AERIS: Intellidrive\textsuperscript{SM} for the Environment
Applications for the Environment: Real-Time Information Systems

\textit{Data Needs and Performance Measures}

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Special Session 14: “How Do You Measure ‘Sustainability’ – Performance Measures for transportation and Climate Change

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What is IntelliDrive™?

IntelliDrive™ is a suite of technologies and applications that use wireless communications to provide real-time connectivity:

- Among vehicles of all types
- Between vehicles and roadway infrastructure
- Among vehicles, infrastructure and wireless consumer devices
- To all system users/operators
- Applications
  - Safety
  - Mobility
  - Environment
Networked Environment

IntelliDrive\textsuperscript{SM} Networked Environment
DATA IN, ACTIONABLE INFORMATION OUT

- Vehicle Status Data
  - 65 mph...
  - brakes on...
  - two passengers...
- Weather Data
- Transaction Data
- Location Data
- Infrastructure Status Data
- E-Payment Service
- Real-Time Travel Info
- Signal Phase & Timing Adjusts
  - Real-Time Conditions
- Safety Alerts
  - and Warnings
Vehicle-Based Data: Examples

*Imagined:* Managing the system with specific information about vehicle operations.

- Speed and Heading
- Adaptive Cruise Control (ACC)
- Location and Elevation
- Traction Control
- Stability Control
- Hours of Operation
- Sun/Rain Sensor
- Windshield Wiper Setting
- Head Lights Status
- Barometric Pressure
- Ambien Air Temperature
- Antilock Braking System (ABS)
- Brake Status
AERIS: Setting Some Context

- AERIS is a **new direction** for the ITS JPO
- In the process of **educating ourselves**
- Research **scope and program is forming**
- **Depending on the ITS community** to help form and inform
- Team is **multimodal**
  - FHWA (TFHRC, HEP, HOFM)
  - NHTSA
  - FTA
  - FMCSA
  - OST
  - Seeking other modes if interested (MARAD, FRA?)
- **Today, we want your input.**
Why AERIS?

Environmental Problem
- 2.9 billion gallons of wasted fuel each year – 3 weeks worth of gas for every traveler
- Transport approx 28% of US GHG;
- Vehicles 80% of this slice of pie

Environmental Goal
- ↓Emissions ↓Greenhouse Gases ↓Particulates:
  - Enable better environmental management through connectivity
  - Enable traveler choice for eco-friendly options
What Can ITS Do?

- Many strategies available to reduce transportation’s percentage contribution to GHG
  - Vehicle improvements (zero-carbon or near-zero-carbon vehicles)
  - Fuel improvements
  - Reductions in VMT
  - Operational improvements to the system as a whole
  - Improvements in operating efficiency of individual vehicles

- ITS can contribute – *we think*
  - Need to quantify and prove

- Our job is to figure out how ITS may contribute to GHG reductions and how much, in an IntelliDriveSM-enabled future.
Background

- AERIS research scoped with extensive stakeholder input, including Departmental leadership
- AERIS Charter signed mid-March
  - Finally ready to move forward
- Now in the process of refining the roadmap, articulating exactly what we plan to do, how we plan to do it, when, and with whom
Knowledge Gaps for Environmental Data and ITS: Opportunities to Learn

- Need to look at the **existing transportation system data**, and the cutting edge of **communication and data exchange** between vehicles and between vehicles and infrastructure (and vice versa), and see if there are a handful of **applications or scenarios** that provide a **significant** environmental benefit as a consequence of employing **IntelliDriveSM**.

- We are just **beginning the effort to extensively test V2V and V2I communications and data exchange**, and looking at developing applications for safety, mobility, and environment.
  - For the environment, research is underway, but much more **needs to be understood, modeled, tested and evaluated**, especially in **real-world situations at a larger scale**.
Knowledge Gaps for Environmental Data and ITS: Opportunities to Learn (cont’d)

- Need to **leverage and expand opportunities** for public, private, and academic sector application development and research by developing new data sets and **new opportunities for data use**, focused on using **public infrastructure**.

- Opportunity to take a **multi-modal approach** to research: all types of vehicles (cars, transit, trucks, etc.) must be examined
  - This is **critical to the success** of AERIS.

- Understanding of data issues, evaluation techniques and performance measurement critical as well.
AERIS: Research Goal and Objectives

- **Ultimate “Stretch” Goal**
  - Transform environmental management of the transportation system.

