Integrated Corridor Management (ICM)
Agenda

• Integrated Corridor Management (ICM)
• USDOT ICM Initiative
• Program History
• Deployment sites: Dallas, TX and San Diego, CA
• Comprehensive evaluation
• Knowledge and Technology Transfer
Recent Headlines (2010 and 2011)

“Rebounding areas pay price in gridlock”
“New study estimates for first time the public health costs of traffic congestion in U.S.: At least 2,200 premature deaths and $17.8 Billion”
“Expect to spend more time in traffic this year.”
“Vehicle crashes cost region $11.3 billion annually”
Corridor managed as system

- Freeway Systems
- Rail Systems
- Parking Systems
- Bus Systems
- Integrated Operations
- Arterial Signal Systems
Management implies action

- Management” implies more than passive monitoring—It implies action.
- Pro-active, and integrated multi-modal management
- Improve Situational Awareness
- Enhance Response and Control
- Better inform travelers
Examples of Supporting Technologies

- Active Traffic Management
- Managed Lanes
- Transit only lanes
- Transit signal priority
- Multimodal, actionable traveler information
- Real-time traffic signal control
- Integrated electronic payment
Supporting Systems

- Data fusion engines
- Decision support systems
- Predictive Capabilities
- Expert Systems
- Real-time Simulation
- Data Hub
- Performance Monitoring
ICM Systems (ICMS)
USDOT ICM Initiative

• Goals
  • Demonstrate and evaluate ICM
  • Provide tools, knowledge, and guidance

• Program Performance
  • Success of the ICM Program will be defined by the ability of future locations to implement ICM
ICM Pioneer Sites

- Seattle
- San Diego
- Montgomery County
- Dallas
- San Antonio
- Houston
- Minneapolis

**LEGEND:**
- All Pioneer Sites developed ICM Concept of Operations, Sample Data, and Requirements
- *Italicized:* Completed ICM AMS
- **Bolded/Italicized:** Demonstration Site

From Research to Results: Analysis, Modeling and Simulation

Approach and Findings
ICM AMS Focus: Integrated Performance Measures
## ICM AMS Pioneer Site Corridors

<table>
<thead>
<tr>
<th>Location</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dallas, TX</td>
<td>Major employers, No ability to expand, Surrounding construction planned</td>
</tr>
<tr>
<td>Minneapolis, MN</td>
<td>Busy commuter corridor, Limited expansion capacity, Major construction planned</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>Popular freight, tourist and commuter corridor, Lengthening peak travel periods</td>
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**Strategies**

<table>
<thead>
<tr>
<th>Dallas, TX</th>
<th>Minneapolis, MN</th>
<th>San Diego, CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated management</td>
<td>Integrated management, Coordinated incident management, Multi-agency data exchange</td>
<td>Integrated management, Coordinated incident management, Dynamic ramp metering</td>
</tr>
<tr>
<td>Coordinated incident management</td>
<td>Manag</td>
<td></td>
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</table>
# ICM Benefits Corridor Performance

<table>
<thead>
<tr>
<th></th>
<th>San Diego</th>
<th>Dallas</th>
<th>Minneapolis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Travel Time Savings</td>
<td>246,000</td>
<td>740,000</td>
<td>132,000</td>
</tr>
<tr>
<td>(Person-Hours)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement in Travel Time</td>
<td>10.6%</td>
<td>3%</td>
<td>4.4%</td>
</tr>
<tr>
<td>Reliability (Reduction in Travel Time Variance)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gallons of Fuel Saved Annually</td>
<td>323,000</td>
<td>981,000</td>
<td>17,600</td>
</tr>
<tr>
<td>Tons of Mobile Emissions</td>
<td>3,100</td>
<td>9,400</td>
<td>175</td>
</tr>
<tr>
<td>Saved Annually</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
ICM Benefits Far Outweigh Costs

**KEY:**
- □ 10-Year Cost
- □ 10-Year Net Benefit
- *Benefit Cost Ratio (italicized)*
Multi-level Analysis

• Regional patterns and mode shift; Transit analysis capability

• Traveler information, HOT lanes, congestion pricing and regional diversion patterns

• Traffic control strategies such as ramp metering and arterial traffic signal control
Iterative Feedback Process between Macro, Meso, and Micro Models

- Trip Generation
- Trip Distribution
- Mode Choice
- Trip Assignment

Regional Travel Demand Model

- Trip Table
- Network
- Other Parameters

Interface

- Peak Spreading
- Network Resolution

Mesosimulation and/or Microsimulation

- Dynamic Assignment
- Pivot Point Mode Choice
- Refined Transit Travel Times

- Refined Trip Table (Smaller Zones and Time Slices)
- Refined Network

Corridor-Level Performance Measures

- VMT/VHT/PMT/PHT
- Travel Time/Queues
- Throughput/Delay
- Environment
- Travel Time Reliability
- Fuel Consumption

