Advanced Operational Concepts

National Rural ITS Conference
Huntington, WV
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Workshop Objectives

- Provide an overview of National ITS / Operations priorities and future program directions
- Describe and apply recommended approach to planning for operations
- Present a range of advanced operational strategies
- Provide examples and resources
Agenda

- Introductions
- Overview of US DOT ITS Programs
- Overview of ITS Architecture and National ITS Initiatives
- Overview of the FHWA Planning for Operations Program
- Planning for Operations
- Advanced Operational Strategies
- ITS Knowledge Resources
Welcome and Introductions

- **Facilitators**
  - **Cheryl Lowrance, P.E., PTOE**
    Principal ITS Engineer
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  - **Jocelyn Bauer**
    Senior Research Analyst
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  - **Jim Hunt, P.E.**
    Transportation Specialist
    FHWA, Office of Operations, jim.hunt@dot.gov

- **Participants**
Overview of USDOT ITS Program

- ITS Strategic Research Program
- Cross-Cutting Programs
- IntelliDrive℠
ITS Strategic Research Program, 2010-2014

- Focused on Connectivity
- Four Program Elements:
  - IntelliDrive™ Research
    - Applications research
    - Technology research
    - Policy research
  - ITS Modal Applications: New highways, transit, rail, and maritime applications
  - ITS Cross-Cutting Programs
    - ITS Professional Capacity Building for a high performing workforce
    - ITS Architecture and ITS Standards for planning and interoperability
    - ITS Evaluation to produce knowledge on cost, benefits, lessons learned, and deployment tracking
  - ITS Exploratory Initiatives: Soliciting new and innovative ideas
The ITS Program: Past, Present and Future

The Universe of ITS

- Traditional ITS Technologies
  - Ramp Metering
  - Transit Information
  - CV Electronic Credentialing
  - Transportation Management Centers

- Major ITS Initiatives
  - ICM
  - IVBSS
  - VII - POC
  - MSAA
  - NG911
  - NG9-1-1
  - IVBSS MSAA
  - VII - POC
  - CV Electronic Credentialing

- Research
  - Drivers
  - Vehicles
  - Infrastructure
  - Wireless Devices

- Wireless Connectivity

- Deployment

- Demonstration/Deployment
What’s Changed (from VII)

- DSRC only → Technology options
- OEM production units only → Aftermarket & retrofit considerations
- Light vehicle focus → All vehicle types
- Prototyping/proof of concept → Focus towards deployment
- Limited stakeholders → Broader stakeholder engagement
- Limited visibility by “outsiders” → Greater program transparency
- US focus → International harmonization
- Loosely coupled programs → Strong, collective USDOT support, coordination, and leadership
Complexity

- Safety focus
- Continued high fatality rates
- Growing congestion
- Growing interest in transit
- Growing environmental awareness
- Troubled transportation financing
- Road pricing and financing alternatives
- Transportation impacts on livability
Connectivity

- Wireless technology boom
- Strong consumer market
- Wireless connectivity is ubiquitous
- Fast pace of innovation
- Person-to-person networking
- Agency to agency networking
ITS Strategic Plan: Vision for 2010-2014

National, multi-modal surface transportation system that features a connected transportation environment among vehicles (cars, trucks, buses, fleets of all kinds), the infrastructure, and mobile devices to serve the public good by leveraging technology to maximize safety, mobility and environmental performance. Connectivity is achieved through dedicated short range communications (DSRC).

Goal: Safety
Vehicle to Vehicle Communications for Safety
Vehicle to Infrastructure Communications for Safety

Goal: Mobility
Real-Time Data Capture and Management
Dynamic Mobility Applications

Goal: Environment
Applications for the Environment: Real-Time Information Synthesis (AERIS)
Real-time, environmental data from all sources will be integrated and available for use in multimodal transportation management and performance improvement and will contribute to better environmental practices.
What Can IntelliDriveSM Do For You?

Mobility Benefits
- V2I, I2V Interactivity (SPAT)
- Data-Rich Environment
  - Operations Efficiency
  - Traffic, Transit, Parking
  - Weather
  - Performance Management

Safety Benefits
- Increase Driver Situational Awareness
- Reduce or Eliminate Crashes
  - Driver Advisories
  - Driver Warnings
  - Vehicle Safety Controls

Environmental Benefits
- Reduce Emissions
- Save Fuel
For More Information...

http://www.intellidrive.org/
FHWA Operations Programs

- Recurring Congestion
- Non-recurring Congestion
- Freight Operations
- Operations Foundation
How is the Congestion Pie Sliced?

- Bottlenecks: 40%
- Traffic Incidents: 25%
- Work Zones: 10%
- Bad Weather: 15%
- Poor Signal Timing: 5%
- Special Events: 5%
Reducing Non-Recurring Congestion

- Traffic Incident Management
- Planned Special Events
  Traffic Mgt.
- Work Zone Management
- Road Weather Management
- Congestion Mitigation
Reducing Recurring Congestion

- Arterial Management
- Traffic Signal Timing
- Access Management
- Corridor Traffic Management
- Bottleneck Reduction
- Freeway Management / Managed Lanes
- Travel Demand Management
- Tolling & Pricing
Improving Day-to-Day Operations Foundation for 21st Century Ops

- Manual on Uniform Traffic Control Devices
- Real-Time Transportation Information
- Traffic Analysis Tools
- Performance Measurement
- Facilitating Integrated ITS Deployment
- Planning for Operations
Operations Areas to Keep an Eye On

- Real Time Systems Management Information
  - SAFETEA-LU State requirement
- Every Day Counts
  - Traffic Signal Adaptive Control
- Reauthorization?
  - Freight focus?
  - Performance-based?
  - Livability and sustainability?
  - Congestion pricing?
ITS ARCHITECTURE AND SYSTEMS ENGINEERING
ITS Architecture is a Framework for Developing Integrated Transportation Systems

Identifies
- Organizations
- Systems operated
- Functions performed
- Communications
- Information exchanged
ITS Architecture includes: Agencies, Systems, Communications, Information Flows

- Traffic
- Traveler Info
- Transit
- Emergency Services
- Request for Traffic Information
- Traffic Information
What is the National ITS Architecture?

