AERIS OPERATIONAL SCENARIOS & APPLICATIONS

ECO-SIGNAL OPERATIONS

P E M

- **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

P E M

- **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 strategies)*
- **Wireless Inductive/Resonance Charging**
- **Eco-Traveler Information Applications** *(similar to ATIS)*

LOW EMISSIONS ZONES

P E M

- **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

P E M

- **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

P E M

- **Eco-ICM Decision Support System** *(similar to ICM)*
- **Eco-Signal Operations Applications**
- **Eco-Lanes Applications**
- **Low Emissions Zone s Applications**
- **Eco-Traveler Information Applications**
- **Incident Management Applications**

LEGEND

P Policy Considerations
E Educational Tools
M Performance Measures

AERIS OPERATIONAL SCENARIOS

The Applications for the Environment: Real-Time Information Synthesis (AERIS) Program identified five Operational Scenarios or bundles of applications: (1) Eco-Signal Operations, (2) Eco-Lanes, (3) Low Emissions Zones, (4) Eco-Traveler Information, and (5) Eco-Integrated Corridor Management. Each Operational Scenario encompasses a set of applications which individually achieve environmental benefits. By strategically bundling these applications, the AERIS Program expects that the Operational Scenarios can achieve additional environment benefits above those of the individual applications.

Each Operational Scenario is comprised of applications, regulatory/policy tools, educational tools and performance measures. Applications are technological solutions (e.g., software, hardware, interfaces) designed to ingest, process, and disseminate data in order to address a specific strategy. For example, the eco-traffic signal priority application may collect data from vehicles, sends these data to a local processor to determine if a vehicle should be granted priority at a signalized intersection, and then communicate this priority request to a traffic signal controller.

Applications are complemented with regulatory/policy and educational tools to further support the Operational Scenario. Regulatory/policy tools are authoritative rules that govern transportation, land development, and/or environmental behavior. For example, a Low Emissions Zone would require policy to be in place for the geographic area before a low emissions zone could be commissioned. This policy may establish the guidelines or rules that would be in place governing the low emissions system.

Since many of the AERIS Operational Scenarios and applications are new ideas that the traveling public may not be familiar with, there is a need for educational tools or campaigns used for of educating transportation agencies and/or the general public on environmental benefits of the applications or Operational Scenarios. Finally, each Operational Scenario includes performance measures which are used for collecting and reporting information regarding the performance of the Operational Scenario. These performance measures include goals and objectives for reducing emissions, improving traffic flow, and improving transportation or environmental performance.

ECO-SIGNAL OPERATIONS

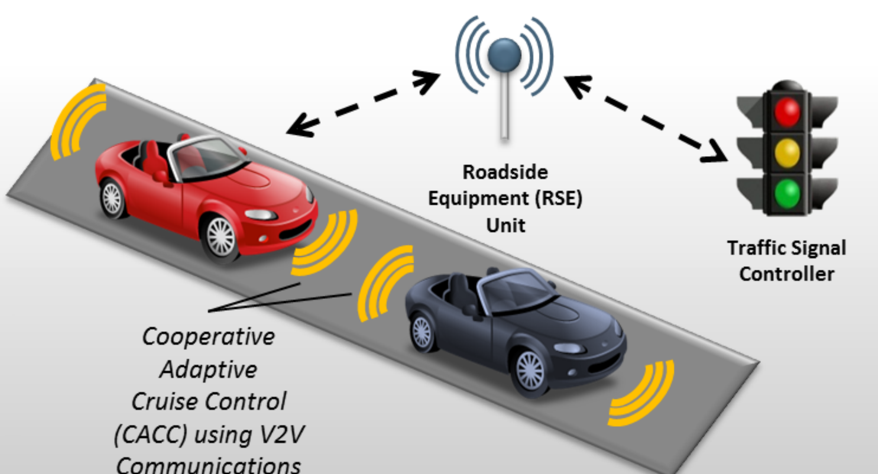
OPERATIONAL SCENARIO DESCRIPTION

- 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.
- The Operational Scenario features the following applications: (1) Eco-Approach and Departure at Signalized Intersections, (2) Eco-Traffic Signal Timing, (3) Eco-Traffic Signal Priority, (4) Wireless Inductive/Resonance Charging, and (5) Connected Eco-Driving.

