AERIS TRANSFORMATIVE CONCEPTS WORKSHOP BREAKOUT SESSION SUMMARY

August 16, 2011

INTRODUCTION

On July 13, 2011, the U.S. Department of Transportation (USDOT) Applications for the Environment: Real-time Information Synthesis (AERIS) program conducted a workshop to solicit input and feedback from stakeholders on its transformative concepts. The AERIS Workshop was intended to gather input on the following issues:

- ***Subjective reactions to the transformative concepts*** | Who are the supporters for each transformative concept? Who are the detractors? Why?
- ***Objective reactions to the transformative concepts*** | What are the strengths and weaknesses of each transformative concept?
- ***Next steps with respect to the transformative concepts*** | What does the AERIS Team need to do further refine the transformative concepts?

The workshop included breakout sessions to engage stakeholders in conversation about four of the six transformative concepts developed by the AERIS team. The four transformative concepts discussed were Eco-Signal Operations, Eco-Lanes, Low-Emissions Zone (LEZ), and Support Alternative Fuel Vehicle (AFV) Operations. The other two transformative concepts, Eco-Traveler Information and Eco-Integrated Corridor Management (Eco-ICM), were not discussed during the workshop break-out session. This document summarizes major themes from the breakout sessions and an online survey.

WORKSHOP PARTICIPANTS

One hundred thirty-seven (137) stakeholders participated in the AERIS Transformative Concepts Workshop. Fifty-six (56) participants attended in-person and it is estimated that 81 participated via webinar. The workshop included a diverse set of stakeholders. Figure 1 provides an overview of the participants' affiliations.

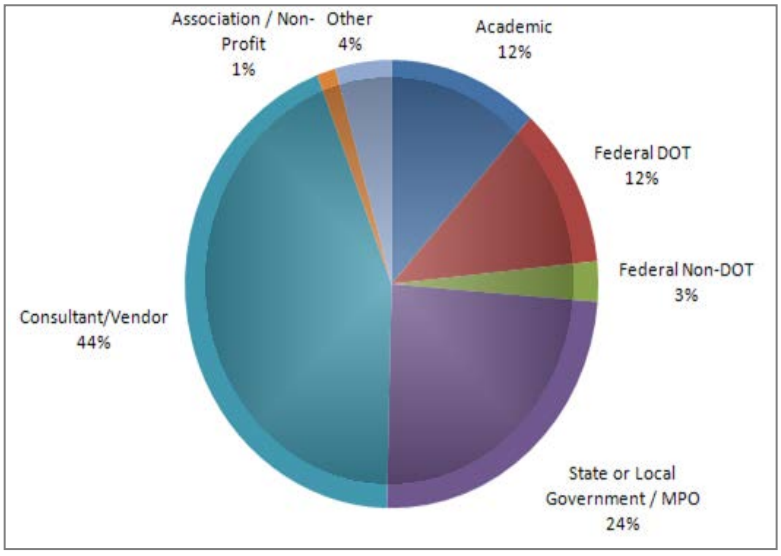

Figure 1. AERIS Transformative Concepts Workshop Participants

STAKEHOLDER COMMENTS ON CONNECTED VEHICLE RESEARCH

Connected vehicle research is both a concept and a program of services that can transform travel as we know it. Connected vehicle research combines leading edge technologies – advanced wireless communications, on-board computer processing, advanced vehicle-sensors, Global Positioning System (GPS) navigation, smart infrastructure, and others – to provide the capability for vehicles to identify threats, hazards, and delays on the roadway and to communicate this information over wireless networks to provide drivers with alerts, warnings, and real time traveler information. At its foundation is a communications network that supports two-way vehicle-to-vehicle (V2V) communications, one- and two-way vehicle-to-infrastructure (V2I) communications, and one- and two-way vehicle or infrastructure-to-device (X2D) communications to support cooperative system capability. Connected vehicle technologies enable a surface transportation system in which vehicles do not crash and roadway operators and travelers have the information they need about travel conditions to make better decisions. Connected vehicle research will establish an information backbone for the surface transportation system that will support applications to enhance safety and mobility and, ultimately, enable a crashless, information-rich surface transportation system. Connected vehicle research also support applications to enhance livable communities, environmental stewardship, and traveler convenience and choices.