- HIGH-LEVEL national framework, “blueprint”, used to help guide ITS deployment and transportation planning
- Based on 33 transportation related ITS User Services:
  - Physical Entities – Subsystems/Terminators
  - Logical Architecture – Processes, Data Flow
  - Interfaces – Information Flows
  - Deployment oriented Market Packages
National ITS Architecture Subsystems
Market Packages

Architecture
Framework spanning all of ITS

Market Packages
Contain pieces of the architecture that provide a particular transportation service
Many Market Packages Suitable for Rural Contexts

- Demand Response Transit Operations
- Transit Vehicle Tracking
- Transit Traveler Information
- Broadcast Traveler Information
- Interactive Traveler Information
- Transportation Operations Data Sharing
- Yellow Pages and Reservation
- Network Surveillance
- Traffic Probe Surveillance
- Traffic Information Dissemination
- Standard Railroad Grade Crossing

- Speed Monitoring
- Roadway Closure Management
- Freight Administration
- Electronic Clearance
- Weigh-In-Motion
- Roadside CVO Safety
- Early Warning System
- Evacuation and Reentry Management
- Emergency Call-Taking and Dispatch
- Wide-Area Alert
Yellowstone Architecture Interconnect Diagram
Federal Rule (Part 940)

- Applies to:
  - Projects funded by the Highway Trust Fund
  - Any project incorporating an ITS User Service

- Regional Architecture
  - Agencies / stakeholders
  - Operational Concepts
  - Agreements
  - System functional requirements
  - Interfaces
  - Standards
  - Project sequencing

- Systems Engineering
Final Rule (Part 940)

- Requires the Use of Systems Engineering Processes
  1. Identify the portion of the regional architecture being implemented
  2. Identification of participating agencies
  3. Definition of requirements
  4. Analysis of alternatives
  5. Procurement options
  6. Standards and testing procedures
  7. Resources for operations and maintenance
Benefits of Using Systems Engineering

- Reduced risk of schedule and cost overruns
- Increased likelihood that the implementation will meet user’s needs
- Improved stakeholder participation
- More adaptable and resilient systems
- Verified functionality and fewer defects
- Higher level of reuse from one project to the next
- Better documentation
Project Failures are Visible

Heinz Stoewer, INCOSE International Symposium 2004
# Project Success is Rare

<table>
<thead>
<tr>
<th>Year</th>
<th>Failed</th>
<th>Challenged</th>
<th>Succeeded</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>23%</td>
<td>49%</td>
<td>28%</td>
</tr>
<tr>
<td>2004</td>
<td>15%</td>
<td>51%</td>
<td>34%</td>
</tr>
</tbody>
</table>


- Average cost overrun: 45%
- Time overrun: 63%
- Functionality delivered on average: 67%

Standish Group
Traditional Project Development Process Has Led to This Success

<table>
<thead>
<tr>
<th>Planning</th>
<th>Program/Budgets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Initiation</td>
<td>Preliminary Engnrng</td>
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Low Risk of Unsuccessful Implementation!

- Performance of products and materials well understood
- Requirements well defined and understood
- Proven, well-known technology
- Documented, proven designs
Result: Long-Lasting Highways Are Designed, Built, and Tested
### ITS Infrastructure Expansion: Low-Risk Projects

<table>
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</table>

| Ops & Maintain | Change & Upgrade | Retire/Replace |

Processes and approved manuals ALSO in place for field installation of many ITS technologies.
This Traditional Process Does NOT Work for Complex ITS Projects.
## SE “V” and the Traditional Project Development Process

<table>
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<tbody>
<tr>
<td>Project Initiation</td>
<td>Preliminary Engnrng</td>
</tr>
<tr>
<td>Construction</td>
<td>Project Closeout</td>
</tr>
</tbody>
</table>

- **Regional Architecture(s)**
  - Feasibility Study / Concept Exploration
- **Concept of Operations**
- **System Requirements**
- **High-Level Design**
- **Detailed Design**
- **Software / Hardware Development**
- **Field Installation**
- **Integration and Reconfiguration**
- **System Verification**
- **System Validation**
- **Changes and Upgrades**
- **Operations and Maintenance**
- **Retirement/Replacement**
- **Operations & Maintain**
- **Change & Upgrade**
- **Retire/Replace**

### Timeline
- **Decomposition and Definition**
- **Integration and Reconfiguration**
V Systems Engineering Model

Lifecycle Processes

- Regional Architecture(s)
- Feasibility Study / Concept Exploration
- Concept of Operations
- System Requirements
- High-Level Design
- Detailed Design
- Software / Hardware Development Field Installation
- Implementation

Development Processes

- System Validation Plan
- System Verification Plan (System Acceptance)
- Subsystem Verification Plan (Subsystem Acceptance)
- Unit / Device Test Plan
- Unit / Device Testing

Integration and Recomposition

Decomposition and Definition

Time Line

Operations and Maintenance
Changes and Upgrades
Retirement/Replacement

U.S. Department of Transportation
Research and Innovative Technology Administration
Systems Engineering Examples / Resources

- Northern Virginia ITS Architecture
- Minnesota ITS Planning and Regional Architecture Update
- Systems Engineering for ITS Handbook
Systems Engineering Examples / Resources

FHWA / Caltrans Systems Engineering Guidebook

- Checklist: Concept of Operations
  - Are the operations described from the viewpoints of all key stakeholders?
  - Are both normal and failure operational scenarios included?
  - Has an identification of stakeholders and their responsibilities been made?
  - Are both constraints and metrics in the system? Does the system include external interfaces?
  - Etc.

MN Project Background and Purpose

- Meet federal requirements
- ITS projects meet identified goals and objectives
- Update the Regional ITS Architecture
- Mainstream ITS projects into the normal planning process

Source: Ray Starr Minnesota DOT
Historic ITS Planning Approach

Vendor has cool idea or gizmo

We agree to test it

It works!

Now, what can we use it for?

Source: Ray Starr Minnesota DOT
Current Development Process

Source: Ray Starr Minnesota DOT
O4 Reduce Incident Clearance Time

- **Need**
  - TM09 Share surveillance video data, and other information with PSAPs

- **Existing**
  - Mn/DOT RTMC operates a CCTV system accessible to Mn/DOT, the state patrol, some cities, and the St. Cloud TOCC

- **Gaps**
  - Provide video from RTMC and TOCCs to local emergency responders

Source: Ray Starr Minnesota DOT
Using ITS Architecture for Project Development

- Challenges
  - Funding
  - Incorporate ITS into the traditional on-going transportation program

- Recommended ITS Mainstreaming Process

Source: Ray Starr Minnesota DOT
Large Group Discussion

- Local / audience sharing of examples of development, maintenance, use of ITS architecture (?).