POTENTIAL BENEFITS

- Eco-Approach and Departure at Signalized Intersections[1]
  - Uncoordinated: Provides 5% – 10% benefits for an uncoordinated corridor.
  - Coordinated: Provides up to 12-13% fuel reduction benefits above the baseline
    - 8% of this fuel reduction benefit is attributable to simply coordinating the signals (without the eco approach and departure application in use)
    - 4-5% attributable to the Eco approach and departure application
  - When considering CACC capabilities, it is possible to get up to 21.84% fuel use reduction.

OPERATIONAL SCENARIO VISUALIZATION



Source: Noblis, July 2013

ECO-SIGNAL OPERATIONS

The Eco-Signal Operations Operational Scenario includes the use of connected vehicle technologies to decrease fuel consumption and decrease GHGs and criteria air pollutant emissions on arterials by reducing idling, reducing the number of stops, reducing unnecessary accelerations and decelerations, and improving traffic flow at signalized intersections. As the AERIS Program defined Eco-Signal Operations, it initially envisioned four applications: (1) Eco-Traffic Signal Timing, (2) Eco-Traffic Signal Priority, (3) Eco-Approach and Departure at Signalized Intersections, and (4) Connected Eco-Driving. Subsequently, a Wireless Inductive/Resonance Charging application was added. These applications are summarized below.

- **Eco-Approach and Departure at Signalized Intersections.** This application uses wireless data communications sent from a roadside equipment (RSE) unit to connected vehicles to encourage "green" approaches to signalized intersections. The application, located in a vehicle, collects SPaT and Geographic Information Description (GID) messages using V2I communications and data from nearby vehicles using V2V communications. Upon receiving these messages, the application would perform calculations to determine the vehicle's optimal speed to pass the next traffic signal on a green light or to decelerate to a stop in the most eco-friendly manner. This information is then sent to longitudinal vehicle control capabilities in the vehicle to support partial automation. The application also considers a vehicle's acceleration as it departs from a signalized intersection and engine start-stop technologies.
- **Eco-Traffic Signal Timing**. This application is similar to current traffic signal systems; however the application's objective is to optimize the performance of traffic signals for the environment. The application collects data from vehicles, such as vehicle location, speed, and emissions data using connected vehicle technologies. It then processes these data to develop signal timing strategies focused on reducing fuel consumption and overall emissions at the intersection, along a corridor, or for a region. The application evaluates traffic and environmental parameters at each intersection in real-time and adapts so the traffic network is optimized using available green time to serve the actual traffic demands while minimizing the environmental impact.
- **Eco-Traffic Signal Priority.** This application allows either transit or freight vehicles approaching a signalized intersection to request signal priority. These applications consider the vehicle's location, speed, vehicle type (e.g., alternative fuel vehicles), and associated emissions to determine whether priority should be granted. Information collected from vehicles approaching the intersection, such as a transit vehicle's adherence to its schedule, the number of passengers on the transit vehicle, or weight of a truck may also be considered in granting priority. If priority is granted, the traffic signal would hold the green on the approach until the transit or freight vehicle clears the intersection. This application does not consider signal pre-emption, which is reserved for emergency response vehicles.

- **Connected Eco-Driving.** This application provides customized real-time driving advice to drivers so that they can adjust their driving behavior to save fuel and reduce emissions. Eco-driving advice includes recommended driving speeds, optimal acceleration, and optimal deceleration profiles based on prevailing traffic conditions, interactions with nearby vehicles, and upcoming road grades. The application also provides feedback to drivers on their driving behavior to encourage drivers to drive in a more environmentally efficient manner. Finally, the application may also include vehicle-assisted strategies where the vehicle automatically implements the eco-driving strategy (e.g., changes gears, switches power sources, or reduces its speed in an eco-friendly manner).