AERIS Transformative Concepts Workshop stakeholders provided the following overarching comments pertaining to the USDOT's connected vehicle research and AERIS:

- Human factors, driver behavior, driver distraction, driver workload or "information overload", and the driver interface are key issues that must be studied further.
- Communications technologies beyond WiFi and Dedicated Short Range Communication (DSRC) (e.g., lidar, radar, GPS) should be considered.
- Connected vehicle data needs to be standardized. A "basic environmental message" should be defined to enable the transformative concepts.

OVERARCHING COMMENTS ON AERIS TRANSFORMATIVE CONCEPTS

Transformative concepts are integrated operational concepts that use V2V and/or V2I data and communications in innovative ways to operate surface transportation networks to reduce environmental impacts resulting from transportation-related emissions and fuel consumption. Transformative concepts are intended to change the way transportation systems operate, with an emphasis on combining applications to provide significant environmental benefits to surface transportation networks. Transformative concepts also consider regulatory/policy and educational tools.

The AERIS program has developed six transformative concepts. These concepts are depicted in Figure 2 below.

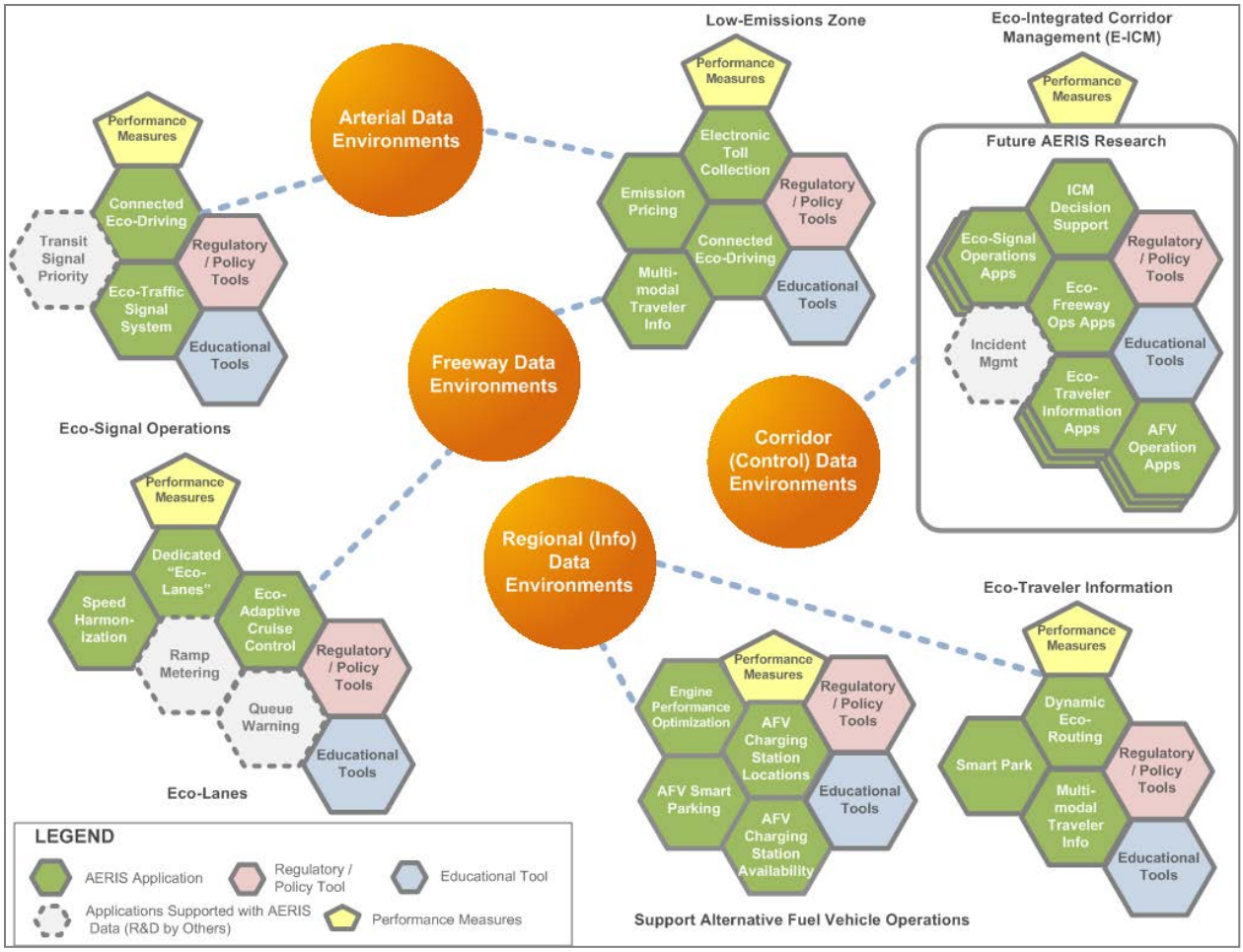

Figure 2. AERIS Transformative Concepts

AERIS Transformative Concept Workshop stakeholders provided the following overarching comments pertaining to the AERIS transformative concepts:

- There was general support for all six of the transformative concepts.
- Better sensors are needed to measure pollution and air quality.
- Some transformative concepts discuss systems management and others focus on individual optimization. What is best for the individual/driver is not necessarily best for the system. USDOT's leadership role is critical and should be geared towards optimizing the transportation system. The private sector is focused on individual optimization.
- The integration of multiple transformative concepts into one scenario will produce exponential benefits due to combined efficiencies.
    - During future outreach activities, the AERIS team may need to explain that multiple concepts are captured in the Eco-ICM transformative concept.

- Stakeholders recommended that platooning strategies be considered in a few transformative concepts.
    - During future outreach activities, the AERIS team may need to explain why platooning and automated highway applications were excluded.
- The transformative concepts do not sufficiently take into account technological changes that will occur in the next 30 years. Technology advances could render some concepts obsolete. For example, all cars will be "eco-friendly" and there will be no need for eco-lanes. Another scenario is that Electric Vehicles (EVs) will be so pervasive that the support infrastructure will be in place.

ECO-SIGNAL OPERATIONS TRANSFORMATIVE CONCEPT

> ***Eco-Signal Operations |*** *This transformative concept includes the use of Connected Vehicle technologies to decrease greenhouse gases (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.*