- What is your experience with your regional architecture and systems engineering process?
Overview of FHWA Planning for Operations Program

• FHWA Office of Operations, FHWA Office of Planning and FTA's Office of Planning

  ▪ Key elements
    □ Promote regional transportation operations collaboration and coordination
    □ Elevate management and operations considerations in regional planning and investment process
    □ Leverage opportunities for linkage between regional operations collaboration and regional planning.
Overview of FHWA Planning for Operations Program: Planning-Operations Linkages

A Cultural Shift
Overview of FHWA Planning for Operations Program: Resources
### System Efficiency

<table>
<thead>
<tr>
<th>Fact Sheet Title/Page Number</th>
<th>Operations Objective</th>
</tr>
</thead>
</table>
| Delay / 41                  | • Reduce hours of delay per capita by $X$ percent by year $Y$.  
|                             | • Reduce hours of delay per driver by $X$ percent by year $Y$. |
| Trip Connectivity / 45      | • Reduce door-to-door trip time by $X$ percent by year $Y$.  
|                             | • Reduce cost of transfer fees paid by $X$ percent by year $Y$. |

### System Reliability

<table>
<thead>
<tr>
<th>Fact Sheet Title/Page Number</th>
<th>Operations Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variability / 50</td>
<td>• Reduce the variability of travel time on specified routes by $X$ percent during peak and off-peak periods by year $Y$.</td>
</tr>
<tr>
<td>Transit On-time Performance / 51</td>
<td>• Improve average on-time performance for specified transit routes/facilities by $X$ percent within $Y$ years.</td>
</tr>
</tbody>
</table>

### Emergency/Incident Management

<table>
<thead>
<tr>
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<th>Operations Objective</th>
</tr>
</thead>
</table>
| Incident Duration / 63      | Discovery and Verification Time  
|                             | • Reduce mean incident notification time (defined as the time between the first agency’s awareness of an incident and the time to notify needed response agencies) by $X$ percent over $Y$ years (i.e., through “Motorist Assist” roving patrol programs, reduction of inaccurate verifications, etc.). |
PLANNING FOR OPERATIONS
Responding to a Changing World

- Travelers expect more choices and better information
- Increasing requirement to get the most out of existing resources
- Expanding opportunities through technology
- Increasing pressure to address climate change
- Efficient evacuations
- Need to share data and information
- Global economy that demands effective multi-modal solutions

Requires a shift towards performance-based solutions and away from project-focused responses
Need for a New Approach

We need an new approach to integrate operations into the planning process that:

- Aligns limited resources with regional needs and goals for the greatest impact
- Focuses on continuous improvement rather than individual projects
- Increases attention to the operational performance of the multi-modal transportation system
- Identifies cost-effective strategies that deliver measurable improvements
Objectives-Driven, Performance-Based Approach
What is Planning for Operations?

- A strategic, collaborative, and continuous effort...
  - To plan for and guide the improvement of regional transportation system performance

- Typically, it is...
  - A joint effort between planners and operators
  - Focused on integrating management and operations strategies in the transportation planning process
  - Driven by objectives and performance measures
What is Management and Operations?

M&O is: “A regionally integrated program to optimize the performance of existing infrastructure

- Through multimodal and intermodal, cross-jurisdictional systems, services, and projects …
- Includes regional operations collaboration and coordination activities between transportation and public safety agencies.”

- **ITS provides the technological tools that enable operations.**
Examples of Management and Operations Strategies

Applied individually or in combination

- Transit signal priority
- Emergency response and homeland security
- Freight management
- Travel demand management
- Transit fleet management and dispatching

- Traffic incident management
- Traveler information services
- Road weather management
- Freeway management
- Traffic signal coordination
- Work zone management
- Electronic payment/toll collection

Regional ITS Architecture provides a blueprint for how ITS (used for many M&O strategies) can be coordinated on a regional level.
Regional ITS Architecture & Planning for Operations

- Planning for operations encompasses ITS architecture development and maintenance
- ITS Architecture contributes to overall planning for operations through:
  - defining operational needs and technologies to address operational issues
  - data availability for planning and monitoring performance
  - engaging multiple agencies in thinking about how to improve system performance
Objectives-Driven, Performance-Based Approach

- Regional goals and motivation
- Operations objectives
- Systematic process to develop and select M&O Strategies to meet objectives
- M&O Strategies
- Metropolitan transportation plan
- Transportation improvement program and other funding programs
- Implementation

Monitoring and evaluation:
- Define performance measures
- Determine operations needs
- Identify M&O strategies
- Evaluate M&O strategies
- Select M&O strategies for the plan
Objectives-Driven, Performance-Based Approach and the Plan

Transportation Plan includes:

- Goals and measurable objectives that advance operational performance outcomes of the transportation system
- Performance measures used to track progress toward objectives
- M&O strategies to meet the measurable objectives

M&O strategies are programmed and implemented in collaboration with local agencies
Benefits of Objectives-Driven, Performance-Based Approach

- Operators and planners work together in developing and addressing short-term and long-term system performance objectives
- Agencies effectively prioritize investments to achieve agreed upon objectives
- System performance outcomes are improved
- Implemented performance measures demonstrate accomplishments
Use of Approach at the Champaign-Urbana MPO in Illinois

- Sets multimodal objectives in areas of operations, safety, security, and others
- Ex. Improve average vehicular travel time by at least 1.5 minutes during peak hour periods on major traffic corridors by 2035
- Establishes specific strategies/actions to accomplish each objective
- Uses MOEs to track progress

Source: Choices – Champaign-Urbana Urbanized Area Transportation Study Long Range Transportation Plan
Operations Goals in the MTP

- Goals describe desired end state
- Examples of operations goals:
  - “Maximize the Efficient Utilization of Existing and Future Transportation Infrastructure…” Choices, Champaign-Urbana MPO’s Long Range Transportation Plan (Illinois)
  - “Use incentives and other strategies to reduce reliance on single occupant vehicles.” 2009 – 2034 Rogue Valley Regional Transportation Plan (Oregon)
- Other goals include safety, economy, land use, etc.
Operations Objectives that are SMART

Operations objectives to be included in the plan are developed through collaboration with a broad range of regional participants and reflect regional values.

