Data Palooza

May 9th, 2013, 9:00 AM – 4:00 PM EDT
U.S. Department of Transportation Headquarters
Washington, DC

Summary of Proceedings

U.S. Department of Transportation
Federal Highway Administration

Contents

Executive Summary

The inaugural Data Palooza brought together transportation industry's data enthusiasts to discuss the current and future role of data in advancing the performance of the nation's transportation system. During the May 9, 2013 event in Washington, DC, nearly 200 in person and online participants discussed innovative technology solutions that enhanced transportation system performance, reduced congestion, and improved safety, among other benefits. These data solutions are being realized through improved public and private sector collaboration. The USDOT Data Palooza was organized into three focused tracks, with each track having an afternoon session and a morning session:

- Acquiring data,
- Processing data, and
- Using data.

The acquiring data track included presentations focused on the various alternative sources of data and real-time data collection methods available to the transportation industry. In order for the public as well as those in the transportation field to understand the performance of their transportation system, data collection must be thorough and reliable. Innovative data collection techniques such as unmanned aerial systems that gather geospatial metadata and bikeshare programs with built-in data collection technology exemplify the way in which real-time data collection is not as inaccessible or challenging as one may think. Additionally, in some cases data may already be collected within an organization, but internal barriers prevent the accessibility of the data. Breaking down these data siloes allows organizations to openly acquire data so it is not repeating or mishandling data collection efforts.

The processing data presentations focused primarily on the integration and visualization of complex data sources. The wide array of data sources available come in many formats and this is a hindrance to data mining. New data management systems are making processing data easier and allowing organizations to produce clear and concise visualizations easy for all stakeholders to understand. Innovative applications such as the use of digital 3-D visualizations and information mapping systems are expanding the perspectives on transportation for more effective decision-making for both transportation leaders and consumers.

In the using data sessions, presenters elaborated on how data can assist in streamlining project evaluation and assuring investment optimization. Breaking down agency data siloes and enhancing integration between various areas of expertise will simplify and improve the ways in which data can be used. Efforts such as FHWA's data integration project and the RAND Corporation's systematic technology reconnaissance, evaluation, and adoption method are programs that streamline data processing for effective decision-making. Other presenters

exemplified the way in which data informed the development of cost effective transportation solutions nationally and locally. Dr. Brian Chow discussed his state-of-the-art investment optimization tool that endeavors to include certainties and uncertainties in calculating the cost-benefit of future transportation scenarios.

Each of the focused tracks works to develop a seamless and holistic data acquisition, processing and use system. Innovative data collection technology combined with comprehensive data processing allows for advanced and valuable uses of data. In furthering collaboration between public and private sector stakeholders to achieve this system, moderators during the panel discussions directed the conversation around three central questions: what panelists believe the current state of the practice is and what barriers need to be addressed in order to advance the state of the practice, what barriers can the transportation data community address in the next six, twelve, and eighteen months, and what role the federal government should play in moving the state of the practice forward.

Panelists from all sessions echoed similar thoughts on the above questions. Acquiring data panelists observed that data gaps and the lack of comfort in handling the large, complicated datasets available are barriers to the industry, but continuing collaborative events such as Data Palooza is important in spreading awareness of accessible information and data collection methods. Additionally, the standardization of data should be a priority for the federal government. In doing so, standard definitions and formats will allow for easier dispersion and handling of various datasets.

The processing data track's panelists were primarily concerned with making data accessible and standardized as well. Addressing the problem of siloed and un-integrated data collection efforts is important for organizations to become more efficient and effective. Accessible data allows for faster processing and application of data. Again, some of the panelists would like to see the federal government take the lead on setting data standards. Audience members inquired about how panelists check for bad data. Some panelists flag the occasional bad incident, while others have QA/QC methods in place or archived data to benchmark the new data against. However, there seems to be room for innovation in this field of assuring correct and accurate data.

Using data panelists reiterated the need for open and free accessibility to data as well as coordination among agencies on data standards and quality. There was high emphasis on the role the federal government should play in achieving better coordination with states and other stakeholders. Some panelists mentioned that it was the federal government's role to perform proper outreach and groundwork to prepare states for any changes to minimize over-burdening state governments. Panelists recognized the importance transportation has in promoting economic growth and that good data will ensure the economical use of strained resources.

Agenda

Data Palooza was a one-day event at the US Department of Transportation (USDOT) Headquarters in Washington, DC. The morning began with Welcoming Remarks from Polly Trottenberg and Greg Nadeau, followed by the keynote address from Pete Stephanos. At 10:30 AM the morning sessions began with all three of the focused tracks, acquiring, processing, and using data, presenting in different rooms. Each session was 90 minutes long and included five to seven presentations and a 30-minute moderated question and answer session. A lunch break from 12:00- 1:00 PM allowed time for attendees to discuss the morning presentations, network, and enjoy the many exhibits set up by participants. Afternoon sessions mimicking the format of the morning sessions followed lunch from 1:00- 2:30 PM. Closing remarks took the form of a brief audience- led discussion from 2:45- 3:00 about significant topics discussed throughout the day. The exhibits remained open until 4:00 PM for attendees to visit on their way out.

Morning Sessions

Session 1a, Acquiring Data: Modal Split and Occupancy

Collecting data on vehicle occupancy levels and transportation modal distributions can be tricky. This session will highlight current use of technologies to capture this type of data.

- Wade Rosade, Capability Development Leader, Cubic Transportation Systems Inc., “Enriching Data through Integration”
- Eric Graye, AICP, PTP, Functional Planning and Policy Division, The Maryland- National Capital Park and Planning Commission, “Using Innovative Data Analysis Methods to Facilitate Communication and Transit Investment Decision Making in Montgomery County, MD”
- Shana Johnson, Senior Transportation Planner, Foursquare ITP, “Bikeshare as Transit: Strategic Expansion through Advanced Data visualization”
- David Mahfouda, CEO, Bandwagon, “High Occupancy Taxi Trips”
- Steve Mortensen, Senior ITS Engineer, Federal Transit Administration, “Data for Integrated Corridor Management (ICM) Analysis, Modeling, and Simulation (AMS), and Operations”
- Anita Vandervalk, PE, PMP, Cambridge Systematics, “Roadway Transportation Data Business Plan”

Session 1b, Processing Data: Data Mining and Algorithm Development

A showcase of examples of how data mining can improve transportation performance. This session will also explore the role of Big Data in this process.

- Brandon Nevers, Principal Engineer, Kittelson & Associates, Inc, “Integrated Transportation Modeling Data Hub”

- Yan (Jane) Jiang, Research Highway Engineer, HRDI/FHWA/DOT, “Long-term Pavement Performance Program Information Management System”
- John MacAdam, PE, ITS Engineer, Ohio Department of Transportation, “ODOT’s Use of Data for Snow and Ice Recovery Evaluation”
- Gene McHale, Team Leader, FHWA Office of Operations R&D, “Research Data Exchange”
- D.J. Swan, Sr., Pavement Management Engineer, Fugro Roadware, “Web Based Delivery of Large Data”
- Vincent Fang, Senior Economist, MacroSys, LLC, “National Highway Construction Cost Index”

Session 1c, Using Data: Life Cycle Approach to Transportation Data Systems and Tools

A panel discussion with presentations on envisioning data, data tools, and decision making as a holistic system. Panel will feature individuals who are on the forefront of data integration and decision tool development.

- Ronald Vaughn Jr., Transportation Specialist, Office of Highway Policy Information Federal Highway Administration, “FHWA Data Integration Project”
- Maria Chau, Senior Community Planner, Federal Highway Administration- New York Division, “Life Cycle Approach to Transportation Data Systems and Tools”
- Jack Sickel, Transportation Information Group Manager, Alaska Department of Transportation and Public Facilities, “Seasonal Weight Restriction Decision Process”
- Stephen Popper, Senior Economist, RAND Corporation, “STREAM: A Systematic Technology Reconnaissance, Evaluation and Adoption Methodology”
- Michael Pack, Director, University of Maryland CATTLAB, “Leveraging Existing Data Through Better Integration, Visualization, and Open Access”
- James Cheeks, Chief of Traffic Signals, Safety, Standards and ITS, District Department of Transportation, “Wireless Vehicle Detection System – Real-time Count Stations”

Afternoon Sessions

Session 2a, Acquiring Data Track: Using Supplementary/ Alternative Data Sources and Real- Time Data

A focus on the use of supplementary/alternative data sources and real time data to improve transportation reporting, decision making, and performance. Social media, surveys, mobile data etc. will be highlighted.

- Bill Toothill, Director Technical Services, DBI Services, “Advanced Mobile Asset Collection”

- Steven DiBenedetto, Senior Geoscientist and Technology Manager, “Underground Imaging Technologies, LLC, Value and Users of Subsurface and Underground Data in Transportation”
- Clark D. Richey, Jr., Technical Director, MarkLogic, “Deriving Intelligence from Multiple Disparate Data Sources”
- Greg Jordan, President, SkyComp, Inc., “Use of Wide-area Persistent Airborne Surveillance to Capture Highway Flow Metrics”
- Todd Audet, Deputy Director, Ohio Department of Transportation, District 2, “Unmanned Aerial Systems (UAS) for GIS Mapping”
- Armand Ciccorelli, Appian Strategic Advisors representing Ted Trepanier, Senior Director, Public Sector, INRIX, Inc., “Data Services for Transportation System Management and Performance Monitoring”

Session 2b, Processing Data: Visualizing Data for Decision Making

Examples of how data visualization is being used to improve transportation decision making.

- Andrew Williams, Administrator, Office of Technical Services, Ohio Department of Transportation, “Transportation Information Mapping System”
- Dan Van Gilder, Engineering Software Support Team Leader, Eastern Federal Lands Highway Division, “Federal Lands Highway Data Visualization Project”
- Rebecca Crowe, Transportation Specialist, Federal Highway Safety, “The Use of 3-D Visualization in the Road Safety Audit (RSA) Process”
- John Redmon, Principal, Redmon Group, Inc., “Features of the Redmon Digital Signage System for Commuters”
- Nathan Paczan, ITS Research Lead, The MITRE Corporation, “Visualizing Algorithms for ITS Research”
- Jonathan Corey, Graduate Assistant, University of Washington STRA Lab, “Digital Roadway Interactive Visualization and Evaluation Network (DRIVE Net) Data Processing Applications”
- Ray Mandli, President, Mandli Communications, “Mobile Data Collection”
- Evan Caldwell, Solution Engineer, Esri, “Contemporary Systems for Map Enabling Transportation Data”

Session 2c, Using Data: Investment Optimization Tools (Trade-off Analysis)

Discussion and presentations that highlight examples that use of data to optimize transportation investments to get the most value from our resources. Panelist will also look at tradeoff analysis.

- Greg Slater, Director, Office of Planning and Preliminary Engineering, Maryland State Highway Administration and Subrat Mahapatra, Transportation Engineering Manager, Office of Planning and

Preliminary Engineering, Maryland State Highway Administration, “Data Visualization to Improve Decision- Making at MDSHA”

- John Giorgis, Director, Office of Strategic Planning, Federal Transit Administration, “FTA Transit Economic Requirements Model Lite (“TERM Lite”)”
- Andrew Zalewski, Transportation Planner, FourSquare Integrated Transportation Planning, “HRT Capital Project Prioritization System”
- Tim Lomax, Senior Research Engineer and Regents Fellow, Texas A&M Transportation Institute and Shannon Crom, Director of Research, Texas Department of Transportation, “Data Driven Approach to the Development of Possible Solutions to Transportation Corridor Problems”
- Rabinder Baines, Senior Economist, Federal Highway Administration, “Highway Economic Requirements System (HERS): A Tool for Trade- Off Analysis”
- Brian Chow, Senior Physical Scientist and Professor, RAND Corporation, “A Practical Investment Optimization Tool by Means of Certainty- Uncertainty Searches”

Welcoming Remarks

Polly Trottenberg, Under Secretary of Transportation for Policy, US Department of Transportation

Greg Nadeau, Deputy Administrator, Federal Highway Administration

Keynote Address: Transportation Data Needs for Performance Management and Decision Making
Pete Stephanos, Director, Office of Pavement Technology, Federal Highway Administration

Session Recording

Highlights

In welcoming attendees, Polly Trottenberg emphasized the imminent importance of collecting and understanding transportation data. With the implementation of the Moving Ahead for Progress in the 21st Century Act (MAP-21), USDOT is relying heavily on data in developing the first nation-wide performance measures and targets effort. It is a demanding task, but with the assistance of technological innovators and data experts, like those in attendance at Data Palooza, USDOT is prepared to meet the challenge.

Greg Nadeau followed with his remarks highlighting the many positive contributions advancing transportation performance management will have on the entire United States. Not only will the public be safer and more mobile, but also it will advance the competitiveness and growth of the US economy. This effort cannot be done alone and the collaboration with stakeholders is crucial to making sure transportation innovation continues to grow. On May 8, 2013, President Obama hosted a reception recognizing the winners of the Champions of Change Program. The event honored twelve innovators, both of public and private sector backgrounds, who demonstrated leadership in developing and implementing creative transportation solutions. A few of the honorees presented or hosted displays at Data Palooza.

Pete Stephanos, a leader in the Federal Highway Administration's (FHWA) Transportation Performance Management effort, gave the keynote address. In it he reiterated the importance of data in the performance management effort. Everyone makes decisions using the information available to us and that should not be any different in the government. Objective, metric-based decisions will eventually replace the choices based on intuitive information.