>
> *A foundational component of this concept utilizes Dedicated Short Range Communication (DSRC) wireless data communications among enabled vehicles and roadside infrastructure. This includes broadcasting signal phase and timing (SPaT) data to vehicles. Upon receiving this information, in-vehicle systems calculate and provide speed advice to the driver of the vehicle, allowing the driver to adapt the vehicle's speed to pass the next signal on green or to decelerate to a stop in the most eco-friendly manner. This is referred to as an eco-driving information application. Eco-driving assistance applications can also be more active, connected with vehicle systems to implement eco-driving tactics without distracting the driver. This Transformative Concept also considers eco traffic signal system applications. These applications would use real-time data collected from vehicles to optimize traffic signals for the environment. Transit Signal Priority (TSP) is also considered as part of this Transformative Concept.*

<u>General Comments</u>

General comments pertaining to the Eco-Signal Operations transformative concept are summarized below:

- There was support for the concept and stakeholders believed that it could yield significant environmental benefits, particularly for hybrid vehicles due to their ability to switch between power sources (e.g., gasoline and electric).
- It was not clear in the description that the concept included: (1) vehicles sending information to infrastructure and (2) infrastructure sending information to the vehicle.
- It was suggested that research on this concept consider multiple areas (e.g., urban, suburban, and rural) and various scenarios (e.g., free-flow traffic, saturated roadway).

- It was suggested that research on this concept consider and encourage other travel modes (e.g., freight, transit signal priority, and pedestrians).

Technical Comments

Technical comments pertaining to the Eco-Signal Operations transformative concept are summarized below:

- The concept should consider turning the vehicle's engine off while idling at a traffic signal.
- The concept should consider ramp metering.
- The concept should consider integrating information from other sources including traffic sensors, data collected from Bluetooth readers, and DSRC data collected from vehicles.
- Applications should not be limited to individual traffic signals. The entire corridor or network should be considered to determine a 'green wave'.
- Signal phase and timing (SPaT) information cannot be disseminated for actuated traffic signals. 'Flexible' traffic signal controllers are needed.
- Signal optimization may be difficult in a dynamic, connected vehicle environment if drivers are constantly changing their behavior based on data received from infrastructure.
- Regarding additional data, vehicle type should be considered since decisions may differ if the vehicle is a transit vehicle, heavy vehicle, or hybrid vehicle.
- Regarding additional data, maintenance and construction information should be considered.