- **Wireless Inductive/Resonance Charging.** Wireless inductive/resonance charging includes infrastructure deployed along the roadway that uses magnetic fields to wirelessly transmit large electric currents between metal coils placed several feet apart. This infrastructure enables charging of electric vehicles including cars, trucks, and buses. Roadside charging infrastructure supports static charging capable of transferring electric power to a vehicle parked in a garage or on the street and vehicles stopped at a traffic signal or a stop sign. It also supports charging vehicles moving at highway speeds.

ECO-LANES

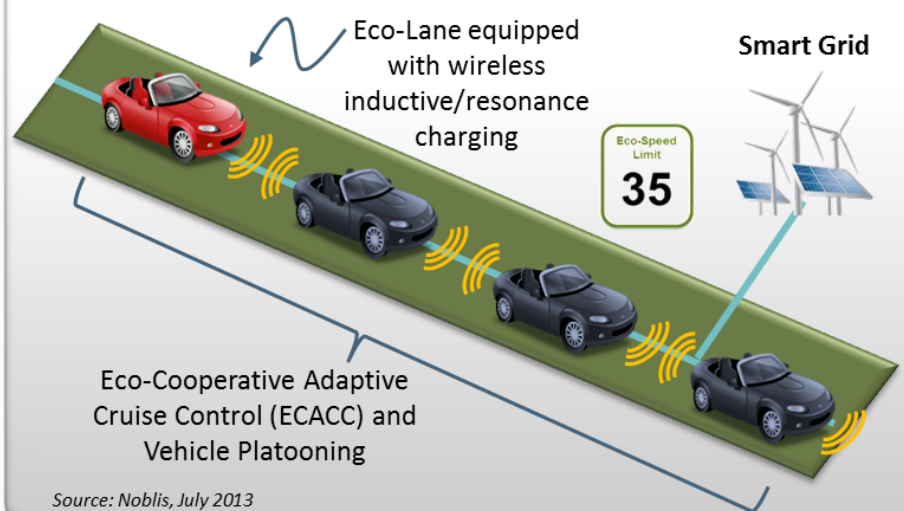
OPERATIONAL SCENARIO DESCRIPTION

- 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/Resonance 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 NO_x over a 24 hour period.[2]
- The Safe Road Trains for the Environment (SARTRE) demonstrations indicated up to a 16 percent reduction in fuel consumption for the following vehicles and up to an 8 percent reduction for the lead vehicle.[3]

OPERATIONAL SCENARIO VISUALIZATION



Source: Noblis, July 2013

ECO-LANES

The Eco-Lanes Operational Scenario includes dedicated lanes optimized for the environment, referred to as Eco-Lanes. Eco-Lanes are similar to HOV and HOT lanes; however these lanes are optimized for the environment using connected vehicle data and can be responsive to real-time traffic and environmental conditions. Eco-Lanes allow an operating entity to change the location of the eco-lanes, the duration of the eco-lanes, the number of lanes dedicated as eco-lanes, the rules for vehicles entering the eco-lanes, and other parameters. These lanes would be targeted towards low emission, high occupancy, freight, transit, and alternative fuel vehicles. Drivers would be able to opt-in to these dedicated eco-lanes to take advantage of eco-friendly applications such as eco-cooperative adaptive cruise control, connected eco-driving, and wireless inductive/resonance charging applications. Applications associated with the Eco-Lanes Operational Scenario are briefly described below.