While it is natural that wrong decisions will occasionally be made, it is important to learn from these mistakes. By learning from past faults, smarter and more informed decisions will be made. The tracks at Data Palooza were selected to promote best practices and new innovation available to the transportation industry. These topics exemplified the way in which states and stakeholders should be applying their data. In the acquiring data track, the industry must remember the importance of credible, reliable, and accessible data. Then while processing data, it should be simple, integrated, and in real-time. Finally, the using data track highlighted accountable, predictive, and visual models that extract the most relevant and applicable information.

Acquiring Data Track

To improve the performance of the transportation system, USDOT and their partners must find better ways to collect various kinds of data. The acquiring data track focused on spreading awareness of data collection best practices under development or currently being used in the field. The collection of real-time data is necessary for a realistic understanding of how the transportation system is performing. Consumers as well as transportation professionals rely on real-time and reliable data collection for informed and speedy decision- making. Not only is real-time data becoming easier to obtain, but also the use of alternative data sources is becoming less complex with better technology.

Session 1a examined the question of how to collect difficult data elements such as vehicle occupancy levels and the new technology working to solve those issues. With more people using transportation infrastructure, it is becoming increasingly important to measure certain pieces of data that are hard to collect. Through surveys and greater use of intelligent transportation systems (ITS) technologies, public and private sector leaders have implemented pilot projects measuring the flow and density of different transportation modes. The Capital Bikeshare program uses advanced data visualization techniques to understand the movement of their bicycles. The Federal Transit Administration is piloting a new model and analysis tool that monitors corridors as a system rather than individual assets through innovative information technologies.

Session 2a explored alternative data sources that are improving transportation reporting and decision-making. Although these data sources are unconventional, they are still credible and reliable. Presenters discussed the use of airborne technologies that collected geospatial data as well as the use of radar to collect information on mobile assets and pavement condition. Through advanced technology, data collection methods are becoming less laborious and more dependable. Innovative solutions, like INRIX's Transportation Intelligence Platform collect various real-time data to reduce congestion and understand other traffic issues, are making transportation systems better for all users.

The question and answer portions of the two sessions saw most panelists agreeing that accessibility and standardization of data as two important issues that must be addressed moving forward. While moderators steered the conversation around the three broad questions examining the future of the field and the federal government's role, audience members sought more specific questions from panelists.

Session 1a: Modal Split and Occupancy Data

Moderator: Josh Witson

Enriching Data through Integration
Wade Rosade, Capability Development Leader, Cubic Transportation Systems Inc.

Using Innovative Data Analysis Methods to Facilitate Communication and Transit Investment Decision Making in Montgomery County, MD
Eric Graye, AICP, PTP, Functional Planning and Policy Division, The Maryland- National Capital Park and Planning Commission

Bikeshare as Transit: Strategic Expansion through Advanced Data Visualization
Shana Johnson, Senior Transportation Planner, Foursquare ITP

High Occupancy Taxi Trips
David Mahfouda, CEO, Bandwagon

Data for Integrated Corridor Management (ICM) Analysis, Modeling, and Simulation (AMS), and Operations
Steve Mortensen, Senior ITS Engineer, Federal Transit Administration

Roadway Transportation Data Business Plan
Anita Vandervalk, PE, PMP, Cambridge Systematics

Session Recording

Session 1a: Modal Split and Occupancy Data

Enriching Data through Integration
Wade Rosade, Capability Development Leader, Cubic Transportation Systems Inc.

- There are more people trying to use transportation infrastructure and straining resources
- Started a strategic agenda called Next City that is aimed at solving that problem
  - Share data with users of infrastructure to travel more wisely
  - Integrate various data sources to contribute to better predictive models and outcomes
- Completed an R&D project recently using these theories
  - GTFS data combined with bare collection data to explain passenger travel as density map
  - Added flow concept to view how people flowing through major transport hubs

Using Innovative Data Analysis Methods to Facilitate Communication and Transit Investment Decision Making in Montgomery County, MD
Eric Graye, AICP, PTP, Functional Planning and Policy Division, The Maryland- National Capital Park and Planning Commission

- Rapidly urbanizing county challenging decision making for the transportation system
- Transportation Policy Area Review (TPAR)
  - Evaluate transportation adequacy of roadways and transit performance independently
  - Categorized by urban, suburban, and rural
- Found inadequacies with peak headway, coverage, and span of service
  - Increase service frequency, expand bus routes within Policy Area

Bikeshare as Transit: Strategic Expansion through Advanced Data Visualization
Shana Johnson, Senior Transportation Planner, Foursquare ITP

- Develop six year strategic growth plan for Capital Bikeshare
  - Project capital and operating costs to understand funding needs and sources
- Bikeshare already record detailed user data through the system's operator
  - Recover operating costs easily
  - User survey and online comment forum to gain qualitative data

High Occupancy Taxi Trips
David Mahfouda, CEO, Bandwagon

- Taxi and car sharing service to and from airports as form of public transit

- Case study: lack of efficient intermodal transportation to LaGuardia airport
  - Destination density data
  - Fare analysis
- Solutions
  - Make sharing faster- improved communications
  - Remind users of cost savings

Data for Integrated Corridor Management (ICM) Analysis, Modeling, and Simulation (AMS), and Operations
Steve Mortensen, Senior ITS Engineer, Federal Transit Administration

- Management of the corridor as a system rather than individual assets
- Set of procedures, processes, and information systems to decide optimal performance of transportation networks in a corridor using ITS technologies
  - 8 pioneer sites, 2 selected to demonstrate (San Diego and Dallas)
  - Arterial performance measures
  - Transit performance measures
  - Associated Corridor Performance Measures
- Currently undergoing evaluation analysis

Roadway Transportation Data Business Plan
Anita Vandervalk, PE, PMP, Cambridge Systematics

- U.S. DOT's Office of Operations wanted to identify data needs and gaps in the operations and coordination of DCM programs
  - Definition inconsistencies
  - Redundancies in collection efforts
  - Varying standards prolonging processing time
  - Duplication of studies wasting resources
- Recommendations
  - Foster coordination and communication across US DOT through
  - Best practices for data services and knowledge management
- Integration test pilots
  - Applicability of Connected Vehicle Data for National Performance Monitoring
  - Reconciliation of various Speed Data sources

Session 1a: Modal Split and Occupancy Data Q&A Summary

The question and answer portion saw most panelists agree that data gaps and the ability to present data in a visually stimulating way as challenges in the field. While some panelists thought the standardization of data was an important goal for the federal government, it was also mentioned that coordination with the private sector would assist in the development and promulgation of standards. Audience members were concerned with privacy issues surrounding open data as well as challenges in collecting valid survey data. Unfortunately, the panelists did not have solutions in those areas.

- **Moderator:** Name the barrier to the business and art of data collection that bugs you the most.
  - **Steve Mortensen:** In my presentation we identified some data gaps, but we are beginning to address that. You ultimately need the information to know what is going on in your network and it is difficult to implement these strategies if you do not have the data. The data is not being collected. We have encountered operational challenges.
  - **Eric Graye:** Being able to convey the information in a visual format that is most accepted by decision makers.
  - **Wade Rosade:** I would second that. Presenting data so that it is appropriately interpreted and comprehending is a significant challenge.
  - **David Mahfouda:** The "no data" problems come to mind, but a problem I have encountered is regulatory issues. The ability for multiple passengers to pay with different credit cards is an issue for us.
  - **Anita Vandervalk:** Overcoming data siloes.
  - **Shana Johnson:** More specific to capital bikeshare, something that we would have liked to have is point to point data tracking the bicycle between the originating and end station.

- **Moderator:** In the immediate term, in the next six months, or maybe in the next year, what are you excited about that is coming online?
  - **Steve Mortensen:** With respect to our two demonstration sites, Dallas never had a 511 system so they are rolling that out. We have really been pushing them to provide comparable travel times in one concise format and even dynamic message signs and both have had difficulty trying to present that information. All the data we are collecting is going to be available on an XML feed to the public, so third party providers can take that information and develop innovative applications. So that is something exciting that we do not know what will come out of it.

  - **Eric Graye:** Something that certainly offers potential that I mentioned is the use of AVL data provided by the local bus operators. That is something that offers potential next steps in refining what we do.
  - **Wade Rosade:** The movement toward mobile payment is exciting as it offers additional sources of data that can be used to better manage demand.
  - **David Mahfouda:** A few things that I am looking forward to are explicit multi-modal way-finding between taxis and transit, servicing single taxi and van trips with multiple people, and raising the efficiency.
  - **Anita Vandervalk:** Getting a handle on all of the data and finally starting to archive data to model short-term impacts of traffic on transportation management practices.
  - **Shana Johnson:** For Capital Bikeshare in particular, DDOT has a dashboard where a lot of the data can be studied and downloaded and real-time information on these websites.

- **Moderator:** What do you need the government to do or not do?
  - **Eric Graye:** This is a great event, the continuation of Data Palooza is something that I would look forward to in terms of getting insight on what others are doing and to inform them of what I am doing.
  - **Wade Rosade:** I am learning more about the already existing datasets that are available and there is value in those existing data sources that offers a lot of potential.
  - **David:** More standardization for interfaces.
  - **Anita Vandervalk:** Standardization, but also looking toward the private sector for a coordinated approach. The development of standards is important.
  - **Shana Johnson:** Funding for performance measurement, especially at the local level. There is a lot of uncoordinated data that is a big effort to go through and maintain and that requires money.
  - **Steve Mortensen:** Agencies are asking for knowledge transfer, we provide some guidance documents to help agencies to implement ICM. A lot of aspects such as predictive modeling are brand new and providing information on how to move that forward would be helpful.

- **Question:** What role does stored data play when everyone wants real-time information to make decisions?
  - **Wade Rosade:** Historical data is used to establish tolerances for any kind of real-time system that monitor performance and determine any kind of deviations from the expected performance and to realize when you are out of the tolerance band. So historical data definitely plays a strong role in training any kind of predictive analytic tool that would be employed by any real-time decision support system.
  - **Anita Vandervalk:** In the same way that we need standards, we need the same kind of standard with archiving data to be able to look backwards and compare data.

- **Question:** How far away are we from being able to measure modal split and the number of travelers travelling through the system?
    - **Steve Mortensen:** That is exactly what we are doing through ICM. We have done that as modeling and will be doing that as part of the demonstration independent evaluations. A lot of the data is going to be collected automatically, we are looking at thru-put not only as a corridor as a whole, vehicles, passengers but also individual networks. We have a traveler behavior survey to see how they used the travel information.
    - **Wade Rosade:** We did demonstrate that was a feasible outcome with our passenger density pilot project. It varies between systems.
    - **Anita Vandervalk:** We are close too with personal communication devices but we have to be comfortable with people probe projects as a privacy issue.

- **Question:** How are privacy concerns constraining all this data movement?
    - **David Mahfouda:** In the private sector is seems to be almost a non-issue. It seems that passengers using services are very willing to give up their information as to why they are using services and who they are. That is very valuable to companies in terms of how that data gets shared, but public sector that remains a question.
    - **Anita Vandervalk:** To get a handle on freight movement. It is moving, but I cannot say we have a solution, it continues to be a barrier.

- **Question:** For the presenters that presented survey data, what are the challenges and solutions to valid response rates from survey data?
    - **Shana Johnson:** The survey I discussed was of annual members of Capital Bikeshare, so short-term users were not covered in that survey.

Acquiring Data Track

Session 2a: Using Supplementary/ Alternative Data Sources and Real-Time Data

Moderator: Ed Strocko

Advanced Mobile Asset Collection
Bill Toothill, Director Technical Services, DBI Services

Value and Users of Subsurface and Underground Data in Transportation
Steven DiBenedetto, Senior Geoscientist and Technology Manager, Underground Imaging Technologies, LLC

Deriving Intelligence from Multiple Disparate Data Sources
Clark D. Richey, Jr., Technical Director, MarkLogic

Use of Wide-area Persistent Airborne Surveillance to Capture Highway Flow Metrics
Greg Jordan, President, SkyComp, Inc.

Unmanned Aerial Systems (UAS) for GIS Mapping
Todd Audet, Deputy Director, Ohio Department of Transportation, District 2

Data Services for Transportation System Management and Performance Monitoring
Armand Ciccorelli, Appian Strategic Advisors representing Ted Trepanier, Senior Director, Public Sector, INRIX, Inc

Session Recording

Session 2a: Using Supplementary/ Alternative Data Sources and Real-Time Data

Advanced Mobile Asset Collection
Bill Toothill, Director Technical Services, DBI Services

- Requirements of a traffic sign based on MUTCD changes in 2012
  - Visible to driver with retro reflectivity
- Created vehicle using technologies to measure the retro reflectivity of all the surrounding signage
  - Retro reflectivity = luminance/ illuminance
  - High sensitivity cameras from astronomy field
  - Regulated LED lighting system

Value and Users of Subsurface and Underground Data in Transportation
Steven DiBenedetto, Senior Geoscientist and Technology Manager, Underground Imaging Technologies, LLC

- Help you see what cannot be seen
  - Condition assessment of assets
  - Inform project prioritization process and decision making
  - Reduce risk, increase safety, improve quality, accelerate project delivery
- Applications
  - Bridges
  - Pavements
  - Tunnels
  - Railroad
  - Airport runways
- What can be measures and mapped?
  - Deterioration
  - Voids
  - De-bonding
  - Delamination
  - Moisture pockets
  - Pavement thickness
  - Soils and geology
  - Utility location and depth

Deriving Intelligence from Multiple Disparate Data Sources
Clark D. Richey, Jr., Technical Director, MarkLogic

- MarkLogic is a database that can address transportation data problems
  - Rapid accommodation of new data structures

  - Real-time monitoring for powerful search and quick decision making
- FAA used MarkLogic
  - Made sense of unstructured content
  - Identify and generate metadata
  - Pilot built in less than two weeks
  - Geospatial aspect, integration with Google Earth

Use of Wide-area Persistent Airborne Surveillance to Capture Highway Flow Metrics
Greg Jordan, President, SkyComp, Inc.