Modeling Comments

Modeling comments pertaining to the Eco-Signal Operations transformative concept are summarized below:

- This concept is well suited for modeling.
- The AERIS Team should investigate the TRAffic Network StudY Tool, version 7F (TRANSYT-7F) traffic signal optimization program, which currently includes an option for optimizing to reduce emissions.

ECO-LANES TRANSFORMATIVE CONCEPT

Eco-Lanes | *This transformative concept includes dedicated eco-lanes on freeways that are optimized for the environment. Drivers would be able to opt-in to these dedicated lanes to take advantage of eco-friendly applications. Low emission, high occupancy, freight, transit, and alternative fuel vehicles would be encouraged to use these lanes. Once in the eco-lanes, drivers would be provided with recommended or variable speeds optimized for the environment. Vehicles would be encouraged to drive at these speeds to improve throughput and reduce transportation-related emissions.*

This transformative concept also considers eco-adaptive cruise control applications for the eco-lanes. These systems would automatically adjust a vehicle's speed targeted at fuel-consumption reduction. Eco-adaptive cruise control applications consider topography, roadway geometry, and vehicle interactions to determine a driving speed for a given vehicle that uses the momentum of the vehicle, when suitable, to avoid unnecessary accelerations and reduce emissions.

General Comments

General comments pertaining to the Eco-Lanes transformative concept are summarized below:

- The concept was viewed primarily for highways, but there was discussion of extending it to arterials.
- Eco-lanes can provide incentives for AFVs. Questions and comments included:
    - Is the purpose of eco-lanes to improve traffic flow for all vehicles or to serve as an incentive to increase the penetration of AFVs?
    - What is considered an efficient vehicle for eco-lanes?
    - What normalizing factor will be used: number of vehicles or passenger vehicle miles?
    - There are opportunities to add truck platooning to the Eco-Lanes concept.
    - Consider combining Eco-Lanes and AFV transformative concepts.

Technical Comments

Technical comments pertaining to the Eco-Lanes transformative concept are summarized below:

- The highest concept level would be a highway with fully automated platooning of vehicles at optimal speeds to improve fuel economy, reduce crashes, and alleviate congestion. This would provide the greatest benefits in terms of fuel savings and emissions reductions.
- Eco-Lanes could be adjusted dynamically based on traffic conditions, air quality, and other factors.

- The concept includes two different components that may need to be developed separately because they are not necessarily compatible: (1) vehicles can use Eco-Lanes if they are AFVs, low-emission vehicles, High Occupancy Vehicles (HOVs), or transit vehicles; and (2) vehicles can use Eco-Lanes if they have V2V technologies that permit the use of eco-adaptive cruise control, platooning, or other forms of automation that reduce congestion and emissions.
- Suggested performance measures for the Eco-Lane, the whole highway facility, and the broader regional corridor include: emissions (grams of carbon dioxide (CO_2) and pollutants) per vehicle mile traveled (VMT), emissions per person miles traveled (PMT) (to account for occupancy), travel times, crash rates, and vehicle operating costs.
- Freight is an important component of this concept due to the efficiencies provided, the economic value of freight movement, and environmental benefits from reduction in diesel fuel. Truck-only Eco-Lanes would enable platooning with significant reductions in the number of power units on the road, significant reductions in emissions, reduced freight costs, and improved air quality.

Policy/Regulation Comments

Comments pertaining to policy/regulation tools for the Eco-Lanes transformative concept are summarized below:

- Enforcement could be difficult because many of the criteria, such as current emissions profile, would not be readily observable to a state trooper the way occupancy is for HOV lanes. Enforcement could be handled electronically, but the connected vehicle program has been reticent about using V2V for enforcement because that may erode public support.

Educational Comments

Comments pertaining to educational tools for the Eco-Lanes transformative concept are summarized below:

- Public support for the concept could be limited if it does not deliver tangible benefits to travelers.
- Public support for the concept could be hampered by perceived privacy concerns if Eco-Lane operations require too much detailed data about the vehicle, driver, or trip.