- **Eco-Lanes Management.** This application establishes parameters and defines or geo-fences the eco-lanes boundaries. Eco-lanes parameters may include the types of vehicles allowed in the eco-lanes, emissions parameters for entering the eco-lanes, the number of lanes, and the start and end of the eco-lanes. The application also conveys pre-trip and en route traveler information about eco-lanes to travelers, including information about parameters for vehicles to enter the eco-lanes, current and predicted traffic conditions in the eco-lanes, and geographic boundaries of the eco-lanes.
- **Eco-Speed Harmonization.** This application determines eco-speed limits based on traffic conditions, weather information, and GHG and criteria pollutant information. The purpose of speed harmonization is to change speed limits on links that approach areas of traffic congestion, bottlenecks, incidents, special events, and other conditions that affect flow. Speed harmonization assists in maintaining flow, reducing unnecessary stops and starts, and maintaining consistent speeds, thus reducing fuel consumption, GHG emissions, and other emissions on the roadway. Eco-speed limits can be broadcast by roadside equipment (RSE) units and received by on-board equipment (OBE) units or displayed on VSL signs located along the roadway. This application is similar to current VSL applications, although the speed recommendations seek to minimize emissions and fuel consumption along the roadway.
- **Eco-Cooperative Adaptive Cruise Control.** The Eco-Cooperative Adaptive Cruise Control application is an extension to the adaptive cruise control (ACC) concept. Eco-Cooperative Adaptive Cruise Control includes longitudinal automated vehicle control while considering eco-driving strategies. In addition to feedback loops used in ACC, which use radar and LIDAR measurements to derive to the vehicle in front, the preceding vehicle's speed, acceleration, and location are used. These data are transmitted from the lead vehicle to the following vehicle. This application allows following vehicles to use CACC aimed at relieving a driver from manually adjusting his or her speed to maintain a constant speed and a safe time gap from the lead vehicle. The Eco-Cooperative Adaptive Cruise Control application incorporates other information, such as road grade, roadway geometry, and road weather information, to determine the most environmentally efficient trajectory for the following vehicle. In the long term, the application may also consider vehicle platooning,

where two or more vehicles travel with small gaps, reducing aerodynamic drag. Platooning relies on V2V communication that allows vehicles to accelerate or brake with minimal lag to maintain the platoon with the lead vehicle. The reduction in drag results in reduced fuel consumption, greater fuel efficiency, and less pollution for vehicles. This application is applicable to all vehicle classes.

- **Eco-Ramp Metering.** The Eco-Ramp Metering application determines the most environmentally efficient operation of traffic signals at freeway on-ramps to manage the rate of entering vehicles. This application collects traffic and environmental data to allow on-ramp merge operations that minimize overall emissions, including traffic and environmental conditions on the ramp and on the freeway upstream and downstream of the ramp. Using this information, the application determines a timing plan for the ramp meter based on current and predicted traffic and environmental conditions. The objective for this application is to produce timing plans that reduce overall emissions, including reducing emissions from bottlenecks forming on the freeway as well as emissions from vehicles on the ramp.
- **Connected Eco-Driving.** The Connected Eco-Driving application provides customized real-time driving advice to drivers, allowing them to adjust behaviors to save fuel and reduce emissions. This advice includes recommended driving speeds, optimal acceleration and deceleration profiles based on prevailing traffic conditions, and more local interactions with nearby vehicles. Finally, the application may also consider vehicle-assisted strategies, where the vehicle automatically implements the eco-driving strategy (i.e., change gears, switch power sources, or use start-stop capabilities to turn off the vehicle's engine while it is sitting in congestion).
- **Wireless Inductive/Resonance Charging.** Wireless inductive/resonance charging includes infrastructure deployed along the roadway that uses magnetic fields to wirelessly transmit large electric currents between metal coils placed several feet apart. This infrastructure enables charging of electric vehicles including cars, trucks, and buses. Roadside charging infrastructure supports charging vehicles moving at highway speeds.
- **Eco-Traveler Information Applications.** Applications included in the Eco-Traveler Information Operational Scenario apply. Eco-Traveler Information Applications provides pre-trip and en-route multimodal traveler information to encourage transportation choices with reduced environmental impacts. The application collects traffic and environmental data from connected vehicles and other sources and uses it to determine real-time or predicted traffic conditions. This information is provided to travelers so they can either plan to or adjust departure times or mode choices or select an alternate route. Another key component of this application is providing travelers with transit options to encourage mode shift, including information about transit schedules and real-time transit vehicle arrival and departure times. Traveler Information specific to Eco-Lanes may include: parameters for the Eco-Lanes, travel time or fuel savings comparison between the Eco-Lanes and general purpose lanes, incident information, availability of wireless inductive/resonance charging in the Eco-Lanes, vehicle platooning rules and parameters, transit options, and parking information. This information may be disseminated to travelers using websites, 511 systems, dynamic message signs, smart phone applications, and connected vehicle technologies.