**Specific.** Sufficient to guide approaches

**Measurable.** Quantitative measurement

**Agreed.** Consensus among partners

**Realistic.** Can be accomplished

**Time-Bound.** Identified time-frame for accomplishment
Sample Operations Objectives

- Improve average travel time during peak periods by X percent by year Y.
- Improve average on-time performance for specified transit routes/facilities by X percent within Y years.
- Reduce time between incident/emergency verification and posting a traveler alert to traveler information outlets (variable message signs, agency website, 511 system) by X minutes in Y years.
- Increase customer satisfaction rating of the timeliness, accuracy, and usefulness of traveler information in the region by W, X, and Z percent, respectively, over Y years.
## Operations Objectives in the Planning Process

<table>
<thead>
<tr>
<th>Stage of Planning Process</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operations Goal(s)</strong></td>
<td>Improve transportation system reliability / reduce unexpected traveler delay</td>
</tr>
<tr>
<td><strong>Operations Objectives</strong></td>
<td>Reduce incident-based delay so that by 2010, travelers experience…</td>
</tr>
<tr>
<td><strong>Performance Measures</strong></td>
<td>• Average incident duration (mean minutes per incident) • Vehicle hours of non-recurring delay due to incidents</td>
</tr>
<tr>
<td><strong>Strategies</strong></td>
<td>• Traffic cameras and detection systems to identify incidents more quickly • Roving incident response teams</td>
</tr>
<tr>
<td><strong>Projects/ Implementation</strong></td>
<td>• Install traffic cameras on Route X (2009) • Install variable message signs on Route X (2010) • Implement Incident Clearance Teams on Route X (2010)</td>
</tr>
</tbody>
</table>
Exercise: Forming SMART Operations Objectives

- **Purpose:**
  - Review and critique regional objectives for an MPO developing its MTP

- **Review objectives and re-write objectives to be SMART**
  - Specific, Measurable, Agreed, Realistic, and Time-Bound
  - Reduce traffic congestion on major interstate highways
  - Reduce incident based delay by 40 percent
  - Encourage participation in the regional commuter travel demand management program
  - Ensure that transit service is reliable
Systematic Process for Developing and Selecting M&O Strategies to Meet Operations Objectives
Definition of Performance Measures

- Indicators of how well transportation system is performing
- Provide adequate information on progress toward achieving objectives
- Developed collaboratively among planners and operators in the region
The Key Role of Performance Measures

- Track progress toward operations objectives
- Identify needs and system performance deficiencies
- Assess potential impacts of M&O strategies
- Evaluate effects of implemented projects
- Communicate progress to stakeholders
## Sample Transportation System Performance Measures

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>Average travel times; Average travel speeds</td>
</tr>
<tr>
<td>Congestion extent</td>
<td>Lane miles of congested conditions</td>
</tr>
<tr>
<td></td>
<td>Average hours of congestion per day</td>
</tr>
<tr>
<td>Delay</td>
<td>Vehicle-hours of recurring delay</td>
</tr>
<tr>
<td></td>
<td>Non-recurring delay</td>
</tr>
<tr>
<td>Incident occurrence/delay</td>
<td>Median minutes from time of incident to clearance</td>
</tr>
<tr>
<td>Travel time reliability</td>
<td>Buffer time; Buffer time index</td>
</tr>
<tr>
<td>Transit performance</td>
<td>On-time performance</td>
</tr>
<tr>
<td></td>
<td>Transit travel times in comparison to personal vehicle travel times</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>Percent reporting being satisfied</td>
</tr>
<tr>
<td>Person throughput</td>
<td>Peak hour persons moved per lane</td>
</tr>
</tbody>
</table>
Data Sources for Performance Measurement

- Permanent collection devices producing continuous data to be archived
- Temporary data collection efforts (floating cars, etc.)
- Other agencies in the region
- Estimated data from transportation model output
- Private data collection companies
SMALL GROUP EXERCISE: DEVELOP OPERATIONS OBJECTIVES, PERFORMANCE MEASURES & DATA
Determining Operations Needs

Regional goals and motivation

Operations objectives

Systematic process to develop and select M&O Strategies to meet objectives

M&O Strategies

Metropolitan transportation plan

Transportation improvement program and other funding programs

Implementation
Discussion

- A first step in reaching objectives is determining needed changes from a multi-agency, regional perspective
- How are operations needs identified in your region?
Methods for Determining Needs

- Collecting data on transportation system to determine location and causes of performance issues
- Convening operators in region and examining where activities can be coordinated and improved
- Revisiting needs brought out during the regional ITS architecture development
Developing and Selecting M&O Strategies

1. Regional goals and motivation
2. Operations objectives
3. Systematic process to develop and select M&O Strategies to meet objectives
4. Metropolitan transportation plan
5. Transportation improvement program and other funding programs

Monitoring and evaluation:
- Define performance measures
- Determine operations needs
- Identify M&O strategies
- Evaluate M&O strategies
- Select M&O strategies for the plan

Implementation
Identifying M&O strategies to address operations needs

- M&O strategies best established through collaboration between operators in the region and planners

- Strategies may include:
  - Expansion of current operations capabilities/services
  - Adoption of best practices from another region
  - Institutional arrangements enabling mutual support and cooperation between operators
  - Implementation of new systems
Operations Committees at the MPO

- Many MPOs convene committees of operators in their regions to coordinate ITS/operations activities and recommend M&O strategies for consideration in the Plan and TIP

Examples:
- Capital District Transportation Committee (Albany, NY) hosts Regional Operations Committee to assist in proposing M&O strategies/initiatives in TIP
- Hampton Roads Intelligent Transportation System (ITS) and Operations Planning Committee reviews ITS applications for CMAQ funding and provides recommendations to MPO
Evaluating proposed M&O strategies – a variety of tools

- Sketch-Planning Tools
- Travel Demand Models
- Analytical/Deterministic Tools (HCM-Based)
- Traffic Signal Optimization Tools
- Macroscopic Simulation Models
- Mesoscopic Simulation Models
- Microscopic Simulation Models
Sketch Planning Tools