- Benefit Valuation

Outputs

- Benefit/Cost Analysis
- Sensitivity Analysis
- Ranking of ICM Alternatives

User Selection of Strategies

Cost of Implementing Strategies
ICM AMS Helps Corridor Managers:

- **Invest in the right ICM strategies**
  - Help determine which combinations of strategies are likely to be most effective and under what conditions
  - Enables better, tangible understanding of ICM impacts and benefits
- **Invest with confidence**
  - Minimize conflicts or unintended consequences that would otherwise be unknowable before implementation
- **Improve the effectiveness/success of implementation**
  - Help build consensus among stakeholders
  - Optimize implementation staging
  - Provide insight to operators on how to refine ICM strategies in different operational conditions
- **Provide long-term capability to continually improve implementation based on experience**
Impact of ICM AMS

• ICM AMS improved analysis tools and method
  – More comprehensive picture of corridor performance through the integration of existing models that provide visibility into full travel shed
  – New tools for analysis of transit, congestion pricing, HOT lanes, ramp metering, and active traffic management
  – Improved model calibration and data analysis methods
From Research to Results: Demonstration
ICM Demonstration Scope

- Construct ICM Systems
- Integrate Transportation Operations
- Share and Utilize data for decision-making
- Operate differently
- Improve performance

Learn More: http://www.its.dot.gov/icms/
ICM Demonstration Sites

• San Diego, CA

• Dallas, TX
ICM Demonstration Schedule

• ICM Phase 3 Demonstration Stage Kick-off – Jan. 2010
• Design and Development – 18 months
  – Includes Pre-deployment data collection period
• Operations and Maintenance – 18 months
  – Includes Post-deployment data collection period
• Evaluation –
  – 6-12 months pre-deployment
  – 18 month post-deployment
ICM Demonstration Site – San Diego

ICM Strategy categories:
- Share/distribute information
- Improve Junctions/Interfaces
- Accommodate/promote network shifts
- Capacity/demand Management

Learn More: http://www.its.dot.gov/icms/
ICM Demonstration Site – San Diego

- Joint Operations and Maintenance Plan
- Real-time Decision Support
- Integrated regional data system
- Managed priced lanes
- Bus Rapid Transit
- Real-time transit data/information
- Actionable Traveler Information
- Coordinated Freeway/Arterial control
- Responsive signal operation
- Coordinated network management
San Diego ICMS Context Diagram

ICMS

System Services
IMTMS
DSS

PeMS³
LCS
RMIS
ATMS 2005
MLCS²
CPS
REMS¹
WebEOC⁴
3C's⁵
RTMS
SPS
Sprinter TCS
ATIMS (511)
RAMS

2-Managed Lanes Control System (currently implemented as a 5-mile Reversible Lane Control System (RLCS) until managed lanes construction is completed)

1-Regional Event Management System—public safety CAD systems (currently CHP but others possible over time)

4-County EOC maintains WebEOC as regional information exchange

5-Regional High-Bandwidth uWave Network

Modal Color Scheme
- Freeway
- Arterial
- Transit
- Public Safety
- ATIS/511

One-way ICMS interface
Two-way ICMS interface
DSS/control interface
ICM Demonstration Site – Dallas

• ICM Approaches:
  – Increase corridor throughput
  – Improved incident management
  – Improve travel time reliability
  – Enable intermodal travel decisions
ICM Demonstration Site – Dallas

• Joint Operations and Maintenance Plan
• Real-time Decision Support
• Integrated regional data system
• Managed lanes
• Light rail transit
• Real-time transit data/information
• Actionable Traveler Information
• Responsive signal operation
• Coordinated network management

• Learn More: http://www.its.dot.gov/icms/
ICM – Decision Support Systems

• Decision Support System (DSS)
  – Information systems that support multimodal, transportation operational decision-making in real-time.

  – The significance and importance of the ICM DSS lies in the fact that modal actions in response to short-term or long-term impacts on the corridor will be coordinated and not carried out in isolation as is usually the case.
ICM – Decision Support Systems

• DSS – A family of systems
  – GIS-based visualization platform
  – Source(s) of real-time data
  – Source(s) of historical data
  – Persistent data storage
  – Business Process engine
  – Expert systems or other rule-based engine
  – Traffic-responsive algorithms
  – Predictive algorithms
  – Real-time simulation/tools
  – Off-line modeling
ICM – Decision Support Systems

System Services
- Persistent Storage (includes Library of a-priori plans)
- Non-R/T Simulation
  - Off-Line Modeling
  - A-Priori Response Plans
- Archived Data
  - Enhancements to serve as the corridor performance management element of DSS

