, special event, etc.).

POTENTIAL BENEFITS

- The London Low Emissions Zone “aims to reduce traffic pollution by deterring the most polluting diesel-engine lorries, buses, coaches, minibuses, and large vans from driving within the city.”
- According to a 2006 study, concentrations of small particles from traffic sources were expected to decrease across London by 4.3 percent in 2008 and 8.0 percent in 2010 due to the Low Emissions Zone, and NOx was expected to decrease by 3.2 percent in 2008 and 4.1 percent in 2010.
Eco-Traveler Information

OPERATIONAL SCENARIO DESCRIPTION

- Enables development of new, advanced traveler information applications through integrated, multisource, multimodal data. An open data/open source approach is intended to engage researchers and the private sector to spur innovation and environmental applications, including:
  - Responsive Eco-Routing
  - Alternative Fuel Vehicle Charging/Fueling Information
  - Eco-Smart Parking
  - Multi-Modal Traveler Information (e.g., fuel use/$ saving/emissions reduction smartphone apps, car sharing information, mode choice, etc.)

POTENTIAL BENEFITS

- A study titled “Green Routing Buffalo Final Report” found that green routing could yield an average fuel consumption benefit of 16.7%.
- The benefits of multi-modal traveler information include reducing driving and VMTs due to increased carpooling, car sharing, public transportation, and planning ahead to combine trips.
- Estimates show that one person using mass transit for an entire year, instead of driving to work, can keep an average of 62.5 pounds of carbon monoxide (CO) from being emitted. This is equivalent to 28,350 grams of CO.
Eco-Integrated Corridor Management

OPERATIONAL SCENARIO DESCRIPTION

- Considers partnering among operators of various surface transportation agencies to treat travel corridors as an integrated asset, coordinating their operations simultaneously with a focus on decreasing fuel consumption, GHG emissions, and criteria air pollutant emissions.
- Includes a real-time data-fusion and decision support system that uses multisource, real-time data on arterials, freeways, and transit systems to determine which operational decisions have the greatest environmental benefit to the corridor.

POTENTIAL BENEFITS

ICM modeling for I-880 in Oakland, CA show:
- HOT lane and highway traveler information were the most effective strategies.
- Highway traveler information produced a large benefit, especially in the case of unexpected events such as a major incident.
- Transit traveler information produced less benefit than highway traveler information.
- In high demand conditions, arterial signal coordination produced a benefit-to-cost ratio that ranged from 12:1 to 20:1.
- Combining multiple ICM strategies produced a benefit-to-cost ratio that ranged from 7:1 to 25:1.