- One helicopter 1-mile in the sky stationary for 90 to 120 minutes
  - Single high-resolution camera, taking photos every second
  - Trace certain vehicles and understand traffic flow in coverage area
- Applications
  - Calibrate complex micro-simulation models
  - Understand big data sources by analyzing test areas
  - Answer public questions or concerns
  - Obtain vehicle trajectories
  - Compelling visualizations

Unmanned Aerial Systems (UAS) for GIS Mapping
Todd Audet, Deputy Director, Ohio Department of Transportation, District 2

- Northwester Ohio has a lot of assets to inventory
  - Aerial mapping for roadway surveys, roadway construction support, roadway condition assessment, and incident management
  - Mass amounts of real time data
- Small device with artificial intelligence
  - 1.7 pounds, inexpensive, easy to fly
- Partnering with Ohio National Guard, Department of Natural Resources, Agriculture and others to apply UAS for other needs
  - Every day with good weather, putting UAS in the air
  - Coordination with FAA

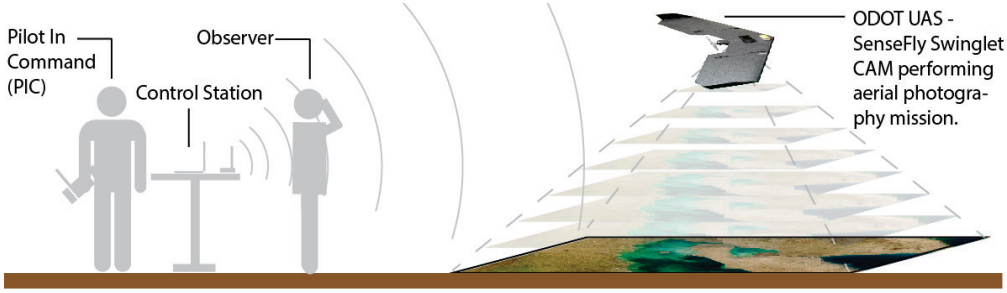


Figure 1. UAS

Data Services for Transportation System Management and Performance Monitoring
Armand Ciccorelli, Appian Strategic Advisors representing Ted Trepanier, Senior Director, Public Sector, INRIX, Inc

- INRIX uses probes to reduce traffic congestion by delivering real time traffic data and analysis
    - Live across 30 countries
- INRIX Traffic Intelligence Platform
    - Massive input data: incident, weather, road sensors, consumer vehicle GPS, mobile, parking, fleet, historical traffic
    - INTRIX processes: Real time, predictive, historical, crowd tech, cloud based
    - Produces optimized solutions that are ubiquitous, accurate and actionable
        - Real time data, historical data, short-term predictive data, and analytics
- Several free services for public agencies
    - INRIX Traffic App

Session 2a: Using Supplementary/ Alternative Data Sources and Real-Time Data
Q&A Summary

The Session 2a panelists' highlighted the problems with data credibility and usage during their question and answer portion. There was general agreement that data acquisition techniques are improving, however the usage of data seems to be behind. This brought up the issue of assuring credible data is going into models and that expertise must grow in the learning how to handle big datasets. Perhaps greater integration of data management in higher education will allow USDOT to take advantage of alternative human resources. It was then mentioned that the lack of knowledge and use of advanced technology in transportation may be a public sector issue with the lack of competition and difficulty in consensus-building. Standardization was again revealed to be an issue. One panelist offered the solution of a national dataset available to everyone with set data formatting.

- **Question:** Armand and Greg, interstate is so fast, but TMC coding is not fast. It is messy and riddled with mistakes. They still do not have the IDC in there for Maryland even though it has been open for a couple years now. Is that a barrier that you are dependent on this slowly evolved coding?
    - **Armand:** I am not an expert in TMC coding, but that said that is a standard that is impacting the whole industry. It is impacting not just INRIX, but its competitors. Do you have any thoughts as to what needs to be or could be done to make these adjustments?
    - **Audience:** Is there a need for another standard that is more open and non-proprietary. It is proprietary and expensive.
    - **Greg:** They are trying to create another standard.
    - **Moderator:** We have played around with a crude, rudimentary cut based on my own code not TMC.

- **Question:** Greg, how far are we away from getting traces from all the vehicles in the video with machine vision rather than human tracing?
    - **Greg:** At the moment, in order for a machine to do it you need to get your frame rate up to 5 or 10 frames per second. I have vendors who say they can do it at 97 percent accuracy, but it is not good enough because we cannot afford to jump vehicles. Humans understand when a car goes under a shadow or makes a turn. We need an acceptable accuracy level.

- **Question:** Todd, can you talk a little bit more about what kinds of data are collected?

  - **Todd:** Our system flies 200 to 400 feet above the ground level. It is the same type of information collected from a 10,000 foot manned- systems, but its field of view is much tighter. The imagery is so sharp and the survey markers can get within one centimeter of accuracy.

- **Moderator:** What is the biggest hurdle to take the next step in acquiring data?
  - **Armand:** The data is becoming more readily available and the quality is increasing, but finding ways to use it and to increase usage. Not everyone is comfortable with big data and we need a wider range of people to start making use of these things. People need to get more comfortable to get their hands into this data and better decision quality information.
  - **Greg:** Any model out there is only as good as the data that goes into it. I think general uniformity of becoming sophisticated tonight to use the models at the right time and the right place with the right backups so you do have credibility.

- **Moderator:** The big data, the comfort, and accuracy—the whole process from the public side on how we need to think about it—you have to have that confidence and good data and decision-level data. How do we get our heads around a different paradigm or is there a different framework we need to think about with all these different applications?
  - **Clark:** There are a lot of changes happening right now. Traditionally government has been about structure and order and maintaining that certain structure, even with data because we use the data to drive the government processes. The biggest hurdle are the people, the technology for the things we are trying to do is out there. If you look commercially, they started using it for years because there are economic pressures. Nobody is competing against USDOT, so we have the ability to remain more fixed and push back on change. The useful data out there is really important and even though we are not comfortable with it, there are very similar problems that they are solving in a slightly different framework.
  - **Audience:** I do not think we have the kind of expertise to analyze this data, particularly mathematics. If there was a concerted effort to introduce the methods and orient professionals with these new information sources and tools.

- **Moderator:** Todd, what was your experience like with your staff bringing in the new datasets and integrating the new data sources and teaching them how to use it in Ohio?
  - **Todd:** This information we have been gathering is the same for the past seventy years, but public perception of un-manned aviation is not favorable. Whether it is a matter of public policy implemented by private industry or government. We are

trying to find the interface so we can transfer our data collecting systems and information to private sector. The biggest problem right now is socializing this concept and making the public not fear the data that is being collected.

- **Clark:** It is a lot of data and the math is hard, if you look at universities they have a new field called data scientists to deal with that. There are not nearly enough people in that field and the few that are around are very expensive, so how do we fill that gap? There is too much data and they must be told what to look at to pivot and pick up patterns in data.
- **Steve:** It has been a concern; I think the ultimate goal is a national dataset available for everyone. Some of what we wrangled with 15 years ago was standardization. How do we get that all into one platform, one access point for the user? We are missing that. All the disparate data makes it challenging for the users
- **Clark:** I am going to take a different point of view. The problem with standards is that we all have to agree. On a small scale standards are great, but it takes a long time to get people to agree, especially in government. Traditionally, you could not do anything with different data formats, but there is technology available now that makes them compatible. You can bring in human intelligence to logically standardize it.
- **Steve:** I think you are right that there is technology, but there is one missing element and that is metadata. The quality of your analysis is junk if you have different accuracies of data so standardization from that perspective is a huge issue.

Processing Data Track

As Pete Stephanos outlined in his keynote speech, processing data needs to be simple, integrated, and in real-time. The processing data track stressed the importance of those concepts and introduced to attendees new techniques to process data efficiently and effectively. While data mining in big data is not an easy task, however the use of new technology has improved this process to improve transportation performance. Additionally, innovative data visualization practices are currently improving the way in which data is presented for successful transportation decision-making.

Session 1b showcased examples of new data mining tools that are helping achieve the goal of integrated and simple datasets. Both private and public sector entities are working towards better processing of big data. Kittelson & Associates developed an Analysis and Modeling Data Hub to integrate and unify the many datasets that feed transportation performance. In a similar, but less broad effort, FHWA began a program called the Long-term Pavement Performance Program that investigates various types of pavement designs using comprehensive data sources. The goal of this project is to create a central database with consistent and credible data that informs the development of pavement performance measures. Creating a seamless and replicable data integration process of numerous and large datasets is challenging, but the presentations at Session 1b showed the technology now available for transportation professionals to operate.

Session 2b presenters addressed the very pertinent issue of data visualization. The end result of processed data is for it to be useful. New opportunities in data visualization allow for new perspectives on transportation issues and more informed decision-making. Ohio Department of Transportation (ODOT) developed a simple, yet powerful GIS tool called the Transportation Information Mapping System (TIMS). TIMS is displayed on their public website for external as well as internal use. Users can interact with various types of mapping layers in addition to communicating with ODOT staff. All the presentations displayed exceptionally innovative ways to visualize data in all arenas of transportation. Ranging from 3-D visualization of the Road Safety Audit process to real-time signage systems for commuters, the field is ensuring smarter transportation performance decisions.

Panelists primarily answered questions specific to their projects. The audience in both session 1 and 2 seemed concerned with data quality issues. Panelists typically had QA/QC protocols already established, but it appears there is room to improve in that area of data. Processed data is only as good as the quality of the data. It was echoed again that the federal government should take the lead on setting data standards.

Session 1b: Data Mining and Algorithm Development

Moderator: James Pol

Integrated Transportation Modeling Data Hub
Brandon Nevers, Principal Engineer, Kittelson & Associates, Inc.

Long-term Pavement Performance Program Information Management System
Yan (Jane) Jiang, Research Highway Engineer, HRDI/FHWA/DOT

ODOT's Use of Data for Snow and Ice Recovery Evaluation
John MacAdam, PE, ITS Engineer, Ohio Department of Transportation

Research Data Exchange
Gene McHale, Team Leader, FHWA Office of Operations R&D

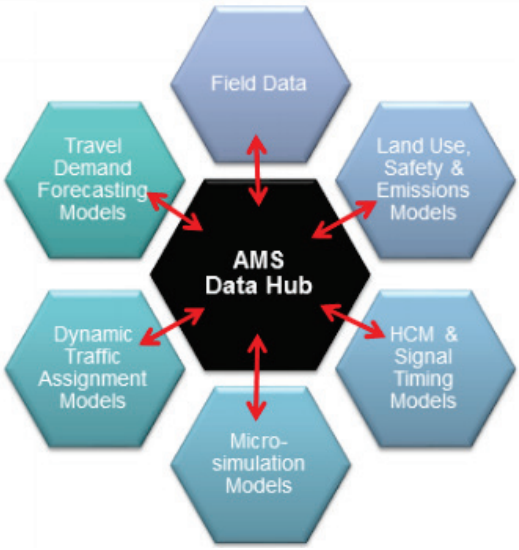
Web Based Delivery of Large Data
D.J. Swan, Sr., Pavement Management Engineer, Fugro Roadware

National Highway Construction Cost Index
Vincent Fang, Senior Economist, MacroSys, LLC

Session Recording

Session 1b: Data Mining and Algorithm Development

Integrated Transportation Modeling Data Hub
Brandon Nevers, Principal Engineer, Kittelson & Associates, Inc.