- Provide quick order of magnitude estimates with minimal input data in support of preliminary screening assessments
  - SCRITS
  - Quickzone
  - Turbo Architecture
  - Cal B/C
  - Simple spreadsheets
  - Deployment frameworks
Example Sketch Planning – Wisconsin Traffic Operations Infrastructure Plan

- Desire to integrate operations into long range planning
  - Consistency with WisDOT planning
- Help to guide statewide operations infrastructure
- Quantitative – data driven approach
- Uses 10 operations oriented criteria
- Result – score that prioritized corridors for different intensities of ops improvements

http://www.topslab.wisc.edu/workgroups/toip.html
1 Data Collection

- Criteria are chosen to reflect areas of Mobility, Safety, and Development Pressure
- Include impacts of severe weather and special events
Scoring

- Roadway links are scored based on Criteria
- Weights are applied to generate overall Deployment Density Class
3 Technology Recommendations

- Based on Deployment Density Class and Roadway Functional Class
- Are provided as a range of options

Spectrum of Deployment Density

Baseline
Low
Medium
High

- Mobile Probes:
  - Negotiate for use of private or other public agency cameras
- Surveillance:
  - Supply cameras at site specific locations based on data
  - Cameras no more than two miles spacing
- Incident Management:
  - Reference markers
  - Coordination with local PSAPs to identify closest resource
  - Preplanned closure and detour plans
  - Incident management resources available on-demand for major incidents
  - Trailblazer signs on freeway and alternate routes activated for emergency detours
  - Dedicated weekday service patrols
  - Cameras at interchanges and site specific locations based on data
- Traffic Flow Management:
  - Portable DMS and/or HAR for major incidents or closures
  - Ramp Closure Gates
  - Ramp metering in specific segments where cost-effective
- Traveler Information:
  - Portable DMS and/or HAR used for construction, major incidents and special events
  - Pre-trip information (i.e., web-based or kiosk)
  - Fixed DMS and/or HAR at major interchanges/decision points
  - Fixed DMS at major interchanges and every 5-10 miles along freeway – DMS report travel times to major decision points
- 511 – RWIS

U.S. Department of Transportation
Research and Innovative Technology Administration
Wisconsin Traffic Operations Infrastructure Plan

In July 2006, the Wisconsin Department of Transportation (WisDOT) initiated preparation of a Traffic Operations Infrastructure Plan (TOIP) with the goal of developing a methodology and associated tool to strategically evaluate potential operational improvements from technology applications, improved communications, and intelligent transportation systems (ITS) in a manner similar to traditional highway infrastructure projects. The planning effort has resulted in a quantifiable method for that evaluation, designed to build upon current WisDOT planning and programming processes.

The plan is structured around primary corridors across Wisconsin, and the technology areas include detection, incident management, traffic signal systems, surveillance, ramp and highway traffic flow management, communications, and traveler warning and information. An initial TOIP report was completed in May 2008, and the plan was refined in 2009 with benefit-cost analyses and implementation guidance.

The TOIP received the FHWA & FTA Transportation Planning Excellence Award.

Final Reports (2008)
Corridor and Metro Node Maps
Resulting Metropolitan Transportation Plan and TIP

Operational goals and motivation

Operations objectives

Systematic process to develop and select M&O strategies to meet objectives

Metropolitan transportation plan

Includes:
- Regional goals
- Operations objectives
- Performance measures
- M&O strategies

Transportation improvement program and other funding programs

Implementation

Monitoring and evaluation
Including M&O strategies in the plan

- Formalized commitment to efficient operation of regional transportation system
- Required by SAFETEA-LU
- No “one-size-fits-all” solution for how this is done
- Operations objectives guide decisions on funding projects/programs for operations

Discussion: What are examples of how M&O strategies are included in your plan? Are there projects that result from these strategies?
Potential Resources to Support M&O

- M&O projects may be eligible for:
  - State or local funds
  - Surface Transportation Program (STP)
  - Congestion Mitigation and Air Quality (CMAQ) Improvement Program
  - State planning and research funding
  - Others

- Examples of innovative funding sources:
  - Development fees
  - Partnerships with private companies
  - Turnpike tolls
Federal-aid Eligibility for M&O: Operating Costs

- Many M&O costs are eligible for Federal funding from National Highway System and Surface Transportation Programs
  - Examples include integrated traffic control systems, incident management programs, and traffic control centers.

- Operating costs in air quality non-attainment and maintenance areas may be eligible for Congestion Mitigation and Air Quality Improvement Program funds

- For more information:
  - [http://ops.fhwa.dot.gov/travelinfo/resources/ops_guide.htm](http://ops.fhwa.dot.gov/travelinfo/resources/ops_guide.htm)
Monitoring and Evaluation of System Performance and M&O Strategies
Reasons to Monitor and Evaluate

- Re-examine success of approach in reaching operations objectives
- Increased understanding of effects on system performance
- Adjust projects/programs based on results
- Provides information to calibrate/refine planning tools and models
- Increased understanding of connections between investments and performance
ORGANIZING FOR OPERATIONS
Operations Culture

▪ Institutionalizing Operations
  ▫ Orientation to customers and their service needs
  ▫ Focus on now rather than future
  ▫ Focus on performance outcomes not outputs
  ▫ Emphasis on managing rather than development
  ▫ A 24/7 service, not a 9-5 office
  ▫ Scaled to trip – not just my jurisdiction

▪ Capability Maturity Model
▪ Systems O&M Guide
▪ Virginia DOT Experiences
Capability Maturity Model

- Characteristics of successful SOM programs
- Adopted from IT / software development
- Two key dimensions
  - Business processes (scope, planning and programming, technology and systems, performance measurement)
  - Institutional architectures (culture/outreach, organizational staffing, resource allocation to SO&M, collaboration)
- Levels (Performed ➔ managed ➔ integrated ➔ Optimized)
- Has been applied to several states
- Will be included in AASHTO Guide to Systems Operations and Management
Objective: Mainstreaming SO&M as formal SDOT program

- Guidance for SDOT managers
- Identify the appropriate next steps in improving the effectiveness of their SO&M activities – based on the current state of play

Guide is developed as an on-line, self-evaluation-driven, user-tailored tool

Scheduled completion date December 2010
# The Process Dimension

## 1. Business processes
- Scoping/Planning
- Program development
- Programming and Budgeting
- Procurement
- Operations

## 2. Systems and Technology
- Regional architectures
- Project systems engineering (design) process
- Standards/interoperability
- Testing and validation
- Maintenance