LOW EMISSIONS ZONES

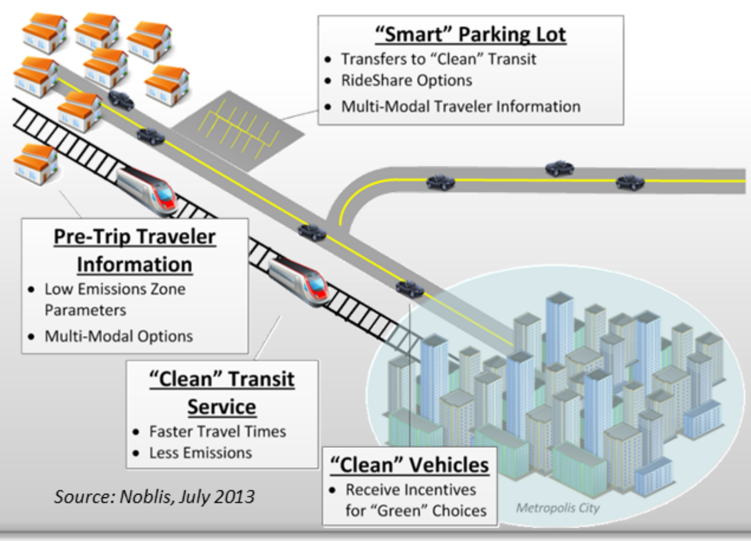
OPERATIONAL SCENARIO DESCRIPTION

- 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 NO_x was expected to decrease by 3.2 percent in 2008 and 4.1 percent in 2010.[4]

OPERATIONAL SCENARIO VISUALIZATION



Source: Noblis, July 2013

LOW EMISSIONS ZONES

The AERIS Program seeks to expand on the concept of low emissions zones by investigating the potential of connected vehicle technologies to support emissions pricing and incentives for travelers. The purpose of these zones would be to encourage decisions by travelers that help reduce transportation's negative impact on the environment. The Low Emissions Zones Operational Scenario envisions entities responsible for the operations of the transportation network to have the ability to define geographic areas that seeks to restrict or deter access by specific categories of high-polluting vehicles into the area for the purpose of improving the air quality within the geographic area. Alternatively, the Operational Scenario may incentivize traveler decisions that are determined to be environmentally friendly such as the use of alternative fuel vehicles or transit. Low emissions zones in a connected vehicle environment would be similar to existing low emissions zones; however they would leverage connected vehicle technologies allowing the systems to be more responsive to real-time traffic and environmental conditions. Connected vehicle technologies provide the ability for entities operating the transportation networks to collect more detailed information from vehicles and infrastructure and better communicate traffic information to travelers directly to in-vehicle systems or handheld devices. As the AERIS Program defined the Low Emissions Zones Operational Scenario, it initially envisioned three applications: (1) Low Emissions Zone Management, (2) Connected Eco-Driving, and (3) Eco-Traveler Information Applications. These applications are summarized below.