- Transportation decision making is getting more complicated incorporating ITS
    - Current practice is ad hoc and scattered with data various data sources
- Analysis and Modeling Simulation (AMS) Data Hub
    - Unify data scheme- develop common set of definitions
    - Support cross resolution modeling
    - Facilitate data exchanges between modeling and software packages
- Saved 80% of time compared to performing manually

Long-term Pavement Performance (LTPP) Program Information Management System
Yan (Jane) Jiang, Research Highway Engineer, HRDI/FHWA/DOT

- LTPP mission statement
    - Increase pavement life by investigation of various designs of pavement structures, materials, loads, environments, and maintenance practices
    - Data is all encompassing- environment, structure, traffic, maintenance, construction
- Data upload to central database to produce publically available data
    - Consistent, high quality data to use for setting pavement performance measures
- Case studies
    - AASHTO Pavement ME Design
        - LTPP data mined to develop performance models and national calibration
    - Virgin versus Recycled
        - Compare performance versus material to increase sustainability and cost savings

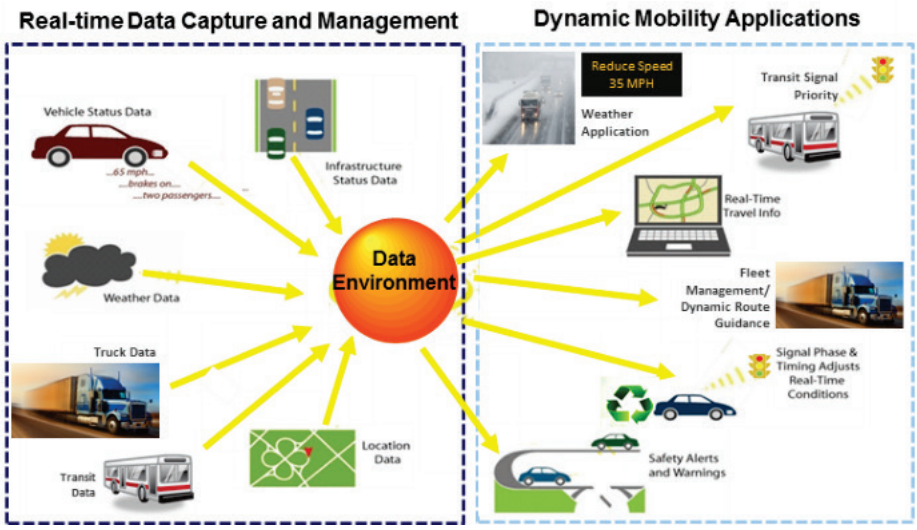
ODOT's Use of Data for Snow and Ice Recovery Evaluation
John MacAdam, PE, ITS Engineer, Ohio Department of Transportation

- Speed and weather data

  - INRIX and RWIS
  - Archive data and did not want to place their own sensors
- After a snow event, each district needs to report the speed of their roads within three hours
  - Snow event starts when speeds drop while it is snowing
  - Snow event ends when it stops snowing, wind dies down, and another event does not start within the next hour
- Generate monthly reports and each snow event is scored
- Going forward
  - Turn into real time data
  - Adjust program thresholds

Research Data Exchange (RDE)
Gene McHale, Team Leader, FHWA Office of Operations R&D

- Fully connected vehicles
  - Collect mass amounts of real time vehicle data
  - Collision avoidance
- ITS Mobility Program
  - Merge real time data capture and management with dynamic mobility applications for customers to use
- RDE host and provide access to well documented data for development of ITS connected vehicle applications
  - Multi-source, multi-modal
  - Archived and real time data feeds
  - Evolution from independent data sets to RDE



Web Based Delivery of Large Data
D.J. Swan, Sr., Pavement Management Engineer, Fugro Roadware

- Automatic road analyzer
  - Drive around lots of roads and collect lots of raw data and images
  - Expanded more to asset management beyond basic pavement condition
- Disseminating data through iVision
  - Moved beyond spreadsheets to better visualizations and data extraction

  - Not just for DOTs but designers, contractors, maintenance crews
  - Web based data exchange with raw data and graphic

National Highway Construction Cost Index (NHCCI)
Vincent Fang, Senior Economist, MacroSys, LLC

- Process detailed construction cost information into aggregate measure
  - What is actually going into the system for each dollar?
  - Quarterly national price index tracking trends of construction costs
- Data sources
  - Different cost components such as traffic control, bridge, grading, bituminous pavement
  - Pay-item data from states
  - Clean data and statistical editing because each state defines the inputs
- Usage of NHCCI
  - One single measure for so many items
  - Roughly indicates how construction costs changes over time for across time and different sectors

Session 1b: Data Mining and Algorithm Development Q&A Summary

Many of the questions during this part of the session were project- specific questions for individual panelists. This attests to the interest the audience has in using some of these data mining techniques. Audience members were interested in the data analytics system used by panelists as well as how panelists address the issue of bad data. A couple of panelists flag bad data in order to provide the data in its rawest form and others have numerous QA/QC procedures in place to assure high quality data.

- **Montana DOT:** Why were Google Fusion/ Google Maps selected as the cloud interface and visualization tool?
    - **Brandon:** We had an 18-month project and as we were looking at potential cloud options we simply went with the one that was the simplest and easiest to use. Our software developers were also more familiar with it. We want to emphasize there is no intention to be vendor specific, but we needed to do a prototype demonstration and we went with the one that worked the best with the constraints of the project.

- **Question:** John MacAdam, why is it only when the traffic slows down the snow incident starts?
    - **John MacAdam:** That question comes up a few times. We do not change anything that maintenance crews are doing; this is simply looking back and grading their performance. We only care about the snow event that affected the traffic and grading what would affect the public. That brings up a good point, how do we reward our crews for keeping the speed up before an event?

- **Question:** Gene McHale, how do you see the relationship of your project with real time data exchange efforts that are maybe used for operations?
    - **Gene McHale:** Right now we are supporting the offline algorithm development and testing, but as we enter into the next phase of the real time data capture and management program, we are looking at prototyping an operational data environment. We will be collecting real time data from physical sensors on the highway and dedicated short range communication. We will be integrating that to start really testing whether we these applications can collect this data in real time and what are the issues of pulling all this data in from a variety of sources? That is where we are headed in the next year or two for our program.

- **Question:** Gene, are you expecting the application providers to do all the QA and smoothing of data in the RDE to move from raw data to operational data?
    - **Gene McHale:** We really are trying to provide the data in its rawest form. We have identified gaps in the data or data we know came from a bad sensor, but we still make that data available for those researchers that deal with dirty data and

identify that in the documentation. But as we move to real time data we will get more involved to ensure the quality is satisfactory.

- **Question:** Brandon, you talked a lot about bringing in all the different models, one issue we have is in developing base observations that are used to validate and calibrate the models, does you application deal with this at all?
    - **Brandon:** I think your second point has to do with field to model data matching. We have users looking for that kind of information and want to provide some sense of realism to the simulation model. We have a couple examples of applications of how to look at lengths from both volume and speed data. For our Portland example, we were able to read in both INRIX and Bluetooth data for links and create side by side comparisons to compare against the projections of the original traffic consignment model. So it is a useful way to pull in field data and compare visually to look at how you line up. Once we can read in the data and have a consistent format, geocoded, we can do a lot of comparisons that way.

- **Question:** This is for Mr. Swan, you talked about collecting large amounts of data and images. How do you package that data into manageable pieces for transmission to your clients over the web?
    - **D.J. Swan:** There are a couple ways we can do it. The clients typically want a copy of it themselves so we provide an external hard drive. When packaging things on the web we go through a lot of thumbnails so you can see them in several ways. Most people want to know what is there rather than drill down to level of seeing each crack.

- **Question:** Dr. Fang how might you be able to quantify or account for intangible costs? Something like construction how might businesses closing for example be included in your model?
    - **Vincent Fang:** The consequences are not accounted for in the construction index. The noise, dust, etc. are not directly paid for are external costs or social costs and benefits that are not included in this price index.

- **Question:** John, are you getting to use some of the datasets to evaluate what different snow removal techniques were in the past and compare which did more or less damage?
    - **John MacAdam:** My office is not doing that, but I know our Office of Technical Services is looking at the data from that point of view.

- **Question:** D.J., have you been involved in any programs like that, where you specifically look at different corridors and the different techniques they are using?
    - **D.J. Swan:** Not so much specifically at the winter maintenance, it is pretty common to come in when we are doing the larger networks to identify a specific corridor. There is some change that is going on there that needs to be monitored

because of new industry coming in or heavier traffic flow. On the construction side it is important to track the behavior of everything to find out what works and what doesn't.

- **Question:** D.J., are you looking much at bike paths?
  - **D.J. Swan:** Often times we have considered bike paths. We have done special runs where we have to get permission for driving a larger vehicle. Often times we do as much as we can from the road, so if we are driving down the road we aim one of our cameras further down to make sure we see the bike paths. We do our best to get as much as we can.

- **Question:** D.J., has your company done any work on trying to visually tag elements to speed up review and find informational things that the large quantities of data provides?
  - **D.J. Swan:** So to more automate the process to find a lot of the points of interests? We try to do that, but a lot of times agencies have interesting information that they are already holding onto. We take a lot of information to flag the data. A lot of it is still more manual than we would like and a lot of work is going into automatic image identification, but it is challenging across states and countries.

- **Question:** Gene, you mentioned that you label the bad data, is that correct? Can you speak more about the useful applications of the ITS data? I am interested in security data, how can we use your data to determine when cars are under attack?
  - **Gene McHale:** Yes, some of the datasets have flags if there are any issues. If some users find issues they can report back to us and we will flag it for you. I cannot comment on security things, but we do have applications we are working on. Vehicles communicating messages to give driver guidance to not run a red light or make a fuel efficient stop. There are other applications related to freight, better flow on freeways, we have a bundle of applications that we are working on. There is nothing in the security area that we are looking at, but the data is out there if others want to do interesting things.

- **TFHRC:** A follow up to the last question to Dr. Fang, are you using Big Data analytics to evaluate global, national, regional, local, and other data sets such as social costs to improve precision and accuracy in NHCCI?
  - **Vincent Fang:** The traditional price index as defined by economists focuses on direct out of pocket costs that go into construction of highways. There are social, economic, and environmental consequences that are not paid for and therefore not included in the cost index. There is a measurement effort in trying to quantify the social costs and benefits that would include those.

- **Question:** D.J., you refer to the fact that faces are going to show up sometimes and other privacy issues, what do you do?

  - **D.J. Swan:** We keep this internal and within agencies. It we were going to make it public, we would have to cover the privacy issue to make sure there is no conflict.

- **Question:** Jane, was establishing this community of users who can perform analysis part of the program when developing the LTPP? And how do you continue to maintain this relationship with the community of users and are the aspects that you can share with us?
  - **Jane:** I would not say that is part of the design, however, it is a very successful part of our outreach to professors and students because that is very helpful to us. We have a tremendous amount of data so without some education and training it is very difficult to sue this data. We do a contest with the professors and students with ASC and so the professors integrated the data into their curriculum. We plan to continue doing what we're doing and working on a web access portal to put the data online. We might create a module for them to integrate into their graduate studies.

- **Question:** Just a general question for everyone, what data analytical tool do you use?
  - **Dr. Fang:** We use SAS to build a number of procedures.
  - **Brandon Nevers:** We are bringing in model data to a single place, so we store it as GSC files because it was an easy way to provide access and built in visualization.
  - **D.J. Swan:** We use a range of tools; we use SAS for simpler statistics. Mainly there's a lot of custom image data that we spend a lot of our time on and we use a variety of different tools.
  - **Jane Jiang:** For our database the tables are set on the Oracle platform and for data analysis people sue different tools. SAS is one of them and data manipulation tools like MS Access or Excel. For modeling, engineers use different analysis tools.

- **Question:** Are you guys tracking the confidence level and integrity of the data you are collecting?
  - **Jane Jiang:** We have all kinds of data and these data elements come to us differently. So we have different QA/QC methods. As far as confidence intervals, that is more for the testing and establishing some kind of round-trip. It is very difficult to say what the confidence level is there because it is not a duplicate, reproduced sampling scenario.
  - **D.J. Swan:** We are lucky to have more research-level data, such as LTPP, to have benchmark data. We look for repeatability and accuracy. We do year to year comparisons to make sure everything matches.
  - **Brandon Nevers:** For the prototype we had an algorithm and comparing the field to the model data.

- **John MacAdams:** Our speed data comes straight from INRIX, but we also have a second level of testing confidence in our office. On the weather side, we have identified a few stations that were giving us bad data and have replaced them.
- **Vincent Fang:** Actual construction project data is contractually set with the states. We do have a number of procedures to consistently check the data.

Processing Data Track

Session 2b: Visualizing Data for Decision Making

Moderator: Robert Dingus

Transportation Information Mapping System
Andrew Williams, Administrator, Office of Technical Services, Ohio Department of Transportation

Federal Lands Highway Data Visualization Project
Dan Van Gilder, Engineering Software Support Team Leader, Eastern Federal Lands Highway Division

The Use of 3-D Visualization in the Road Safety Audit (RSA) Process
Rebecca Crowe, Transportation Specialist, Federal Highway Safety

Features of the Redmon Digital Signage System for Commuters
John Redmon, Principal, Redmon Group, Inc.