## 3. Performance
- Measures definition
- Data acquisition management
- Measures utilization
The Institutional Dimension

1. Mission
   □ Mission commitment
   □ Operations Culture
   □ SDOT authorities (laws)
   □ Continuous improvement acceptance (culture)

2. Leadership
   □ In-reach
   □ Outreach (policy-makers, stakeholders)

3. Organization
   □ Status/authority (equivalence)
   □ Unit relationships (consolidation)
   □ Authority/responsibility allocation

4. Staffing
   □ Core capacities definition/filled
   □ Technical capacities (staff development)
   □ Career path (incentives),
   □ Recruitment and retention

5. Resources
   □ Funding sources
   □ Budgeting/resource allocation

6. Partnerships
   □ Interagency (cooperation, co-training)
   □ Intergovernmental (cooperation, coordination)
   □ Participation in MPO activities
   □ PPP (rationalized outsourcing)
<table>
<thead>
<tr>
<th>Level</th>
<th>Name</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>1</td>
<td>Incomplete</td>
<td>Ad hoc processes</td>
</tr>
<tr>
<td>2</td>
<td>Performed</td>
<td>Procedures defined and tracked</td>
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<tr>
<td>3</td>
<td>Managed</td>
<td>Process is managed and measured</td>
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<tr>
<td>4</td>
<td>Established</td>
<td>Continuous Analysis</td>
</tr>
<tr>
<td>L-1</td>
<td>L-2</td>
<td>L-3</td>
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<tr>
<td>Need for architectural standardization among state and regional systems are ignored</td>
<td>Regional architecture developed and subjected to periodic reviews</td>
<td>System implementations recognize need for future upgrades as systems installed by others offer increased functionality and expanded data interchange requirements</td>
</tr>
</tbody>
</table>
## Appropriate Strategy to Get to the Next Level

<table>
<thead>
<tr>
<th>GENERAL STRATEGY TO ADVANCE LEVELS OF MATURITY – TOP MANAGMENT</th>
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<tbody>
<tr>
<td><strong>L-1 (\rightarrow) L-2</strong></td>
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<tr>
<td>Ensure that agency is an active participant in the development and maintenance of the regional architecture.</td>
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</table>
Virginia Department of Transportation
Organizational Change

Source: Connie Sorrell VDOT
Connie.Sorrell@vdot.virginia.gov
VDOT Case for Organizational Change

- Last 100 Years - Two Core Missions – Build and Maintain Roads
- Corporate cultures of DOTs - Engineering focused, top down, hierarchical
- Primary responsibilities for interstate and arterial networks
- Multiple other entities with overlapping responsibilities
  - Toll and other authorities
  - Metropolitan Planning Organizations
  - Local governments
  - Transit agencies
- Local roads under local controls
VDOT Case for Organizational Change

- Few organizational changes over decades
- Early 1990s Technology Applications deployed for congestion – ITS in more congested regions
- 2000s – Recognition by FHWA, AASHTO that Operating the highway system is an equal CORE function.
- Increasing attention to congestion issues

New Mission – OPERATE the Network
VDOT Mission

VDOT will plan, develop, deliver, operate and maintain, on time and on budget, the best possible transportation system for the traveling public.

- **Plan** – Design the network to meet future needs
- **Develop** – Provide the engineering and financial expertise to construct the project
- **Deliver** – Construct the projects
- **Operate** – Manage the operation of a safe, effective and efficient ground transportation system
- **Maintain** – Preserve and operate assets
How do you geographically organize all the Operations functions that are and are “to be” (ITS, System Engineering, Traffic Engineering, Smart Traffic Centers, Safety) to deploy them in a systematic statewide, programmatic way?
Case 1: Deciding How To Deliver Services Statewide

Do we move forward with 9 Districts Geographical coverage versus travel sheds and corridors organized differently?

**Background:**

- Decentralized approach to delivering the day to day operational aspects of traffic engineering, ITS, incident management, emergency operations, etc. in the field.
- Not all districts are equally equipped for the task.
- VDOT has 5 ½ Smart Traffic Centers (STC) established within the most urban of the 9 existing construction districts.
- The construction district boundaries were created in the 1920s based on the 1922 Congressional maps.
- Traffic patterns have no regard for these boundaries and development has spilled out of urban areas crossing district lines.
State DOT structures

Construction Districts
Systems Operations Regions
Case 2: How To Organize Functions for a Statewide Operations Program?

Once the corporate decision is made, to make Operations a “core” function, what critical functions must be identified and organized to deliver this new business?
Decide How To Organize the New Business of Operations

- After the decision to only deploy operations in the field through 5 regional service centers, **how should it be organized and staffed?**
- What changes are needed with central office/headquarters functions?
- What are the critical functions that are needed to deliver the business and which ones need to be in the central office (headquarters) versus the field? How should they be organized and staffed.
- What should be outsourced?!
Operations Functions

**Planning**: ITS program development, planning, administration, and funding.

**Engineering**: ITS project development and engineering; ITS system analyses (technology / failure); data analyses. Traffic Engineering; capacity and safety improvements; public liaison and response; plan development, review and coordination.

**Operations**: Operability and condition monitoring of the roadway network and work zones; incident management; emergency management coordination; operability and condition monitoring of ITS systems, devices and applications.

**Inspection, Maintenance and Construction**: ITS systems & devices, traffic and pedestrian signals, traffic control and safety devices – signs, pavement markings, lighting, rumble strips, and guardrail.
Case 3: Building New Organizations and Filling Positions

Now that there are defined geographic areas of responsibility and functional responsibilities, how do you build the new organization to carry out the business?