DSS
- Visualization
- Business Processes
  - Business Process Workflow
  - Business Rules
  - Response Plans
- R/T Simulation
- Predictive Tool(s)

Data Hub
- Data Transformation
- Servers/Communications
- Interfacing Systems

External Feeds
San Diego ICM DSS Context Diagram

**Corridor Management**
- Transportation Coordinator
  - Decision Support System

**Area Coordinators**
- Transportation Coordinator

**IMTMS Web Services**
- Monitoring Strategies
  - XML
  - Control Strategies

**IMTMS Network**
- 511
  -XML
- Arterial (QuicNet 5)
- Transit (RTMS)
- 911 (CAD)

**Modal Color Scheme**
- Freeway
- Arterial
- Transit
- Public Safety
- Public Safety

**Using tools such as:**
- Expert systems
- GIS
- Real-time modeling
- ETc.

**Regional Transportation Network**
- Freeway Events
  - Arterial Events
  - Road closures
  - EV routing
- RMS Timing
  - CMS signing
  - CCTV control
- Congestion Events
  - CMS
  - CCTV
  - RMS

**Signal timing**
- Congestion Events
- CMS
- CCTV
- Signal Phasing

**Congestion Events**
- CMS
- CCTV
- Signal Phasing

**Freeway Events**
- Arterial Events
- Road closures
- EV routing

**RMS Timing**
- CMS signing
- CCTV control

**ATIS/511**
- Freeway
- Arterial
- Transit
- Public Safety
- Public Safety

**Control Strategies**
- Modify bus service
- Create new routes

**Bus location**
- Train location
- Events
- Security CCTV Schedule

**Freeway**
- (ATMS 2005)
Dallas ICM DSS Context Diagram

- DSS
  - Expert System
  - Evaluation System
  - Predictive System
  - DSS-DD GUI
  - SmartNET (Web based information sharing tool)

- SmartFusion
  - DSS-DD Process
  - Data Dissemination
  - Data Archive
  - Data Fusion
  - Data Store
  - Data Collection
From Research to Results:
Evaluation
Comprehensive Evaluation

• Does the system do what it is intended to do?
• ICM Hypotheses – “ICM will…”
  • Improve Situational Awareness
  • Enhance Response and Control
  • Better Inform Travelers
  • Improve Corridor Performance
  • Hold other priorities harmless
Evaluation – Institutional & Organizational

- **DOT Hypothesis**
  - Document enhancements to operating agencies’ management, operational, and coordination practices and measure the change in their ability to implement ICM strategies
  - Breadth, Decisions, Formalization, Capabilities, Behavior
    - Sustainability, Lessons Learned

- **Primary Data Sources**
  - Deployment team interviews, Stakeholder interviews
  - Partnership documents, Technical Capability Analysis Findings

- **Design**
  - Pre and Post Deployment interviews

- **Evaluation Methods**
  - Content Analysis of partnership documents
  - Perceptions and interview summaries
  - Identification of best practices, good-faith efforts that fell short, lessons learned

• Learn More: http://www.its.dot.gov/icms/
Evaluation – Corridor Performance

DOT Hypothesis

Evaluation Hypothesis

Primary Data Sources

Design

Evaluation Methods and Statistical Analysis

Optimizing networks at the corridor level will result in an improvement to multi-modal corridor mobility performance, particularly on high travel demand and/or reduced capacity periods

Mitigate recurrent and incident-related congestion, overall corridor performance

Freeway Data
Transit Data
HOV and Managed Lanes Data
Arterial and Frontage Data

“Before” and “After” Design

Compare mobility measures among pre-implementation, shakedown and post-implementation periods under various scenarios
Use AMS model for person-based corridor performance MOEs
Isolate and separately analyze data associated with routine versus non-routine (incidents, maintenance, construction, and weather-influenced) conditions
Compare corridor performance to a control corridor; or, alternatively, compare to a control group composed of a sample of transportation facility segments in the region

Learn More: http://www.its.dot.gov/icms/
Evaluation – Benefit Cost

Because ICM must compete with other potential transportation projects for scarce resources, ICM should deliver benefits that exceed the costs of implementation and operation.

- DOT Hypothesis
- Primary Data Sources
- Design
- Evaluation Methods

Deployer’s Cost Reports

- Standard Benefit-Cost Ref’s (for Benefits Monetization Factors)
- Other Nat’l Eval Analyses and/or Regional Models (benefits)

“With” vs. “Without ICM” over a 10-year Life-Cycle

- Excel-based B/C Model
- Annualized Life-Cycle Costs and Benefits
- Sensitivity and Uncertainty Analysis

Learn More: http://www.its.dot.gov/icms/
### Evaluation – Technical Capacity

- **DOT Hypothesis**

  - Evaluation Hypotheses
  - Primary Data Sources
  - Design
  - Evaluation Methods and Statistical Analysis

- **Improve Situational Awareness:** Operators will realize a more comprehensive and accurate understanding of underlying operational conditions considering all networks in the corridor.