Visualizing Algorithms for ITS Research
Nathan Paczan, ITS Research Lead, The MITRE Corporation

Digital Roadway Interactive Visualization and Evaluation Network (DRIVE Net) Data Processing Applications
Jonathan Corey, Graduate Assistant, University of Washington STRA Lab

Mobile Data Collection
Ray Mandli, President, Mandli Communications

Contemporary Systems for Map Enabling Transportation Data
Evan Caldwell, Solution Engineer, Esri

Session Recording

Session 2b: Visualizing Data for Decision Making

Transportation Information Mapping System (TIMS)
Andrew Williams, Administrator, Office of Technical Services, Ohio Department of Transportation

- Out-of-the-box, simple, powerful GIS system
  - Different layers are available for the user to select
  - Base map includes different tools
    - Able to find a place or address
    - Multiple view of location with Bing, Google, etc. to see different perspectives
  - Enhance communication through email function

Federal Lands Highway Data Visualization Project
Dan Van Gilder, Engineering Software Support Team Leader, Eastern Federal Lands Highway Division

- Interactive mapping tool for highways on units in the National Park Service
  - Need to make intelligent decisions on where to spend our funds.
- Pivot viewer through Silverlight tool
  - Organizes and sorts data to provide succinct, intuitive data
  - Look for trends with this tool
  - Taken from Netflix

The Use of 3-D Visualization in the Road Safety Audit (RSA) Process
Rebecca Crowe, Transportation Specialist, Federal Highway Safety

- RSA is safety performance examination by independent multidisciplinary team
- Difficult to perform review during planning process
  - Hard to read and interpret roadway design plans and identify potential safety concerns
  - Developed 3-D model for average user to interact with construction plans

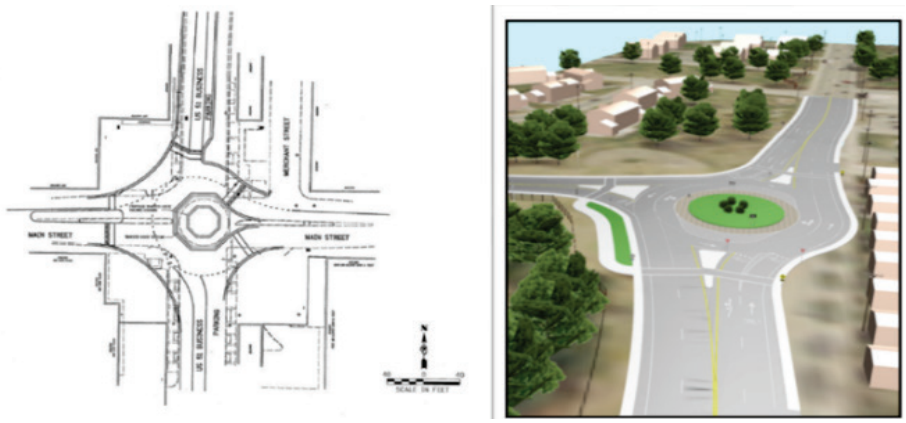


Figure 4. Comparison of 3-D model and sketch

- Benefit of 3-D model
  - See all of the features of the roadway and understand signage, environment, etc.
  - Look at various vantage points and perspectives to identify potential problems and find solutions
  - Share with project owner, stakeholders, and others the recommendations

Features of the Redmon Digital Signage System (RDSS) for Commuters
John Redmon, Principal, Redmon Group, Inc.

- RDSS
  - Provide real time information at popular locations for commuters
  - 70 displays throughout DC in 2013
  - Audio description for those with visual impairment
  - Shows various commuting options available
    - Bikeshare
    - Zip Car
- Requirements for signs
  - Power
  - Hardware
    - Indoor/ outdoor
    - Touch screen
  - Internet connection
  - Content is be customized for client

Visualizing Algorithms for ITS Research
Nathan Paczan, ITS Research Lead, The MITRE Corporation

- Important algorithm factors
  - Algorithm wants to reduce the dimensionality of the data you are working with from so many different and external sources
  - Algorithm is creating a derivative product and it is clear to know what you are looking at
- Data overview
  - Trip segments
  - Stare points (stops)
  - Understand comprehensive driving behavior
- Track segment analysis
  - One algorithm is independent of the end point, just behaviors in between that are impacting the driving
  - Second algorithm looks at end points and understand why different paths were taken

Digital Roadway Interactive Visualization and Evaluation Network (DRIVE Net) Data Processing Applications
Jonathan Corey, Graduate Assistant, University of Washington STRA Lab

- DRIVE Net purpose
  - Convert raw data into information
  - Challenges: storage, quality control, dataset sizes
- STAR lab gathers mass amounts of data
  - DRIVE Net does integrate quality control and correction
  - End goal to put of what the level of service is real time
  - Visualizations include pedestrian routing, emissions, freight performance
- eScience platform

Mobile Data Collection
Ray Mandli, President, Mandli Communications

- Known for high resolution, data rich projects
  - Planning, collection, reduction, and delivery of data
- Platform is versatile
  - Various vehicles can hold the equipment
  - Software for capture, analysis, and display
- Collect data as quickly and consistently as possible with safety as a priority

Contemporary Systems for Map Enabling Transportation Data
Evan Caldwell, Solution Engineer, Esri

- New Esri tool for Excel adding mapping component
  - Esri Maps allows quick input of location data for quick visualization
  - Summary component through aggregation, filters, and classification methods
  - Different base maps are available
  - Share the layer dataset and usable across all ArcGIS platforms or embed in website or create web application

Session 2b: Visualizing Data for Decision Making Q&A Summary

Most panelists agreed that publically available data is important and something the federal government should control. Additionally, some panelists stated that the federal government should coordinate open discussions amongst the many stakeholders to foster agreement on data standards.

- **Question:** Specific to Rebecca, the RSA visualization capability is a great display of innovation, have you thought of adding a simulation aspect to run different scenarios?
  - **Rebecca Crowe:** We have thought of that. It would be awesome to run some sort of simulation on it.
  - Audience: You could run thousands of simulations of traffic, visibility… (cannot hear)
  - **Ray Mandli:** That is happening in Hawaii with the data we collected for them.

- **Question:** How do you deal with data quality control with the data fusion?
  - **Nathan Paczan:** If you are developing algorithms that are doing any sort of statistical analysis, you are fusing it with data that has some sort of truth element. For example, looking at speed data you can easily detect bad data. So a lot of this information is filtered beforehand to identify bad package data.

- **Moderator:** Andrew, your presentation looked at a lot of data integration, within Ohio DOT can you tell me how the different siloes within the Department are using this information?
  - **Andrew Williams:** We developed an asset management leadership team to bring all the business owners of their data to the table. We introduced TIMS systems as a way to introduce their data and come up with standards to be entered into the system. It allowed people to see how other owners use their data. When you visualize data and put it in a format to visualize, you need it to be clean and our data integrity has gotten better. We just opened it to the public on Monday, but for the first time people are beginnings to understand how others use their data.

- **Moderator:** Ohio DOT shows the focus on transparency and opening that line of communication to the public. Rebecca, talk a little bit about the roadway safety data that you have been looking at and has your office been looking at how to do a systemic analysis to have broader applications?
  - **Rebecca Crowe:** Every state, region, locality reports crash and safety information differently so when you are out there doing an RSA data is a big question. We send people to help the team mine that data. We have been working with federal lands quite a bit on parkways. We do not have across the

modes in DOTs or a standard definition of “serious injuries.” That is something rulemaking will be going over.

- **Moderator:** Nathan, is there value in the broader connected and autonomous community in being able to have access to those datasets collected by DOTs and to help them experiment in the research phase?
    - **Nathan Paczan:** Absolutely there is. This is why Google is driving their cars all over and we are driving our cars to collect data. A lot of it is institutionalized knowledge, there is no standardization in the way roadways and urban areas are built across the United States. Companies are collecting all this data to gather point cloud data to see intersections are different times of days or the random situations that occur. What you are looking for is unique characteristics in the data and increasing the richness of the dataset.

- **Question:** How do you account for seasonal variations such as potholes?
    - **Nathan Paczan:** That is something we have been doing research on. You can start to deduce some of that information with the route and the data, you know that the mean track is this but there is a statistical variation here and there. If you start seeing a statistical imbalance and people change the track you can deduce something may be in the road.
    - **Dan Van Gilder:** Roads are always under construction, is there going to be some kind of tool, for example all the construction elements will have RFI and as vehicles drive by the system will learn the new changes?
    - **Moderator:** Cars in the connected vehicle environment, the cars have signals where they can adapt to changes in environment. These technologies have the ability to ride a guide rail and communicate to each other, the problem is that there has to be a first car to experience it and convey the data.

- **Moderator:** One of the things to come out of this event is an answer to what the barriers are and what ways can we facilitate and help to bring these environments around. That is why I asked about the interstate dataset because if it is there it allows all the other players to be able to come together and play off of the same data piece.
    - **John Redmon:** Real-time transit information is a challenge because different data feeds are coming from all over. It would be great to have a data aggregator so they all speak the same language.
    - **Moderator:** That is why I liked Jonathan’s presentation talking about bringing all the different datasets together and automating data quality control methods. Transparency and accessibility help build confidence not just with the public but with policymakers who eventually have to go and justify ways of funding the system. The work of everyone sitting here on the panel is creating an environment for better communication and creating a vision for the future taking the human factor away and become more autonomous.

- **Ray Mandli:** You should take a look at the data states are getting for us because it is ready and available. We can alter it so it is generic, but it is all data owned by the states so it is accessible- Hawaii, Utah, Nevada, Tennessee.

- **Question:** What do you think would be a good role or necessary role of the government besides money?
  - **Ray Mandli:** We need the feds to sit down with everybody and set standardized datasets. They need to play a larger role in building consensus and a role in educating states and public entities to understand why this is important.
  - **Moderator:** There have been some models recently in which FHWA, AASHTO, and the private sector have begun to rapidly produce specifications such as Everyday Counts initiative. If everyone will come together and have a conversation we could solve some of these issues. It will take leadership from both FHWA and AASHTO to create the opportunities. Web listening sessions will not get it done, but people must sit together to build a baseline template.
  - **Jonathan Corey:** I will second the standards request. I would recommend this for documentation and definitions.
  - **John Redmon:** There are companies out in the world that claim they have patents on certain technologies that never actually created anything but came up with the idea such as real time arrival. They are suing companies because they claim they have a patent and that does not seem right to me.
  - **Nathan Paczan:** Not only making data publically available, but creating platform where people can publish derivative products. You often do not know what you are looking for in those big datasets.
  - **Evan Caldwell:** Share the data out as a service, not static spreadsheets or things people have to download. Make it something that developers can leverage and work with and a lot of great things will get created that way.

Using Data Track

Once an organization has acquired and processed data, the next important step is to use the data. The uses of data should be accountable, predictive and visual. Data needs to be used to inform the decision-makers so they can make the best assessments of how to improve transportation performance. By applying data to financial and resource investment decisions, optimal choices will be made that consider the many different aspects and elements of the transportation system. New decision-making tools are streamlining this process so it adopts a holistic approach and optimizes transportation investments.

Session 1c features individuals at the forefront of data integration and decision tool development. Many of the decision-making tools discussed highlight the importance of data integration and the use of various data sources. This demonstrates the importance of reliable data acquisition techniques as well as credible data processing methods. Through the integration of many transportation elements, these decision-making tools mine the data to produce visual results. Users can then determine the best scenario for their needs. The RITIS central database developed by the University of Maryland CATTLAB does just that for their customers. On a smaller scale, Alaska's Department of Transportation has developed a smooth and comprehensive seasonal weight restriction decision process. Through intensive data collection processes, data is mined and then the seasonal weight restriction is determined. New technologies are allowing for easier yet methodical decision-making.

Session 2c highlighted the importance of efficient resource distribution through the application of data. Innovative investment and tradeoff analysis allows decision-makers to optimize transportation investments to get the most value from their resources. The Federal Transit Administration exhibited their Transit Economic Requirements Model (TERM) that is available for local transit agencies to use. It develops best case funding scenarios using asset inventory and investment policy inputs. Another advanced economic modeling tool developed by the Federal Highway Administration focuses more on trade-off analysis of the performance of a highway under alternative investment scenarios. This tool can help states determine what level of investment is needed to set or achieve particular performance targets. The importance of economical and valuable investments cannot be overstated in improving the performance of the transportation system.

The question and answer sections under the using data track focused primarily on funding constraints that the other tracks did not address as directly. Due to the nature of the topic, decision-making inherently brings up the issue of limited financial resources. Just as the other tracks mentioned, accessibility of data and greater coordination between state and federal governments would assist in bringing transportation performance management into the future.

Session 1c: Life Cycle Approach to Transportation Data Systems and Tools

Moderator: Maria Chau

FHWA Data Integration Project
Ronald Vaughn Jr., Transportation Specialist, Office of Highway Policy Information Federal Highway Administration

Life Cycle Approach to Transportation Data Systems and Tools
Maria Chau, Senior Community Planner, Federal Highway Administration- New York Division

Seasonal Weight Restriction Decision Process
Jack Sickel, Transportation Information Group Manager, Alaska Department of Transportation and Public Facilities

STREAM: A Systematic Technology Reconnaissance, Evaluation and Adoption Methodology
Stephen Popper, Senior Economist, RAND Corporation

Leveraging Existing Data Through Better Integration, Visualization, and Open Access
Michael Pack, Director, University of Maryland CATTLAB

Wireless Vehicle Detection System – Real-time Count Stations
James Cheeks, Chief of Traffic Signals, Safety, Standards and ITS, District Department of Transportation

Session Recording

Session 1c: Life Cycle Approach to Transportation Data Systems and Tools

Deconstructing Stovepipes- FHWA Data Integration Project

Ronald Vaughn Jr., Transportation Specialist, Office of Highway Policy Information Federal Highway Administration

- Started an agency-wide data integration effort
- Lost time extracting and manipulating various data systems that were not compatible
- Developed platform so most of that work is done on the back-end, leaving more time for analysis
- Automated processes for data mining, recording, mapping, and visualization

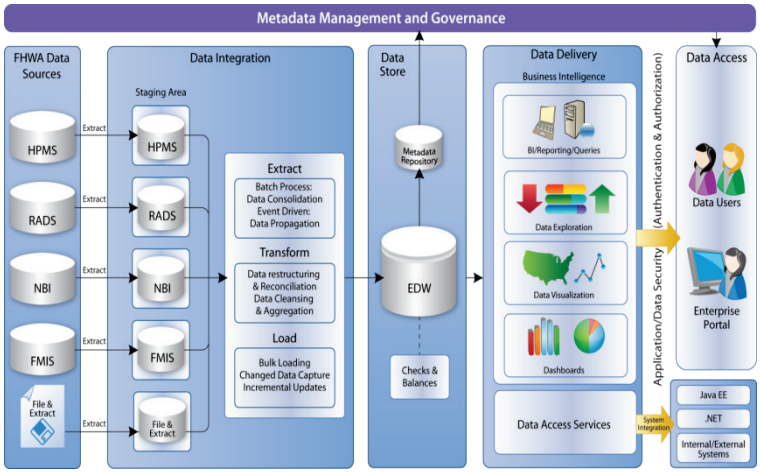


Figure 5. Data Integration Process

Life Cycle Approach to Transportation Data and Systems Tools

Maria Chau, Senior Community Planner, Federal Highway Administration- New York Division