*Form follows function*
Measuring Success

- How will you know your reorganization is successful?
- What are the measures of organizational performance, rather than program or system performance?
- How do you ensure that the measures reflect customer desires?
- How many measures are enough?
- How do you create a sense of shared ownership in success and failure?
What It Takes To Do Real Time Organizational Change

- Support from the CEO
- Vision-driven change manager to engage the organization
- Compelling reason for the needed change
- Clear, regular communications about why the change is needed, what the goal is.
- Employees involvement in help shaping the change.
- Stakeholder involvement and support
- Collaboration with team-based action research to work through the detail and to learn-by-doing.
- Resources to develop the change management plan and to implement the plans
- Actions through on-going decision-making based on team recommendations at each phase.
VDOT Summary

- Organizations are living eco-systems with cultures and subcultures; they live and change. Some die.
- Management teams that spend quality time evaluating organizational capacity for change and risk on the front end will be more successful.
- Strong visionary planning processes help organizations change in proactive ways.
- How you treat the people who are most affected by the change will determine their commitment to the change.
Operations Considerations in Design

- Design Guides / manuals
  - Incident and emergency management
    - Access, locating incidents
  - Criteria for deployment
  - Standards
- Work zone traffic management
- Opportunities to incorporate operations elements into construction

Consideration of Highway Operations during the Project Development and Design Process

Guidance for Division Office Transportation / Area Engineers

BACKGROUND AND PURPOSE

All of us in the Division are becoming more and more involved in operations, traffic management, and operational issues, including the area engineers who are FHWA’s front line for developing and implementing traditional road and bridge (civil) construction projects.

The purpose of this reference is to provide some food for thought for the Area Engineers. With the combination of computer software development, systems engineering,
ADVANCED OPERATIONAL STRATEGIES
Rural Issues: Safety, Mobility, Transit

ITS Enhancements:

- Incident management/Mayday system
- Transportation management in congested areas:
  - Tourist sites
  - Seasonal harvesting areas
  - Construction zones, etc.
- Integrated traveler information: tourist/road/weather/traffic conditions
Advanced Operational Strategies

- Road Weather
- Work Zone Management
  - Smart Work Zones
- Incident and Emergency Management
- Traveler Information Systems
- Transit Management
- Other ITS Tools
  - Advanced Warning Systems
  - Variable Speed Limits
  - Fog detection
  - Curve Warning
Road Weather Management

- **Purpose**: mitigate the effects of rain, snow, ice, fog, high winds, flooding, tornadoes, hurricanes, & avalanches
- **Description**: Advisory, control, & treatment strategies to promote safe travel under adverse weather conditions
Benefits - Road Weather Management

- In North Carolina, a wet pavement detection system on I-85 yielded a 39% reduction in the annual crash rate under wet conditions.

- Signal timing plans implemented in Minnesota to accommodate adverse winter weather resulted in an 8% reduction in delay.

- In Salt Lake City, Utah, staff meteorologists stationed at a TOC provided detailed weather forecast data to winter maintenance personnel, reducing costs for snow and ice control activities, and yielding a b/c ratio of 10:1.

- Evaluation data show that anti-icing and pre-wetting strategies can reduce sanding applications by 20% to 30%, decrease chemical applications by 10%, and reduce chloride and sediment runoff in local waterways.

- In Idaho, 80% of motorists surveyed who used Road-Weather Integrated Data System information as a traveler information resource indicated that the information they received made them better prepared for adverse weather.
Road Weather

- Environmental Sensor Stations
- Mobile Sensors
- Information Dissemination
- Treatment Strategies
- Traffic Signal Control
- Variable Speed Limits
Weather related road closure

- Northern Interstate ramps during adverse weather
- Complete closure in mountain passes
Other Adverse Roadway Conditions

- Advanced Warning Systems
- Animal Crossings
- Pre-Trip/En-Route Information
- Reversible Lanes
Work Zone Management

- Portable Traffic Management Systems
- Traveler Information Systems
- Speed Enforcement & Display Systems
- VMS Merge Point Notification
Benefits - Work Zone Management

- In Nebraska, a portable speed detection and warning system placed upstream from an I-80 work zone decreased the highest 15% of vehicle speeds by about 5 mi/hr as vehicles approached the work zone lane merge area.

- In North Carolina, a modeling study indicated that work zone delay messages reduced maximum traffic backups by 56% and contributed to 55% reduction in traveler delay.

- Modeling data indicated that an automated work zone information system deployed on I-5 near Los Angeles contributed to a 4.3% increase in diversions and an 81% increase in average network speed.

- In North Carolina, a survey of local residents near Smart Work Zone systems found that over 95% would support use of these systems in the future.
Portable Traffic Management Systems

- **Purpose:** Improve safety by increasing driver awareness of traffic conditions in work zones
- **Description:** Collect, process, & display work zone traffic information to the road user
Incident Management
Incident Management

- **Purpose:** Improve safety by coordinating response to incidents, reducing duration of dangerous conditions
- **Description:** Monitor roadways, identify incidents, notify responders, notify travelers via VMS, etc., operate service patrols, alternate routes
Benefits - Incident Management

- The Maryland State CHART highway incident management system facilitated a 28.6% reduction on the average incident duration leading to an estimated 377 fewer secondary incidents.
- In Georgia, the NaviGAtor incident management program reduced the average incident duration from 67 minutes to 21 minutes, saving 7.25 million vehicle-hours of delay over one year.
- In 2004, a survey was conducted by the University of California, Berkeley, which found that the benefits of the Los Angeles Metro Freeway Service Patrols outweighed the costs by more than 8 to 1.
- In Georgia, the NaviGAtor incident management program reduced annual fuel consumption by 6.83 million gallons, and contributed to decreased emissions: 2,457 tons less Carbon monoxide, 186 tons less hydrocarbons, and 262 tons less Nitrous oxides.
- In Atlanta, satisfaction with motorist assistance patrols ranged from 93% to greater than 95% in two surveys of drivers already aware of the service.
Incident Response & Mitigation

- Incident Management
- Emergency Vehicle Signal Preemption
- Telemedicine
- HAZMAT Management
- Emergency Vehicle CAD/AVL
- Motorist Assistance Patrols/Call Box Systems
Emergency Management

- Getting the proper resources to the scene as quickly as possible.
  - Use vehicle location technologies to know where vehicles are
  - Signal pre-emption to clear the way for emergency vehicle
  - Geographical Information Systems to tell response teams where to go
Benefits - Emergency Management