- **Low Emissions Zone Management.** This application supports the operation of a low emissions zone that is responsive to real-time traffic and environmental conditions. The application uses data collected from vehicles using connected vehicle technologies and from roadside equipment as input to the system. The Low Emissions Zone Management application supports the geo-fencing of a cordon that may be scalable and moveable (e.g., created for a day, removable, flexible in its boundaries) and would be less dependent on conventional ITS infrastructure. The application would establish parameters including the types of vehicles permitted to enter the zone, exemptions for transit vehicles, emissions criteria for entering the zone, fees or incentives for vehicles based on emissions data collected from the vehicle, and geographic boundaries for the low emissions zone. The application would also include electronic toll collection functions that support payments of fees or collection of incentives for registered vehicles using connected vehicle technologies.
- **Connected Eco-Driving.** This application provides customized real-time driving advice to drivers so that they can adjust their driving behavior to save fuel and reduce emissions. This advice includes recommended driving speeds, optimal acceleration, and optimal decelerations profiles based on prevailing traffic conditions and interactions with nearby vehicles. The application also provides feedback to drivers on their driving behavior to encourage them to drive in a more environmentally efficient manner. Finally, the application may also consider vehicle-assisted strategies where the vehicle automatically implements the eco-driving strategy (i.e., change gears, switch power sources, or reduce speed in an eco-friendly manner as the vehicle approaches a traffic signal).

- **Eco-Traveler Information Applications.** Applications included in the Eco-Traveler Information Operational Scenario apply. Eco-Traveler Information Applications provide pre-trip and en-route traveler information about the Low Emissions Zone. This includes information about the geographic boundaries of the low emissions zone, criteria for vehicles to enter the Low Emissions Zone, expected fees and incentives for their trip, and current and predicted traffic and environmental conditions within and adjacent to the zone. Traveler information messages may be provided to various personal devices and in-vehicle systems and used by travelers to adjust their departure time or select an alternate route. Another key component of these applications is providing travelers with transit options to encourage mode shift. This includes information about transit schedules and real-time transit vehicle arrival and departure times. Additional traveler information specific to Low Emissions Zones may include: incident information and parking information in the Low Emissions Zone or at parking lots outside of the zone that allow travelers to switch modes or carpool. This information may be disseminated to travelers using websites, 511 systems, dynamic message signs, smart phone applications, and connected vehicle technologies.

ECO-TRAVELER INFORMATION

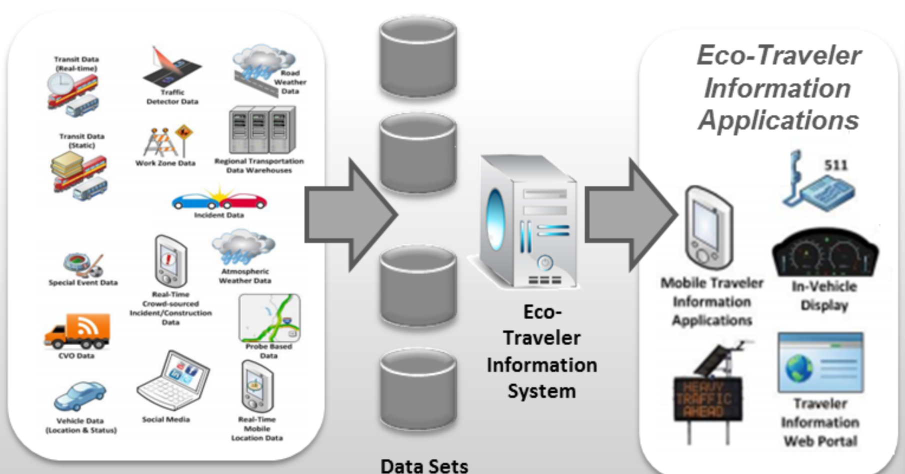
OPERATIONAL SCENARIO DESCRIPTION

- 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:
    - Dynamic Eco-Routing
    - Eco-Smart Parking
    - Alternative Fuel Vehicle Charging/Fueling Information
    - Multi-Modal Traveler Information (e.g., fuel use/$ saved/emissions reduced smartphone apps, car sharing information, mode choice, etc.)