- Existing digital life cycle model approach is “siloed”
- Connect siloes using new technology tools available
  - 3-D GIS, system models, augmented reality, visual analytics
- Share data through digital system that is connected to and updated by different divisions
- Visual analytics allow transportation professionals to view and analyze data to make decisions quickly and efficiently

Seasonal Weight Restriction Decision Process

Jack Sickel, Transportation Information Group Manager, Alaska Department of Transportation and Public Facilities

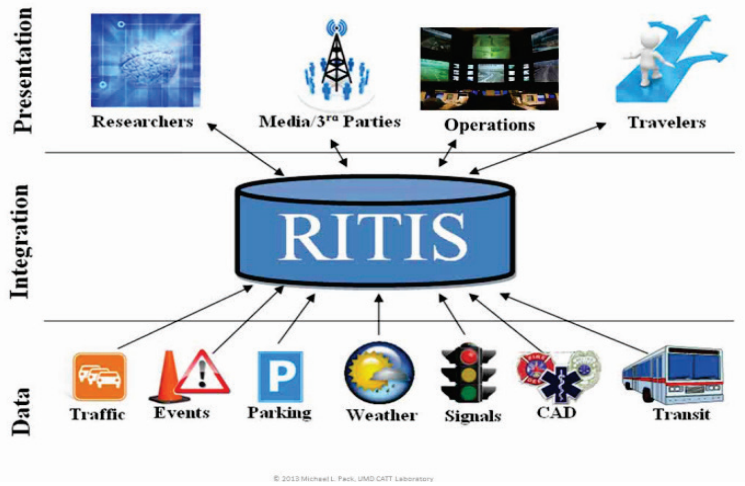
- Weight restrictions prevent damage to vehicles and roads as well as allows commercial trucking to schedule heavy loads prior to implementation
- Spring thaw cycle causes pavement and upper soil to bend under heavy weight
- Decision-making uses a holistic approach
  - Combine environmental impacts, geotechnical impacts, weather trends, and temperature data probe (TDP) trends

STREAM - Systematic Technology Reconnaissance, Evaluation, and Adoption Methodology
Stephen Popper, Senior Economist, RAND Corporation

- Transportation agencies are slow adopters of innovations
- STREAM creates common basis for analysis
  - Frame the overall functions, goals, objectives
  - Identify the relevant technologies
  - Characterize against criteria
  - Compare analysis results
  - Decide on technology choice
- Establishes common vocabulary, diffuses best practice, and provides basis for collaboration

Leveraging Existing Data Through Better Integration, Visualization, and Open Access
Michael Pack, Director, University of Maryland CATTLAB

- Central database called RITIS compiles and archives data from a wide variety of sources
- Challenge is to make data accessible, usable, and understandable
- End users can visually explore data with several analysis tools to further assist in decision-making
  - Incident
  - Weather
  - Congestion



Wireless Vehicle Detection System
James Cheeks, Chief of Traffic Signals, Safety, Standards and ITS, District Department of Transportation

- Washington, DC is implementing a new wireless vehicle detection project
- Chose SENSYS Networks as their operating system
- Collecting traffic speed, vehicle counts, and vehicle occupancy data in real-time for planning and engineering assessments
- Updated old detection system, minimizing installation problems

Session 1c: Life Cycle Approach to Transportation Data Systems and Tools

Q&A Summary

Panelists in this session seemed concerned with the lack of open access to data and the quality of data that is being used. A debate sparked over the problem of data being sold and therefore not publically available. An audience member brought up the point that until a better fund mechanism is in place, states and other organizations will sell data in order to recoup some of the costs of collecting it. Panelists said the federal government should specify not just performance measures, but hopefully methodologies for collecting data in the upcoming MAP-21 rulemakings. Additionally, USDOT and state governments should coordinate better as to lessen the financial burden on states.

- **Moderator:** What is the current state of the practice and what barriers need to be addressed in order to advance the state of the practice?
  - **Stephen Popper:** Fear from agencies to give over data to someone else to analyze is big barrier. The value in sharing information with others is greater than any of the potential risks.
  - **James Cheeks:** Funding is a major issue. Typically, we have enough money to install software and equipment, however funding to utilize and analyze the data is lacking.
  - **Ronald Vaughn:** The lack of coordination is a challenge, particularly on the Federal level. Integration and compatibility of data is important starting at the state level for Federal reporting requirements to streamline data as it advances through the agencies.
  - **Michael Pack:** The quality of the data and assessing technology is a great obstacle. Data that comes from vendors, different interested parties, or academic literature does not always address the issues at hand so various complications arise on quality and assessment of data.

- **Question:** What are the plans for state DOTs and local DOTs to leverage the federal data integration system?
  - **Ronal Vaughn:** Our first step was to develop the platform and implement it within the agency. There is a web-based portal that would allow state DOTs to access the information. This will most likely be a second phase of the data integration system, but we are definitely discussing this further.

- **Moderator:** What barriers can the transportation data community address in the next 6, 12, and 18 months?
  - **Michael Pack:** We have already addressed this, but working towards open access and visualization tools are important.
  - **Ronal Vaughn:** The national linear referencing railway networks that are underway and transportation coordination initiatives are important in building the framework and foundation of network-building to tell the story of the bigger transportation picture.

  - **Michael Pack:** We have talked about data as an asset and some agencies are taking this to the extreme by selling their data which is counter to our efforts.

- **Question:** Until we get dedicated funding mechanisms to allow data to be maintained, DOTs are going to find ways to get revenue and recoup the benefits. There needs to be a concrete funding mechanism resolved in the next authorization bill because I agree open source is the way to go and maximize data's value.

- **Question:** If I were to think of what should be open, it would be the standards that represent the data. Open source is nice so I can reverse engineer what the data looks like, but if it's an open standard and I could require what the data needs that would be much more important without dealing with the code.
  - **James Cheeks:** In the standards world we brought in IT workers to help develop our data elements such as data management and collection standards.
  - **Michael Pack:** There are several standards out there for traffic data and very loosely defined standards. Agency X and Y could conform to those standards, but their data does not come out aligned exactly. An organization can select a certain standard to subscribe to when signing up for a RITIS data feed.

- **Moderator:** What role should the federal government play in moving the state of the practice forward?
  - **Michael Pack:** MAP-21 if done correctly will be very useful. Different state agencies will report different performance measures that manipulate how the numbers come out. The rulemaking with hopefully specify some of the methodologies, not just the measure itself
  - **Ronald Vaughn:** With respect to coordination, there really needs to be a greater degree between federal and state agencies. We often impose requirements on states and this burdens them. There needs to be more open coordination, vetting our needs for the data and hearing and addressing state concerns for fewer backlashes at the backend.
  - **Stephen Popper:** There is an obvious coordination role in STREAM because there is always a group that dictates the technology assessment and adoption process. There is a crowdsourcing aspect, a ground-up approach, where a number of leading agencies can use the STREAM process and provide case studies to demonstrate the value of the efforts to other agencies rather than the formal top-down approach from the federal government.

Using Data Track

Session 2c: Investment Optimization Tools (Trade- off Analysis)

Moderator: Nat Coley

Data Visualization to Improve Decision- Making at MDSHA
Greg Slater, Director, Office of Planning and Preliminary Engineering, Maryland State Highway Administration
Subrat Mahapatra, Transportation Engineering Manager, Office of Planning and Preliminary Engineering, Maryland State Highway Administration

FTA Transit Economic Requirements Model Lite ("TERM Lite")
John Giorgis, Director, Office of Strategic Planning, Federal Transit Administration

HRT Capital Project Prioritization System
Andrew Zalewski, Transportation Planner, FourSquare Integrated Transportation Planning

Data Driven Approach to the Development of Possible Solutions to Transportation Corridor Problems
Tim Lomax, Senior Research Engineer and Regents Fellow, Texas A&M Transportation Institute
Shannon Crom, Director of Research, Texas Department of Transportation

Highway Economic Requirements System (HERS): A Tool for Trade- Off Analysis
Rabinder Baines, Senior Economist, Federal Highway Administration

A Practical Investment Optimization Tool by Means of Certainty- Uncertainty Searches
Brian Chow, Senior Physical Scientist and Professor, RAND Corporation

Session Recording

Session 2c: Investment Optimization Tools (Trade- off Analysis)

Data Visualization to Improve Decision- Making at MDSHA

Greg Slater, Director, Office of Planning and Preliminary Engineering, Maryland State Highway Administration
Subrat Mahapatra, Transportation Engineering Manager, Office of Planning and Preliminary Engineering, Maryland State Highway Administration

- Maryland has done performance measurement for many years
- Trying to integrate data systems within and across programs to understand what the goals are and how MD can meet those goals
- Made data part of the asset- how they manage the data is how they manage the asset so the data does not fall behind
- Built multi-layer travel demand model called Maryland Statewide Transportation Model (MSTM)
    - System performance and long-range planning
    - Corridor studies
    - Scenario Planning
    - Freight movement
- Planning for Operations
    - Collaboration and coordination efforts between regional stakeholders
- Enterprise GIS
    - “One Maryland One Map” philosophy
    - Decision-support system that enables various levels of e-GIS implementation

FTA Transit Economic Requirements Model Lite (“TERM Lite”)

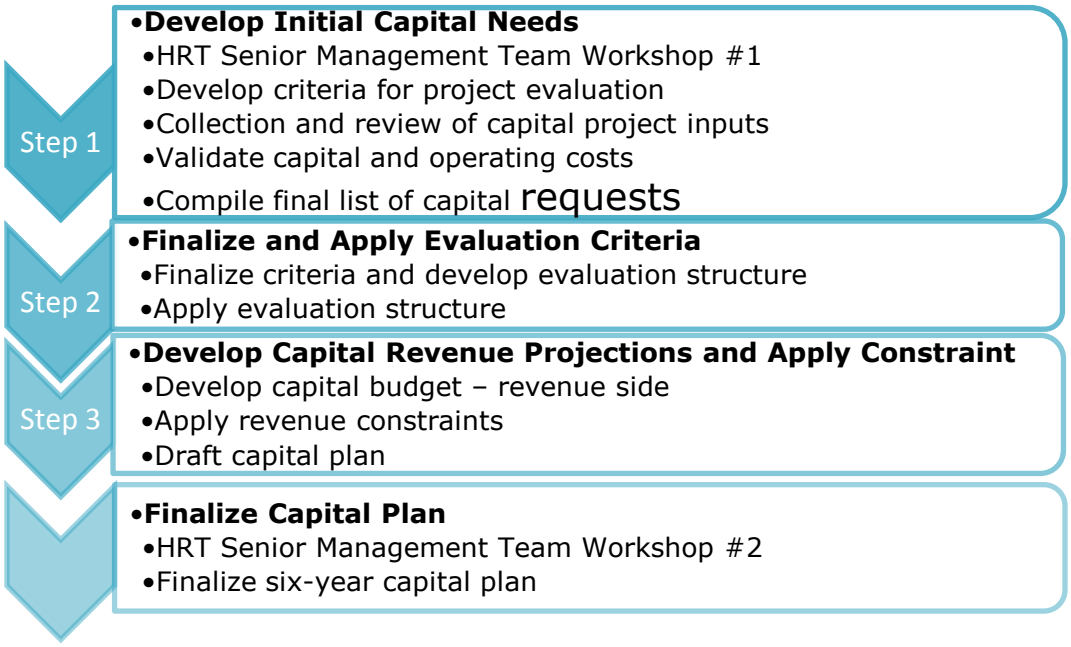
John Giorgis, Director, Office of Strategic Planning, Federal Transit Administration

- TERM designed for analysis of:
    - State of Good Repair backlog
    - Best estimate for future investment needs over the next 20 years
- How does it work?
    - Asset inventory
        - All asset types from various data sources
    - Investment policy
        - Investment scenarios that relate those assets
    - SGR forecast
        - Aggregates different outcomes to create a funding scenario
- FTA uses this to develop national funding estimates
- TERM Lite is available for local or regional transit agencies

HRT Capital Project Prioritization System

Andrew Zalewski, Transportation Planner, FourSquare Integrated Transportation Planning

- HRT is the second largest transit operator in Virginia, including four modes of transit
- Why prioritize capital needs?
  - Agency developing Capital Investment Plan
  - Justify expenditures to stakeholders
  - Large amount of capital needs and limited funding
- Prioritization scoring system
  - 40% quantifiable benefits, 40% qualitative benefits, 20% adherence to agency's strategic goals
- Lessons Learned:
  - Balance detail and simplicity
  - Involve decision- makers from the beginning
  - Cannot only rely on quantitative measures



Data Driven Approach to the Development of Possible Solutions to Transportation Corridor Problems

Tim Lomax, Senior Research Engineer and Regents Fellow, Texas A&M Transportation Institute

Shannon Crom, Director of Research, Texas Department of Transportation

- Texas population and economy is growing, increasing congestion dramatically
  - Civic and business groups approached the state legislature for solutions
- $2 billion shortfall to maintain status quo, need to target high-value projects

- Already had safety and pavement management system, but nothing to identify or quantify congestion
- Mobility investment priorities project:
  - $300 million to do preliminary planning, design, environmental assessments, but no construction
  - Projects incorporate alternatives to additional highways- transit, better management
  - TxDOT does not rank projects, local organizations do with data facilitated discussions

Highway Economic Requirements System (HERS): A Tool for Trade- Off Analysis
Rabinder Baines, Senior Economist, Federal Highway Administration

- HERS projects overall conditions and performance of nation's highways under alternative potential levels of investment
  - HERS could be used to develop fiscally constrained performance targets or estimate levels of investment to reach a particular target
- Run a number of different scenarios for the report to Congress using benefit- cost analysis
- Data is limited to highways eligible for Federal aid
  - Approximately 10% of Federal- aid highways are sampled
- Evaluated Improvements:
  - Infrastructure condition
  - Safety
  - Operation improvements
- HERS- ST available for state level analysis

A Practical Investment Optimization Tool by Means of Certainty- Uncertainty Searches
Brian Chow, Senior Physical Scientist and Professor, RAND Corporation

- DOT typically uses benefit- cost analysis, but work with expected values and sums of various project scores
  - Need to express results in confidence level
  - Need to allow the selected projects to meet multiple requirements individually
- RAND's PortMan (portfolio management) has new approach to investment optimization
  - Simulates future states of the world through random combination of uncertain parameters
  - Identifies optimal solution or portfolio for a given certainty state
  - Use search rules to find globally optimal portfolio

Session 2c: Investment Optimization Tools (Trade- off Analysis) Q&A Summary

The questions during this portion were primarily directed at individual presenters. Investment strains are clearly a problem amongst the transportation industry and the audience was curious as to the applicability and usefulness of these investment tools the panelists developed. Unlike in other sessions, two questions were asked about sustainability and livability issues. As an issue now in the foreground, transportation professionals have the opportunity to include livability measures in their decision-making process.