- **Objectives**
  - To investigate whether it is **possible and feasible** to generate/capture **environmentally-relevant real-time transportation data** (from vehicles and the system), and use this data to create **actionable information** that can then be used by system **users and operators** to support and facilitate **“green” transportation choices for all modes**.
  - Assess whether doing these things yields a good enough environmental benefit to **justify further investment**.
**Examples** of “Green Choices” for System Users and Operators

- Eco-driving using signal phasing and timing (SPaT)?
- Integrated Corridor Management (ICM)-like system able to optimize for environmental factors?
- Work zones, incident management, special event applications?
- Parking applications?
- Transit and freight applications?
- Pricing applications?
- Others?
- “Next-Generation”? 
AERIS Research Questions

- Three overarching questions:
  - Data
    - What vehicle-based data is available, and what is its quality and validity? (All types of vehicles) *(More on this later)*
  - Information/Connectivity
    - How can vehicle-based data be used and integrated with existing transportation system operation and other data (such as road weather data, for example)?
  - Benefit
    - What cross-modal public-sector oriented applications/strategies are available, or could be available/developed, and what are their expected benefits?
How Do We Envision Success?

- Success will be measured by progress on:
  - Development and execution of an extensive foundational research program that will inform application and strategy development by both the public and private sectors.
  - Identification of the most effective and promising technological solutions that merit future research investment.
  - Evaluation of data/technology gaps
  - Use of ITS data to improve models
  - Providing fertile ground for public and private sector application development
AERIS Research Program: Six Tracks/Five Years

- **Track 1: Establish the Foundation** by comprehensively reviewing the state-of-the-practice to:
  - Determine the limits of current technology and available data sets.
  - Identify the limits and challenges of monitoring and analysis, including a review of existing models and algorithms.
  - Examine *where ITS technologies and data can be most effective* and contribute maximum value to addressing environmental impacts.
  - Use existing models to *initially explore* the effectiveness of improvement strategies.
AERIS Research Program: Six Tracks/Five Years

- **Track 2**: Identify initial candidate strategies and applications that appear to improve environmental decisions by public agencies and travelers.
  - Characterization and screening of applications/strategies
  - Assessment of the technology and data gaps
  - Initial cost-benefit analysis and “down-selection.”
Track 3: Analyze and evaluate candidate strategies and applications that make sense for further development and evaluation based on the expectations of their potential contributions.

- Identification and analysis of evaluation tools and baselining of tools for measuring and evaluating applications and scenarios
- Build a robust evaluation process
- Conduct gap analysis with respect to models and data; attempt to fill gaps
- Conduct in-depth evaluation and benefit/cost analysis
AERIS Research Program: Six Tracks/Five Years (cont’d)

**Track 4: Recommend strategies and applications**
- Based on cost/benefit analysis, but also: risks and opportunities, existence of enabling technologies, acceptance of public/stakeholders, feasibility of deployment, and **appropriateness of further DOT support**
- Development of *Research Investment Plan* in consultation with stakeholder community.
AERIS Research Program: Six Tracks/Five Years (cont’d)

- **Track 5: Develop the facts and evidence needed to inform any future policy and regulatory issues.**
  - Ideas include:
    - Exploration of the relationships between *traveler behavior* and *incentives* including *legislative/regulatory atmosphere* both within and outside the Department;
    - Monitor progress in *private sector application development*, commercialization, and markets;
    - Ongoing analysis of *carbon policies* and worldwide environmental agreements.

- **Track 6: Stakeholder Engagement and Tech Transfer**
  - Who do we engage?
  - How do we engage them?
  - How often do we engage them?
  - How do we do this effectively and creatively?
Applications for the Environment: Real-Time Information Synthesis (AERIS) High-Level Roadmap

**Program Tracks**

- **Track 1: Establish Foundation**
  - Foundational Analysis
  - CY2010
  - CY2011
  - CY2012
  - CY2013

- **Track 2: Identify Candidate Strategies**
  - Candidate Applications Evaluation
  - Q1
  - Q2
  - Q3
  - Q4

- **Track 3: Analyze & Evaluate Candidate Strategies**
  - CY2010
  - CY2011
  - CY2012
  - CY2013
  - Q1
  - Q2
  - Q3
  - Q4

- **Track 4: Recommend Strategies & Applications**
  - CY2010
  - CY2011
  - CY2012
  - CY2013

- **Track 5: Policy & Regulatory Research**
  - Initial Review
  - Policy Assessment of Applications/Strategies

- **Track 6: Stakeholder Interactions & Technology Transfer**
  - Stakeholder Engagement and Outreach Activities (Fact sheets, calls for participation (UTC involvement), workshops, etc.)