- **Enhance Response & Control:** Operating agencies within the corridor will improve management practices and coordinate decision making, resulting in enhanced response and control.

  - situational awareness, response, control and reporting capabilities

  - Site Self-Reporting
    - Incident Reports
  - Operator Logs
  - System Utilization Reports
  - Site Observations at control rooms

  - “Before” and “After” Design

- **Analysis**
  - In depth reviews of coverage areas and availability of field equipment
  - Operator interview summaries and site observations
  - Analysis of data streams and operator logs

- **Learn More:** [http://www.its.dot.gov/icms/](http://www.its.dot.gov/icms/)
Evaluation – Decision Support Systems

Decision Support Systems provide a useful and effective tool for ICM project managers through its ability to improve situational awareness, enhance response and control mechanisms and provide better information to travelers, resulting in at least part of the overall improvement in corridor performance.

- Data Fusion
- Quality Responses
- Complexity
- Timeliness
- Prediction Accuracy

Data Fusion Engine
Input Data
DSS Outputs

Interviews/Surveys/Workshops
On-Site Observations

“Before” and “After” Case Study Design

Qualitative Assessments (operator perceptions & evaluator observations)
Independent Laboratory Testing

Comparison of Quantitative DSS System Data with Approximated “Ground Truth”
Examining All Aspects of Performance Under Varying Conditions

Learn More: http://www.its.dot.gov/icms/
Evaluation – Traveler Response

Travelers will have actionable, multi-modal (highway, arterial, transit, parking, etc.) information resulting in more personally efficient mode, time-of-trip-start, and route decisions.

- Awareness
- Utilization
- Behavior
- Satisfaction

Primary Data Sources
- Corridor Traveler Survey
- Traveler Info. Sys. Utilization Reports
- Transit Ridership Survey
- Diversion Counts

“Before” and “After” Design for Surveys and System Data

Evaluation Methods and Statistical Analysis
- Descriptive Statistics
- Cross-Frequency Tables
- General Linear Regression Models
- Logistic Regression - Poisson Regression
  Include Survey Design and Repeated Measures in Variance Estimation

Learn More: http://www.its.dot.gov/icms/
From Research to Results: ICM Knowledge and Technology Transfer
ICM KTT Mission:
Equip corridor managers and operators across the country to implement and use ICM.
Check out the ICM Knowledgebase

http://www.its.dot.gov/icms/knowledgebase.htm

KTT Resources Coming Spring 2012:

- ICM Implementation and AMS Guides
- Early Adopter Workshops and Webinars
- ICM and Transportation Operations Information Briefs

Resources Available Now:

- Pioneer site CONOPs and Requirements Documents, and Lessons Learned
- AMS Resources and Findings
- Data Gap Technical Resources
- Magazine Articles and Outreach Materials
COMING APRIL 2012

ICM IMPLEMENTATION GUIDE AND AMS GUIDE

FOR PROGRAM MANAGERS
ICM Guidance Features

• Step-by-step Guidance
  – with estimates on relative levels of effort based on experience
• Multidimensional Guidance
  – Technical, Institutional, Programmatic, Operational
• Example Products and Worksheets
• Pitfalls to Avoid and Tips
  – Based on Lessons-Learned from the Pioneer Sites
• Testimonials from Implementers
• Examples (from the Pioneer Sites)
• Pointers to Related Resources
  – National ITS Architecture, Systems Engineering or related initiatives such as FHWA’s Planning for Operations resources
  – Traffic Analysis Toolbox, of which the ICM AMS Methodology is now a part
COMING SPRING 2012~

ICM Knowledge and Technology Transfer Workshops
Workshop Outcomes

• Ability to apply concepts in the Guide(s)
• Genuine buy-in/commitment from all key stakeholders
• Willingness to ‘stay the course’
• Develop the ICM products to the appropriate level of detail.
• All stakeholders contribute to effective use of meeting time, and commitment to action plan
ICM Workshop Outputs

• Progress (Inputs/Agreements/ Framework) towards an ICM milestone or deliverable of interest to the host location
• Action Plan
• Feedback/input to enhance workshop design and KTT materials
ICM Workshop Building Blocks

- Information Sharing
- Peer support
- Tool or Technique Demonstration
- Learning Opportunity or Activity
- Product Development Activity
- Learning Assessment
Check out the ICM Knowledgebase

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Questions?

http://www.its.dot.gov/icms/knowledgebase.htm

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