- **Question:** It was mentioned there is a $14 billion requirement to meet certain performance levels, how much will the Federal government will be able to cover that requirement?
    - **John Giorgis:** That is the amount needed to keep the current state of repair backlog from growing. That is a decision we leave up to Congress, Federal rate of contribution is currently 40% for reinvestment and expansion. How that is split between local and state players is a political decision.

- **Question:** A few of you mentioned operational questions that are lacking in the literature or missing from cost-benefit analysis. How can these economic models with decision-support systems better reflect the value of operational improvements?
    - **Rabinder Baines:** We realize they have high returns, so it is more a modeling issue for us. That is why we do not have the ability yet to incorporate that.
    - Tim Lomax: State government constantly asking what they are getting for the investment and then trying to convey the value of the current system to the public.
    - **Subrat Mahapatra:** Maryland's objective is to save $1.1 million annual user-end costs. Due to funding constraints, we look at system efficiency and seeing what is the value that we are giving to the customers?

- **Question:** How does your process differ from the congestion management system for corridors that you had with the MPOs and the models and analysis you have for your regional transportation plan? Are you seeing positive investments in metropolitan areas and system-wide levels?
    - **Tim Lomax:** The privately collected traffic data that allows the public to understand the traffic congestion problems in ways planners and engineers can relate to, so it is very quantifiable and location-based but does not really apply to what do we do about it? There is definitely a connection with the MPO congestion management process as we sell our data through a bidding system. Trying to get MPOs more comfortable with data analysis rather than making them collect the data.
    - **Subrat Mahapatra:** Congestion management systems are a good starting point. Once you have the same datasets feeding into the same system, we have

identified the issues, but still strategizing on quantifying the level of coordination and what is the end result.
    - **Shannon Crom:** Texas has had a change in decision-making at the MPO level. Local community groups are starting to voice concerns more.

- **Question:** Transportation systems have a huge impact on natural environments. Can you talk a little about how data can drive decision- making to improve land use decisions at the local level and how that affects Federal decision-making in terms of allocation of resources? Is the trend of expanding sustainability measures just related to cars?
    - **Subrat Mahapatra:** Maryland looks at quality of life measurements, beyond highway measures. We consider sustainability and equity indicators and how these play out at the corridor-level.
    - **Andrew Zalewski:** There is a trend to monitor broader measures that really capture the livability and accessibility aspects of transportation. DOT's TIGER grants are a good example of funding available going beyond regular transportation improvements.
    - **Tim Lomax:** It is a trend across the modeling world. Eventually we cannot keep doing what we are doing; the long commutes and travel times are not sustainable with the land use and distribution.

- **Question:** Some cities around the country have enough space while others do not, what kind of policies will help us see better results on the congestion and reliability problem?

- **Moderator:** Let us share some closing comments and touch on his question.
    - **Subrat Mahapatra:** It is not about fixing the congestion problem, but the reliability problem. Take it from demand and supply side approaches by providing multi- modal connections and having dialogue with MPOs and localities.
    - **John Giorgis:** The FTA recognizes transportation investments have a role in promoting economic development. There is definitely opportunity for additional research to be done and the best way to model those impacts of valuing transportation on land use and economic growth.
    - **Andrew Zalewski:** Data is important in helping frame the discussion for capital investment as well as guiding the eventual investment.
    - **Shannon Crom:** The discussion is the important part. Be open to the solutions that come from outside the building you work in or the ingenuity that comes from the private sector.
    - **Brian Chow:** USDOT is not using enough portfolio management to advance risk management.
    - **Rabinder Baines:** We need to use our resources efficiently and make investments where it will make a difference to the economy and society.
    - **Tim Lomax:** We need to connect community values with our solutions.

Closing Remarks: Audience Discussion

Session Recording

Highlights

Data Palooza closed with an open audience discussion asking attendees, online and in person, to review highlights from the day and the challenges that need to be solved. Comments ranging from greater coordination between transportation modes, such as technology sharing between aviation and railroad, to greater inclusion of livability and sustainability measures in transportation data were offered by Data Palooza participants. Just as many of the panelists had mentioned during the Question and Answer portions, audience members reiterated the importance of open and accessible data as well as the federal responsibility to set standards and coordinate consensus among partners and stakeholders.

While standardization is difficult, some audience members offered their solutions. There are many different aspects of data that can be standardized and overall consensus is challenging to achieve. The federal government could regulate the structure of data or definitions of data elements. One audience member offered the comparison of an iTunes store for data as a framework of a data clearinghouse. The ability to categorize, rate, share, and access various data sources should be a priority of USDOT. Another audience member said the government should not accept data that is submitted in different formats or missing particular elements. However, this may inhibit the collection of rich data that goes above and beyond the government requirements.

The challenges discussed throughout the day gave a better sense of what the transportation industry is already doing and what it can do in the future. While some goals may be difficult to tackle now, greater innovation and understanding in this field will help USDOT, state departments of transportation and other partners in achieving better data management and coordination. With MAP-21 performance requirements being released soon, many relevant discussions took place at Data Palooza that will better prepare the transportation industry for a comfortable implementation. Data is essential in helping USDOT tell the national story of America's transportation system and the work of the many panelists and participants at Data Palooza will keep motivating the Department to move into the future.

Appendix A: Presenter Biographies

Session 1a:

Enriching Data through Integration
Wade Rosado, Capability Development Leader, Cubic Transportation Systems Inc.
Capability Development Leader for Cubic's information analytics Initiative focusing on data capture and integration, operational business intelligence, complex analytics processing, scalable computing models, and feature extraction against structured and unstructured data sources to improve business insight. Wade has an extensive background in applied analytics, including prior work with machine control systems, automatic visual inspection systems, and currently with electronic payment solutions.

Using Innovative Data Analysis Methods to Facilitate Communication and Transit Investment Decision Making in Montgomery County, MD
Eric Graye, AICP, PTP, Planning Supervisor, Maryland-National Capital Park and Planning Commission (M-NCPPC) - Montgomery County
Eric Graye is an urban planner with more than 25 years of transportation planning experience focusing primarily on the application of regional and sub-area travel demand models in support of the evaluation of master plans and conduct of County-wide growth management studies in Montgomery County, MD. Among his other key responsibilities with the M-NCPPC include managing travel data collection and analysis activities in support of the County's travel monitoring program. He holds a Bachelor's degree in Civil Engineering and Master's degree in Urban Systems Engineering from Howard University.

Bikeshare as Transit: Strategic Expansion Through Advanced Data Visualization
Shana Retherford Johnson, AICP, Senior Transportation Planner, Foursquare Integrated Transportation Planning
Shana Johnson, AICP is a Senior Transportation Planner with eight years of experience in transportation planning, policy analysis and research. The focus of her work is on public transportation, transportation demand management and the transportation-land use relationship. Prior to becoming a consultant, Ms. Johnson worked as a contractor at the Bureau of Transportation Statistics, where she analyzed data from every mode of transportation. Shana holds a Master's degree in Urban and Regional Planning from Virginia Tech and a Bachelor's degree in Geography and International Development from Clark University.

High Occupancy Taxi Trips
David Mahfouda, CEO, Bandwagon
David graduated from Harvard's Visual and Environmental Studies program in 2005 and went on to earn his master's degree, studying Product Architecture and Engineering at Stevens Institute, where he modeled what would become the basis for Bandwagon — a dynamic transportation system initially entitled Modular Node Based Public Road Transportation on

Digital Infrastructure (MNBPRTODI). David has since become a pioneer of the networked-vehicle industry, having been invited to speak about new technology and transit at institutions and conferences including The Open Planning Project, Portland State University, Transportation Transformation, Advanced Energy 2012, and Parsons School of Design. Prior to Bandwagon, David co-founded the Very Polite Movers, a successful Brooklyn-based furniture moving cooperative. He is also the co-founder of the Fixers Collective- a growing New York based social movement dedicated to the care and restoration of broken things.

Data for Integrated Corridor Management (ICM) Analysis, Modeling, and Simulation (AMS), and Operations
Steve Mortensen, Senior ITS Engineer, Federal Transit Administration
Steve Mortensen is a Senior ITS Engineer with the Federal Transit Administration Office of Research, Demonstration and Innovation. Mr. Mortensen is the manager of the FTA's Vehicle Assist and Automation (VAA) program, and the FTA lead for the USDOT's Connected Vehicle for Safety program, and Integrated Corridor Management (ICM) initiative. Steve has a Bachelor of Science degree in Mechanical Engineering and a Master of Community and Regional Planning degree from Iowa State University.

Roadway Transportation Data Business Plan
Anita Vandervalk, Cambridge Systematics

Session 1b:

Integrated Transportation Modeling Data Hub
Brandon Nevers, Principal Engineer, Kittelson & Associates, Inc.
Simulation models used in transportation analysis are not well integrated among different domains (e.g., operations, safety, and environment) and for different levels of analysis (i.e., macro, meso, and micro). This project developed a prototype data hub and data schema using the Network Explorer for Traffic Analysis (NeXTA) open-source software tool to save users time to input data and to model and display results in a common format. Researchers tested the newly developed model integration approach to address real-world transportation planning, operations, and management problems and demonstrated the approach to transportation planners at Portland Metro and Pima Association of Governments.

Long-term Pavement Performance Program Information Management System
Y. Jane Jiang, Research Highway Engineer, Federal Highway Administration Office of Infrastructure R&D
Jane Jiang is a member of the FHWA LTPP team, in charge of the LTPP Information Management System activities. In addition, she oversees data analysis projects using LTPP data.

ODOT's Use of Data for Snow & Ice Recovery Evaluation

John MacAdam, PE, ITS Engineer, The Ohio Department of Transportation

John MacAdam is a transportation engineer who has worked in the ODOT Office of Traffic Engineering for seven years. He developed a Snow & Ice Performance Evaluator which grades the department's maintenance efforts by analyzing two sources of data. The program detects weather events that affect the motoring public and then evaluates how ODOT maintenance crews responded to the weather event.

Research Data Exchange

Gene McHale, Team Leader, Federal Highway Administration Office of Operations R&D

Gene McHale is the Enabling Technologies Team Leader within the Federal Highway Administration, Office of Operations, R&D, located at the Turner-Fairbank Highway Research Center in McLean, Virginia. He has been supporting ITS and transportation operations research for over 20 years. He is currently serving as modal co-lead for the ITS Real-Time Data Capture and Management Program.

Web Based Delivery of Large Data

D.J. Swan, Sr. Pavement Management Engineer, Fugro Roadware

D.J. has an extensive background in developing long-term pavement plans, experience in the conceptualization and creation of pavement management systems, as well as expertise in the collection and analysis of pavement asset performance data. D.J. uses his understanding of engineering principles to provide context and meaning to collected data, thereby enabling DOTs to make informed infrastructure decisions.

National Highway Construction Cost Index

Vincent Fang, Sr. Economist, MacroSys, LLC

Dr. Vincent Fang has been a senior economist with MacroSys working on a number of U.S. DOT projects. He played a leading role in establishing the first U.S. Transportation Satellite Accounts, estimating highway capital stock, developing the multi-factor productivity index of transportation industries, and measuring the economic impacts of highway maintenance activities.

Session 1c:

Life Cycle Approach to Transportation Data Systems and Tools

Maria Chau, Senior Community Planner, Federal Highway Administration – New York Division

Maria Chau is the Senior Community Planner for Federal Highway Administration in the New York Division Office and is on the division performance management team. She is a member of the Federal Highway Administration Visualization Working Group, and is involved with the TRB Visualization Committee. She graduated in 2008 with her Master's degree in Regional Planning with a concentration in Transportation from University at Albany.