- HAZMAT safety and security technologies can reduce the potential for terrorist consequences by approximately 36%.
- In Hampton Roads, Virginia, a hurricane evacuation plan indicated that lane reversal is warranted for any hurricane predicted to make landfall as a Category 4 or 5 storm, and is strongly recommended for any Category 3 storm.
- HAZMAT safety and security technologies can have tremendous societal cost savings well beyond the break even point for benefits and costs.
- Freeway lane reversal improved traffic volumes by 44% following South Carolina hurricane.
- Survey responses from key professionals in five states indicate the following ITS technologies have the highest potential to benefit emergency transportation operations: interoperable radio communications, dynamic message signs, GPS and geographical information systems, closed circuit television roadway surveillance, and Enhanced 911.
Traveler Information Systems
Benefits - Traveler Information Systems

- IDAS models of ARTIMIS in Cincinnati and Northern Kentucky estimated traveler information reduced fatalities 3.2%.
- In the Washington DC metropolitan area, drivers who use route-specific travel time information instead of wide-area traffic advisories can improve on-time performance by 5% to 13%.
- In the DC area, models showed pre-trip departure notification can reduce early/late arrivals and save 40% of users $60 or more each year in lost time.
- Modeling studies in Detroit, Seattle, and Washington, DC have shown slight improvements in corridor capacity with provision of traveler information.
- A simulation study indicated that integrating traveler information with traffic and incident management systems in Seattle, Washington could reduce emissions by 1% to 3%, lower fuel consumption by 0.8%, and improve fuel economy by 1.3%.
- Customer satisfaction with 511 ranged from 68% to 94% in four deployments studied.
Transit Management
Transit Management

- Components of system
  - Computer-aided dispatching
  - Automatic passenger counting
  - Automatic vehicle location
  - Advanced voice and data communication
  - Electronic payment
Benefits - Transit Management

- Transit signal priority systems improved bus travel times 1-42%.
- An evaluation of scheduling software for the paratransit service in Billings, Montana found that the break-even point for savings as a result of the software implementation was a 3% improvement in efficiency.
- In Portland, OR, models of transit data showed AVL/CAD may allow same level-of-service to more travelers using the same rolling stock.
- Simulation of a transit signal priority system in Helsinki, Finland indicated that fuel consumption decreased by 3.6%, Nitrogen oxides were reduced by 4.9%, Carbon monoxide decreased by 1.8%, hydrocarbons declined by 1.2%, and particulate matter decreased by 1.0%.
- Surveys found that riders on Vancouver's 98 B-line Bus Rapid Transit (BRT) service, which implemented transit signal priority to improve schedule reliability, rated the service highly with regard to on-time performance and service reliability (an average of 8 points on a 10 point scale).
Advanced Warning Systems

- **Purpose:** Improve driver performance under dangerous conditions
- **Description:** Sensors monitor roadway and/or vehicle conditions to warn of excessive speed in curves, ramps, or downhill grades
Variable Speed Limits

- **Purpose:** Post an enforceable speed limit that is set to maximize throughput, and/or accommodate specific conditions
- **Description:** Speed limit signs controlled by traffic operations/management centers
GROUP DISCUSSION ON DEVELOPING STRATEGIES TO ACHIEVE OPERATIONS OBJECTIVES
**ITS JPO Knowledge Resources**

- **ITS Applications Overview**
  

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<th>Intelligent Infrastructure</th>
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<td><strong>Arterial Management</strong></td>
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<td><strong>Freeway Management</strong></td>
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<td><strong>Crash Prevention &amp; Safety</strong></td>
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<td><strong>Road Weather Management</strong></td>
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<tr>
<td><strong>Electronic Payment &amp; Online</strong></td>
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<tr>
<td><strong>Traveler Information</strong></td>
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In Florida, the addition of Open Road Tolling (ORT) to an existing Electronic Toll Collection (ETC) mainline toll plaza decreased crashes by an estimated 22 to 26 percent.
The City of Tyler, Texas deployed Adaptive Control System (ACS)-Lite on a 3.17-mile corridor at a cost of $546,900.

12/09/2007
Tyler, Texas, USA

Summary Information

In November 2007, the City of Tyler deployed the Adaptive Control System (ACS)-Lite on a 3.17-mile corridor at a cost of $546,900. The deployment included the following costs: $150,600 for the control software, $150,300 for traffic sensors, and $357,900 for detection devices.

Citing the results of a study of the ACS installation, an analysis of traffic improvements:

- Weekday morning: At peak traffic hours in the morning, motorists experienced the largest drop in drive time, with the average trip time in both directions dropping from just more than nine minutes each way to less than six minutes. On average, motorists' amount of stops dropped from 2.9 on the route to one stop per trip while traveling north, and from 3.1 to two per trip travelling south.

- Midday: The average northbound trip time dropped from about 9.5 minutes to 8 minutes and 46 seconds, and the
ITS Lessons Learned

www.itslessons.its.dot.gov

Coordinate the schedules for ITS deployment and roadway construction to maximize use and benefits of the system.
Fourteen states report Deploying Pedestrian Safety Systems.
Rural ITS

http://www.ops.fhwa.dot.gov/int_its_deployment/rural/rural.htm

Rural Intelligent Transportation Systems

FHWA has made efforts to support deployment of Intelligent Transportation Systems (ITS) technology in statewide and rural areas in the United States. In an ongoing effort to continue the support for ITS solutions for rural applications, this web page provides the most current information provided by FHWA regarding ITS deployment for rural transportation needs as well as links to other organizations that are addressing rural transportation related issues.

- Publications
- Related Links

Contact Us

Steve Clinger
Stephen.Clinger@dot.gov
(202) 366-2168
Additional Resources

- www.its.dot.gov
- www.pcb.its.dot.gov

ITS Professional Capacity Building Program

Welcome to ITS Professional Capacity Building

The ITS Professional Capacity Building (PCB) Program provides comprehensive, accessible, and flexible ITS learning for the transportation industry. By using the program’s, public agencies can build and sustain a capable and technically proficient ITS workforce and transportation professionals can develop their knowledge, skills, and abilities while furthering their career paths.

ITS Technical Assistance

The ITS PCB Program offers technical assistance resources to State and local transportation agencies, and to FHWA Field Offices.

- ITS Peer-to-Peer Program helps resolve ITS challenges by speaking to your peers.
- The ITS Help Line provides technical support by e-mail or telephone 888-367-7487.

Scheduled T3 Webinars

- Presentations by Mac Lister, ITS PCB Program Manager, at 2010 ITSA Annual Meeting
- Added to the T3 Archives: 10/27/09 Webinar: National ITS Architecture Update