**Phase I: Foundational Analysis**
- Analyze State of Practice
- Develop Indicators, Benefits Criteria and Evaluation Framework
- Assess Data Resources and Opportunities
- Develop Operational Concept

**Phase II: Candidate Applications Evaluation**
- Initial Benefit/Cost Analysis
- Downselect Applications/Strategies
- Benefit/Cost Analysis
- Develop Recommendations

**Phase III: Research Investment Planning**
- Refine Roadmap/ConOps/PMP
- Do the applications/strategies show enough environmental benefits to warrant further investment?
- Are the stakeholders engaged?

**LEGEND**
- Decision point
- Expert Panel Meeting
- Stakeholder workshop/review
- Outreach event
- Resource from Data Capture and Management program
- Coordination with FHWA/FTA/FMCSA/NHTSA Research
- Coordination with Data Capture and Management and Dynamic Mobility Applications program

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AERIS Stakeholder Engagement and Leveraging Research: Ideas? Input?

- **New stakeholder group** for ITS JPO: opportunities and challenges too.
  - Some combination of environment experts and interest groups, IntelliDrive℠ stakeholders, academic researchers, and other parties including private sector
    - Leverage/support existing research and activities – how to best do this?
    - International interest and cooperation is also critical
- Identification of **champions**, not just stakeholders – how to do this?
- **Challenge** with some stakeholders – how to overcome?
- **Creative strategies** for identifying and educating stakeholders and researchers about AERIS?
- How do we best **identify and engage stakeholders** and **leverage research** to help accomplish AERIS research objectives and help us **answer research questions**?
- **IDEAS/ANSWER NEEDED.**
The “Don’t Knows”: Baseline Questions - A Starting Point

- Existing benefits database: **environmental benefits**
  - Relatively **few evaluations** done, but older
    - Are results from a 10-year old study still valid today?
  - Quality of evaluations?
  - Wide **range of results/benefits** (too wide??)

- **New environmental data sources** from IntelliDrive\textsuperscript{SM} – how is this a game-changer? Is it?
  - Improve ability to **refine, or redefine** what a “good” result is, narrow the benefit range – or change the result completely?

- How effective are our **environmental models**?
  - How can we make them better with IntelliDrive\textsuperscript{SM}?
The “Don’t Knows”: Overarching Evaluation Issues

- In a data-rich IntelliDrive℠ environment, what are the most state-of-the-art techniques for modeling and evaluating the performance of technologies that hope to show a definitive and worthwhile environmental benefit?
  - Some types of projects cannot be evaluated (on a large scale basis – can be modeled) here in the US (i.e., cordon pricing)
    - Differences in economics, pricing, social values make it difficult to translate results across countries, especially when the cost of fuel and taxation regimes vary so widely.
- Are there good techniques for rolling local results up to national results, and is the final product valid?
- What if regulatory atmosphere changes?
- How do modelers and evaluators account for rapid changes in socio-economic factors?
  - Do we need better tools to assess ITS and the environment under rapidly changing circumstances that can dramatically affect the green choices we do or do not make?
    - Relatively small changes in fuel costs or land use patterns can cause big changes in traveler or operator behavior
The “Don’t Knows”: Basic (or Not So Basic) Questions on Data

- What **environmentally-relevant data** can we get from cars, trucks and buses and other vehicles/modes?

- Does this **data support AERIS research** objectives?
  - If not, what do we need?
    - What are the **requirements** (granularity, frequency, type, mode, etc.)
  - Or, are the **data just not there** with the current sensor technology and post-processing ability we currently have?
  - To what extent can **post-processing improve the usefulness** of the current data set(s)?

- What types of data and how much are needed to make **improvements in current models and algorithms**? Would those improvements be significant?

- What is **the cost to capture and archive this data**, and is the benefit significant enough to warrant this expense?

- Data integration
  - How can in-vehicle data best be **integrated** with transportation system and other data (weather, etc.)

- If the industry could get its “dream data”, what would those data be?
The “Don’t Knows”: What is a “Good Result” - Performance Measurement

- When we look at possible applications, and read the literature associated with evaluations of those applications, what does it mean to have, for example, a new widget that could potentially save “300 million tons of carbon every year”.
  - Is that good? Not so good?
  - Good overall, or good for a particular application? Or particular location?
- By how much should any ITS application or scenario be able to reduce GHG to be a viable candidate for future, more in-depth testing and perhaps eventual deployment?
  - By individual vehicle, or local deployment, or nationally?
- What technologies and data are needed to differentiate, in an evaluation context, between the improvements in air quality as opposed to GHG?
  - Problem of local benefit v. global benefit.
- And the 800-lb gorilla in the room (cue music of doom):
  - Induced demand