POTENTIAL BENEFITS

- A study titled "Green Routing in Buffalo" found that green routing could yield an average fuel consumption benefit of 16.7%.[5]
- 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.[6]

OPERATIONAL SCENARIO VISUALIZATION



Source: Graphic Adapted from Concept of Operations: DCM, August 2010

ECO-TRAVELER INFORMATION

The Eco-Traveler Information Operational Scenario enables development of new, advanced traveler information applications through integrated, multisource, multimodal data. Although the AERIS Program may not directly develop specific traveler information applications, an open data/open source approach is intended to engage researchers and the private sector to spur innovation and environmental applications. This Operational Scenario includes seven applications: (1) Dynamic Eco-Routing, (2) Dynamic Eco-Transit Routing, (3) Dynamic Eco-Freight Routing, (4) Eco-Smart Parking, (5) Connected Eco-Driving, (6) Multi-Modal Traveler Information, and AFV Charging / Fueling Information. Applications associated with the Eco-Traveler Information Operational Scenario are briefly described below.

- **AFV Charging / Fueling Information.** Navigation systems equipped with knowledge of battery capacity, remaining distance, and the locations of charging/fueling stations can help minimize driver fear. The AFV Charging/Fueling Information application informs travelers with locations and the availability of AFV charging and fueling stations and inductive/resonance charging infrastructure. The application informs travelers and enables reservations. Electronic payment for fueling and charging is also included in this application.
- **Eco-Smart Parking.** The Eco-Smart Parking application provides users with real-time location, availability, type (e.g., AFV only, street, garage), and price of parking. The application reduces time required for drivers to search for a parking space, thereby reducing emissions, and also provides incentives to use AFVs. The application also supports dynamic pricing of parking based on emissions, vehicle type, and demand. Finally, this application allows travelers to reserve parking spaces.
- **Dynamic Eco-Routing.** The Dynamic Eco-Routing application determines the most eco-friendly route, in terms of minimum fuel consumption or emissions, for individual travelers. This application is similar to current navigation systems, which determine the route based on the shortest path or minimum time. This application also recommends routes that produce the fewest emissions or reduce fuel consumption based on historical, real-time, and predicted traffic and environmental data (e.g., prevailing weather conditions).
- **Dynamic Eco-Transit Routing.** The Dynamic Eco-Transit Routing application is similar to the Dynamic Eco-Routing application but is focused rather on providing guidance on the most eco-friendly route that minimizes fuel consumption and emissions for transit vehicles along their routes. This application considers both fixed transit routes and paratransit. Because transit vehicles may need to adhere to fixed routes, they may not be as flexible in altering their routes as personal vehicles. The application uses historical, real-time, and predicted traffic and environmental data collected from vehicles using connected vehicle technologies to determine the vehicle’s eco-route between its origin and destination.
- **Dynamic Eco-Freight Routing.** The Dynamic Eco-Freight Routing application is similar to the Dynamic Eco-Routing application but is focused on providing guidance on the most eco-friendly route that minimizes fuel consumption or emissions for all classes of freight vehicles. The

application uses historical, real-time, and predicted traffic and environmental data collected from vehicles using connected vehicle technologies to determine the vehicle's eco-route between its origin and destination. Information about the freight vehicle's deliveries and schedule may also be included in determining the eco-route.