LOW-EMISSIONS ZONE TRANSFORMATIVE CONCEPT

> ***Low-Emissions Zone |*** *This transformative concept includes a geographically defined area (i.e., cordon) which seeks to restrict or deter access by specific polluting vehicles within the zone, for the purpose of improving the air quality within the geographic area. Connected vehicle technology would be leveraged to determine fees for vehicles entering the low-emissions zone. The fee for entering the low-emissions zone would be based on the vehicle's engine emissions standard or historical emissions data collected directly from the vehicle using V2I communications.*
>
> *This transformative concept would also encourage connected eco-driving inside the low-emissions zone. Once inside the low emissions zone, if real-time data from the vehicle shows that it is being driven in a manner that reduces emissions (i.e., practicing eco-driving tactics), the driver would be given an economic reward. Transit vehicles would be able to enter the low-emissions zone without paying a fee, encouraging commuters to use public transportation.*

General Comments

General comments pertaining to the LEZ transformative concept are summarized below:

- This concept is not well defined and the goal is unclear.
    - Is the goal to reduce CO_2 emissions, pollution, impacts on people, or total emissions?
    - A moving boundary based on different factors would be difficult to implement and communicate to drivers.
    - LEZ boundaries would be different if you were to consider greenhouse gas emissions or criteria pollutions. Since there is no such thing as a CO_2 hotspot, in effect this concept only deals with ozone and particulate matter.
    - There is not necessarily a correlation between congestion and emissions, and changing traffic won't dramatically change ozone levels.
    - How would you price vehicles that originate in the zone?
- This concept would need to be managed on a regional level. Benefits in some areas might be offset by negative effects in others. System-wide impacts need to be examined to determine net benefits. Also, if air quality problems stem from another region (i.e., pollution from Ohio coming to Baltimore), an LEZ in Baltimore won't address that.
- Would the LEZ be spatial or time-based? Spatial zones just shift the problem around. Consider de-emphasizing the spatial aspect and emphasizing the time. An example given was the Spare the Air Days in the Bay Area, where the City of San Francisco offers free transit on bad air quality days.
- The concept could have lots of uses including major metropolitan areas with certain characteristics (number of red/orange alert days in a specific time period), areas with

generally bad air quality (e.g., high factory output), health zones (vulnerable populations, hospitals, schools), conservation areas and national parks, U.S. Environmental Protection Agency (EPA) non-attainment areas, areas with high pedestrian traffic (to reduce exposure to pollution), airports (e.g., LAX where they have special taxes for different types of cars), areas where you have defined entry and exit points (e.g., harbors), and areas with attractions (e.g., stadiums, amusement parks).

- This concept may have limited effectiveness and minimal benefits. A LEZ can reduce pollution by forcing people to: (1) not to take a trip (only if there is an alternative), take transit (only if it's available), or use low emission vehicles (over the long term).

Technical Comments

Technical comments pertaining to the LEZ transformative concept are summarized below:

- For dynamic LEZs, parking and transit at zone limits would have to be flexible to support mode switching. This would be difficult if the boundaries keep moving.
- Transit has to be available as an alternative for this concept to work.
- LEZ fees should be used to improve transit service rather than roads.
- Freight and passenger vehicles need to be differentiated. The former services masses while the latter services individuals, and this needs to be taken into consideration. The load splitting/unloading as shown in the storyboard does not fit into the current trucking business models.
- Impacts could be significant for freight.
    - How do you engage the freight community?
    - Freight requires delivery at a certain time, e.g., restaurants
    - Is it more cost-effective for trucks to just pay the fine and drive into the city rather than loading/unloading?

Policy/Regulation Comments

Comments pertaining to policy/regulation tools for the LEZ transformative concept are summarized below:

- Many (e.g., freight community and other stakeholders) could see this as another tax. Will the public accept this?
- Implementation of the LEZ concept is very political (e.g., congestion pricing in New York City). The policy challenges should be carefully considered. Long-term political commitment is needed.
- To gain public acceptance, criteria for declaring LEZs need to be established.
- More cooperation would be needed between DOTs and EPA to set standards. For example, if EPA says a place is a non-attainment area, then it automatically becomes a DOT issue to implement LEZs.

Modeling Comments

Modeling comments pertaining to the LEZ transformative concept are summarized below:

- Measuring benefits will be difficult. There is no good way to evaluate how reduced transportation activities improve air quality.
- Do you define emissions on a per vehicle basis (i.e., occupancy) or a passenger mile basis? How would that be extended to freight? Per ton of freight moved?