FHWA Data Integration Project

Ronald Vaughn, Transportation Specialist, Federal Highway Administration

Ronald is a Transportation Specialist with the Federal Highway Administration's Office of Policy, where he specializes in the area of highway system performance monitoring. Prior to joining FHWA, Ronald spent 5 years working as a Transportation Planner for a bi-county planning agency in Maryland. He holds a Bachelor's Degree in Geographic Information Systems (GIS) & Geography from The University of Maryland, and a Master's Degree in Transportation & Urban Infrastructure Studies from Morgan State University.

STREAM: A Systematic Technology Reconnaissance, Evaluation and Adoption Methodology

Steven W. Popper, Senior Economist, RAND Corporation

Steven W. Popper is a RAND Senior Economist and Professor of Science and Technology Policy in the Pardee RAND Graduate School. From 1996 to 2001 he was the Associate Director of RAND's Science and Technology Policy Institute (S&TPI.) Dr. Popper has also conducted research for, and has served as consultant to, several non-U.S. governments as well as multilateral international organizations such as OECD and the World Bank on issues of technology planning, industrial restructuring, and regional technology and economic development. He is chair of the American Association for the Advancement of Science section on Industrial Science and Technology.

Wireless Vehicle Detection System – Real-time Count Stations

James Cheeks, Chief of Traffic Signals, Safety, Standards and ITS, Washington, DC District Department of Transportation (DDOT)

James Cheeks has worked in the area of Traffic Safety and Engineering for over 32 years. He is a Fellow of the Institute of Transportation Engineers (ITE), a member of American Association of Civil Engineers (ASCE) and the Intelligent Transportation Society of America (ITS America). He has been a member of numerous NCHRP Panels and is currently responsible for the Highway Safety Program for the District of Columbia and all ITS activities. He has a Bachelor's Degree in Engineering from Dartmouth College and a Master's Degree in Civil and Environmental Engineering from Cornell University.

Seasonal Weight Restriction Decision Process

Jack Sickel, Transportation Information Group Manager, Alaska Department of Transportation and Public Facilities

Jack has over 23 years managing transportation data programs that support five Department core programs (traffic, highway safety, traveler information, road weather services, and transportation asset management), project selection, and resource allocation. The DOT experience also includes geographic information system services, highway inventory, and transportation information delivery. Jack is Chair of the TRB Statewide Transportation Data and Information Systems Committee and is a member of the TRB Transportation Asset Management and Statewide Multimodal Transportation Planning Committees.

The Confluence of Operations, Asset, Planning, Emergency Management, and Private Sector Transportation Data: Leveraging Existing Data through Better Integration, Visualization, and Open Access.

Michael L. Pack, Director, Center for Advanced Transportation Technology Laboratory (CATT Lab)

Michael L. Pack is the Director of the CATT Lab—an applied R&D laboratory at the University of Maryland focused on user- centered design of software, data mining, and information visualization systems for solving real-world transportation problems. He has previously worked for the Oak Ridge National Laboratory's Center for Transportation Analysis and the University of Virginia's Smart Travel Laboratory. Michael is the Chair of Visualization Committee of the National Academies of Science Transportation Research Board. Michael's background is in Digital Instrumentation and Measurement, Computer Science, Image Processing, and Systems Engineering. Michael holds degrees from James Madison University and the University of Virginia

Session 2a:

Advanced Mobile Asset Collection

Bill Toothill, Director Technical Services, DBI Services

Bill Toothill is the director Technology Services at DeAngelo Brothers Inc.; Bill is responsible for the research, development and deployment of technology across the company. Bill is the leader of a team of software developers, programmers and database specialists. The current focus of the Division is the integration of technology to facilitate efficiencies and cost savings for asset management and maintenance.

Unmanned Aerial Systems (UAS) for GIS mapping

Todd M. Audet, Deputy Director, Ohio Department of Transportation, District 2

Todd is an Ohio Licensed Professional Engineer with over 20 years of transportation professional experience with ODOT. He also spent 4 years in transportation logistics as president of Operations for Midwest Terminals of Toledo. and 28 years as a Military Engineer with the United States Air Force Reserve, Ohio Air National Guard

Value & Uses of Subsurface & Underground Data in Transportation

Steven DiBenedetto, Senior Geoscientist & Technology Manager, Underground Imaging Technologies, LLC

Mr. DiBenedetto is a geologist turned geophysicist responsible for directing the research and development of new and existing technologies for subsurface investigations at UIT. Among other duties, he and his team collect field geophysical data and interpret it to produce georeferenced three-dimensional maps of subsurface features. He has been collecting, interpreting and mapping geophysical data, along with some environmental consulting, for more than nine years since getting his master's degree from MIT.

Deriving Intelligence from Multiple Disparate Data Sources

Clark D. Richey, Jr., Technical Director, MarkLogic
Clark is the Technical Director, Public Sector for MarkLogic, managing Public Sector pre-sales engineering. Clark has over twelve years of experience in software engineering and system architecture with an emphasis on delivering large scale systems to Government customers.

Data Services for Transportation System Management and Performance Monitoring
Ted Trepanier, Senior Director, Public Sector, INRIX, Inc.
Ted Trepanier is the Senior Director for the Public Sector with INRIX, Inc. Prior to joining INRIX, Ted was the Director of Traffic Operations for the Washington State Department of Transportation. In addition to his extensive background in traffic operations, he has experience in design, planning, project management and toll operations. Ted earned his Bachelor's Degree in Civil Engineering from Washington State University and his Masters in Civil Engineering from the University of Washington.

Use of wide-area persistent airborne surveillance to capture highway flow metrics
Gregory W. Jordan, President, Skycomp, Inc.
Greg Jordan is the President of Skycomp, a company that has captured highway traffic flow metrics from aircraft since 1970. Since joining Skycomp in 1987 he has supervised over 400 traffic surveys. Mr. Jordan graduated from West Point in 1979, and received an MBA in 1987 from Georgetown University.

Session 2b:

Transportation Information Mapping System
Andrew Williams, Administrator, Office of Technical Services, Ohio Department of Transportation
20 plus year Transportation Professional with a B.S. in Industrial Systems Engineering and a Masters in Leadership and Policy. Currently serving as the Administrator of the Office of Technical Services and also the Agencies Asset Management Coordinator.

FHWA – Federal Lands Highway Data Visualization Project
Daniel W. Van Gilder and Armritpal Kang, GIS Program Manager, Eastern Federal Lands Highway Division, Federal Highway Administration
Dan Van Gilder: Dan is the GIS Coordinator for Eastern Federal Lands and has worked for FHWA 35 years. He was the team leader for this project.
Armritpal Kang: Amrit was the GIS developer for this project (Innovative Management Concepts, Inc). He was instrumental in the use of the Pivot Viewer on this project.

The Use of 3-D Visualization in the Road Safety Audit (RSA) Process
Rebecca Crowe, Transportation Specialist, Federal Highway Administration, Office of Safety
Ms. Crowe has been with Federal Highway Administration since February 2001 and has

worked for the Office of Safety since 2007. Ms. Crowe manages the Road Safety Audit, Older Driver and Motorcycle Safety programs. Ms. Crowe has a Bachelor's degree in Urban Planning and a Master's Degree in Transportation Policy.

Contemporary Systems for Map Enabling Transportation Data

Evan Caldwell, Solution Engineer, Esri

Evan Caldwell is a Solution Engineer on the National Government sales team in Esri's DC Technology Center. Evan specializes in several of Esri's Location Analytics offerings including Community Analyst, Business Analyst, and Business Intelligence integrations.

Features of the Redmon Digital Signage System for Commuters

John Redmon, Principal, Redmon Group Inc.

Redmon Group's Digital Sign System (RDSS) has been used in the Washington, DC area for more than 10 years. These signs provide real-time mobility information as well as customized promotional content in one glance. Unlike smartphone-based solutions which target each commuter individually, these signs can be visible to and used by all passers-by. Digital signs managed by the RDSS communicate with a content management system (CMS) that enables the signs to be updated and monitored remotely to ensure accurate information and quality service.

Visualizing Algorithms for ITS Research

Nathan Paczan, Software Systems Engineer, The MITRE Corporation

Mr. Paczan is a Software Systems Engineer at the MITRE Corporation in Mclean, VA. His research interests are in machine learning, algorithm development, and unmanned vehicle control systems. Recent activities include multiple research projects in algorithm development for integrating unmanned aircraft into the national airspace. Mr. Paczan serves as the lead for ITS research at MITRE.

Digital Roadway Interactive Visualization and Evaluation Network (DRIVE Net) Data Processing Applications.

Jonathan Corey, Graduate Research Assistant, University of Washington STAR Lab

Jonathan Corey has focused on transportation data management and analysis since his master's degree work on loop detector sensitivity level error detection and correction. His current work is focusing on traffic signal control development and analysis.

Mobile Data Collection

Ray Mandli, President, Mandli Communications, Inc

Raymond Mandli founded Mandli Communications, Inc. in 1983, and since then his company has grown to be one of the most innovative technology integrators in the transportation industry. During this time Mandli Communications has developed advanced mobile data collection systems that include imaging, positional, pavement, and LiDAR technology

Session 2c:

Data Visualization to Improve Decision Making at MD SHA

Subrat Mahapatra, Transportation Engineering Manager, Office of Planning and Preliminary Engineering, MD State Highway Administration (SHA)

Subrat Mahapatra leads various State Highway initiatives including the mobility and reliability related performance management efforts, MD Statewide Transportation Model, Planning for Operations and the MD SHA Mobility report. He is actively engaged in the development and implementation of various applications and processes for performance driven decision-making at SHA. Subrat holds a Masters in Civil Engineering from University of Maryland, College Park and serves on various national and state research panels and committees.

Greg Slater, Director, Office of Planning and Preliminary Engineering,

As Planning Director, Mr. Slater focuses on data driven decision support frameworks to develop sustainable transportation solutions for Maryland. He leads various SHA initiatives including mobility, safety, performance based planning, asset management and enterprise GIS technology based solutions. Mr. Slater is a 1997 Graduate of Towson University in Geography and Environmental Planning, a 2007 Graduate of the University Of Maryland National Leadership Institute, a 2009 Graduate of the SHA Advanced Leadership Program and a registered GIS Professional. Mr. Slater's career has focused on data driven decision support coupled with performance management and he serves on various national committees in this area.

FTA Transit Economic Requirements Model Lite ("TERM Lite")

John Giorgis, Federal Transit Administration (waiting for his bio)

HRT Capital Project Prioritization System

Andrew Zalewski, Transportation Planner, Foursquare Integrated Transportation Planning

Andrew is a Transportation Planner at Foursquare ITP, a transportation planning firm based in Rockville, Maryland. His work focuses on multi-modal planning with an emphasis on public transportation and bikeshare systems, as well as strategic planning for transit agencies. Andrew holds a Master's of City Planning degree from the University of Pennsylvania.

Data Driven Approach to the Development of Possible Solutions to Transportation Corridor Problems

Tim Lomax, Senior Research Engineer and Regents Fellow, Texas A&M Transportation Institute

Dr. Lomax has been involved in urban mobility research for more than 30 years. He leads a team of researchers and communications specialists who produce the Urban Mobility Report—an examination of congestion trends in major U.S. cities. The team has developed performance measures and communication techniques to describe mobility to a wide range of audiences for several purposes.

HERS: A Tool for Trade-Off Analysis
Rabinder Bains, Senior Economist, Federal Highway Administration
Rabinder has been with FHWA since 2010 in the office of Policy. She is a member of the team that produces the Condition and Performance Report to Congress every two years. She has experience in benefit cost analysis, micro and macroeconomics research and performance management. Prior to joining FHWA, Rabinder worked at the Minnesota Department of Transportation.

A Practical Investment Optimization Tool by Means of Certainty-Uncertainty Searches
Brian G Chow, Senior Physical Scientist and Professor, RAND Corporation
Dr. Chow is a co-developer of PortMan, which is a portfolio management method described in three monographs under the Toward Affordable Systems series, and his latest publication is one in March 2013 on Portfolio Optimization by Means of Multiple Tandem Certainty-Uncertainty Searches. All four free reports can be downloaded from www.rand.org or requested from chow@rand.org. He has authored or co-authored over 100 publications. He received a Ph.D. in physics from Case Western Reserve University, and a M.B.A. with Distinction and a Ph.D. in finance from the University of Michigan.

Appendix B: List of Exhibitors

- Advanced Mobile Asset Collection (AMAC)/DBI Services
- AMEC Inc. – on-site support for HRDI/FHWA/DOT
- ATRI
- Bandwagon
- Bureau of Transportation Statistics
- Dallas/Fort Worth International Airport
- Eastern Federal Lands Highway Division
- FHWA Office of Operations R&D
- FHWA Office of Safety
- Fugro Roadware
- IMPulse NC
- Inrix
- Kittelson & Associates, Inc.
- Limntech Scientific Inc.

- Mandli Communications, Inc.
- MarkLogic
- Mobility Lab
- Redmon Group Inc.
- Skycomp, Inc.
- Smart Transportation Applications and Research Laboratory (STAR Lab) at the University of Washington
- Texas A&M Transportation Institute
- The MITRE Corporation
- Underground Imaging Technologies, LLC
- University of Maryland, Center for Advanced Transportation Technology
- Virginia Tech Transportation Institute