- **Multi-Modal Traveler Information.** The Multi-Modal Traveler Information application provides pre-trip and en route multimodal traveler information to encourage transportation choices with reduced environmental impacts. The application collects traffic and environmental data from connected vehicles and other sources and uses it to determine real-time or predictive traffic conditions. This information is provided to travelers so that they can either plan to or dynamically adjust departure time and mode choices or select an alternate route. Traffic conditions include information about roadway speeds and travel times as well as the forecasting of traffic conditions. Travelers can use this information to adjust their departure time or to select an alternate route. Another key component of this application is to provide travelers with transit options to encourage mode shift, including information about transit schedules and real-time transit vehicle arrival and departure times.
- **Connected Eco-Driving.** The Connected Eco-Driving application provides customized real-time driving advice to drivers, allowing them to adjust behaviors to save fuel and reduce emissions. This advice includes recommended driving speeds, optimal acceleration and deceleration profiles based on prevailing traffic conditions, and local interactions with nearby vehicles. The application also provides feedback to drivers on their driving behavior to encourage them to drive in a more environmentally efficient manner. Finally, the application may also consider vehicle-assisted strategies, where the vehicle automatically implements the eco-driving strategy (i.e., change gears, switch power sources, or reduce speed in an eco-friendly manner as the vehicle approaches a traffic signal).

ECO-INTEGRATED CORRIDOR MANAGEMENT

OPERATIONAL SCENARIO DESCRIPTION

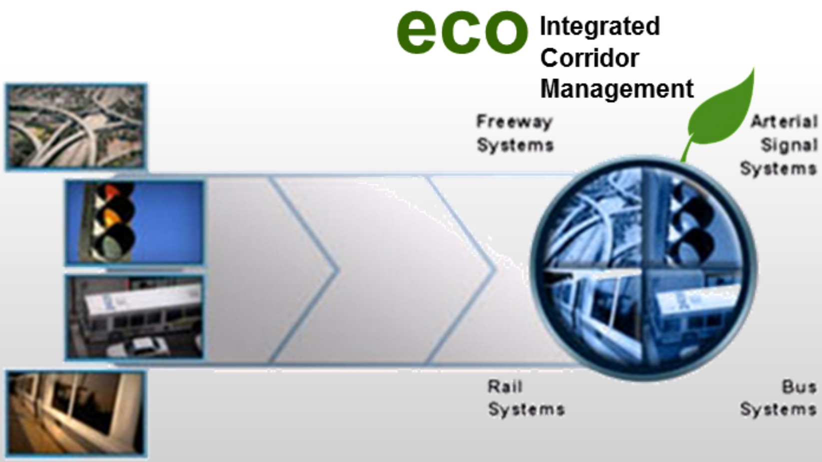
- Considers partnering among operators of various surface transportation agencies to treat travel corridors as an integrated asset, coordinating their operations simultaneously with a focus on decreasing fuel consumption, GHG emissions, and criteria air pollutant emissions.
- Includes a real-time data-fusion 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:[7]

- 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.

OPERATIONAL SCENARIO VISUALIZATION



Source: USDOT

ECO-INTEGRATED CORRIDOR MANAGEMENT

The Eco-Integrated Corridor Management (Eco-ICM) Operational Scenario includes the integrated operation of a major travel corridor to reduce transportation-related emissions on arterials and freeways. *Integrated operations* means 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. At the heart of this Operational Scenario is a real-time data-fusion and decision support system that involves using multisource, real-time V2I data on arterials, freeways, and transit systems to determine which operational decisions have the greatest environmental benefit to the corridor. This Operational Scenario includes a combination of multimodal applications that together provide an overall environmental benefit to the corridor and will be further defined after analysis of the other Operational Scenarios is completed. It is composed on applications from the other AERIS Operational Scenarios and includes an Eco-ICM Decision Support System, described below.

- **Eco-Integrated Corridor Management Decision Support System.** The Eco-Integrated Corridor Management Decision Support System application involves using historical, real-time, and predictive traffic and environmental data on arterials, freeways, and transit systems to determine operational decisions that are environmentally beneficial to the corridor. The Eco-Integrated Corridor Management (Eco-ICM) Decision Support System is a data-fusion system that collects information from various multimodal systems. Data from these systems is then used to determine operational strategies for arterials, freeways, and transit that minimize the environment impact of the corridor. For example, on a code red air quality day, the Eco-ICM Decision Support System may recommend eco-signal timing plans, eco-ramp metering strategies, eco-speed limits, and recommendations for increased transit service.

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