SUPPORT AFV OPERATIONS TRANSFORMATIVE CONCEPT

> ***Support AFV Operations |*** *This transformative concept supports operations of alternative fuel vehicles (AFV) — vehicles that run on a fuel other than "traditional" petroleum fuels, including vehicles whose engines do not solely use petroleum (e.g. electric cars and hybrid electric vehicles). Potential strategies include: (1) disseminating information on the locations and availability of charging/refueling stations, (2) applications targeted at engine performance optimization, and (3) smart parking systems whereby AFVs would have prioritized parking.*

General Comments

General comments pertaining to the Support AFV Operations transformative concept are summarized below:

- There was general agreement that AFV considerations should be integrated into all other transformative concepts. AFVs are a specific type of vehicle and transformative concepts are combinations of applications.
- Environmental improvements resulting from switching to AFVs from petroleum-based vehicles have not yet been determined. The nation's power grid currently relies largely on coal and other "dirty" sources. Therefore, additional research to weigh the environmental benefits associated with the charging from these power sources versus petroleum-based vehicles is needed.
- Consider broadening this concept to include high-efficiency vehicles because conventionally fueled vehicles are becoming more efficient. Consider renaming this concept *Support for Advanced Environmentally Friendly Vehicle Operations*.
- The concept might support higher market penetration of AFVs and drive more rapid environmental benefits.

Technical Comments

Technical comments pertaining to the Support AFV Operations transformative concept are summarized below:

- In addition to transmitting data to vehicles, it is important to collect data (e.g., real-time battery status) that could be useful to transportation agencies or utility companies.
- Minimum data needs include speed; time period over which data is collected; EV battery charge data; battery range information based on operating, traffic, and geographic conditions; fuel type being used for flexible fuel vehicles; real-time emissions data (from the Electronic Control Module); and locations of refueling/recharging stations.
- The concept should consider EV battery swapping/switching, as opposed to recharging at a station. This will greatly reduce the time needed to recharge an EV and possibly increase EV market penetration. The organization Better Place (www.betterplace.com) has launched Europe's first EV battery swapping/switching station in Denmark.
- There are major distinctions between the different types AFVs. EVs may need to be considered separately from other AFVs due to distinct properties/operations (e.g., battery issues, the impact of topography and traffic on battery range, and driver range anxiety).
- Due to their limited range, it might make more sense for EVs to be used in metropolitan settings, rather than for long distance travel.
- Battery technology will need to be significantly improved before EVs fully penetrate the market.
- In addition to battery improvements, infrastructure will need to be in place for AFVs to come into wide-spread use. It took decades for petroleum fueling infrastructure to be installed throughout the country. It will require the same amount of time for electric charging stations and other alternative fueling pumps to become fully integrated into the infrastructure.
- Freight should be considered as a large component of this concept due to the engine technology and the ability of trucks to switch between diesel and electric. The environmental benefits could be significant due to the pollutants emitted from diesel engines. This is an important consideration around major ports in urban locations.
- The concept should consider electrified highways.

Modeling Comments

Modeling comments pertaining to the Support AFV Operations transformative concept are summarized below:

- Modeling of this concept may help to make the business case for industry to build AFVs and their appropriate refueling/recharging infrastructure.
- Modeling for this concept should include considerations of the source of electricity used to charge EVs.

- How will the AERIS Program address increases in emissions due to the growing number of vehicles on the road from population growth? How would this be modeled?

Policy/Regulation Comments

Comments pertaining to policy/regulation tools for the Support AFV Operations transformative concept are summarized below:

- If a goal of this concept is to reduce the nations' dependence on foreign oil, energy policy needs to be addressed.

Education Comments

Comments pertaining to educational tools for the Support AFV Operations transformative concept are summarized below:

- Education on AFVs and their potential to improve the environment should be provided in primary schools to change future drivers' behavior. This model has worked for decreasing smoking and increasing recycling rates.

NEXT STEPS

Using the input and feedback from the AERIS Transformative Concepts Workshop, the AERIS program will update and further define each of the transformative concepts in a concept of operations (ConOps). These ConOps will serve as input for the down-selection and modeling phases of the AERIS program. A second AERIS Transformative Concept Workshop is tentatively scheduled for December 2011 to solicit additional stakeholder input on the transformative concepts.