



Accelerating solutions for highway safety, renewal, reliability, and capacity

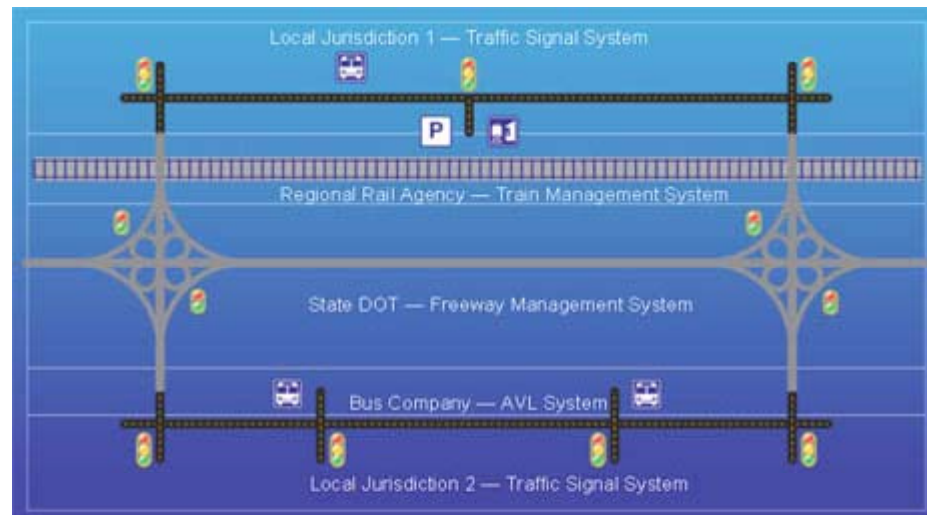
Regional Operations Forum

Managing a Corridor

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

What is a Corridor?

- “A broad geographical band that follows a general directional flow connecting major sources of trips that may contain a number of streets, highways and transit route alignments.”
 - From “Glossary of Regional Transportation Systems Management and Operations Terms” (TRB Circular)



How Travelers Use a Corridor

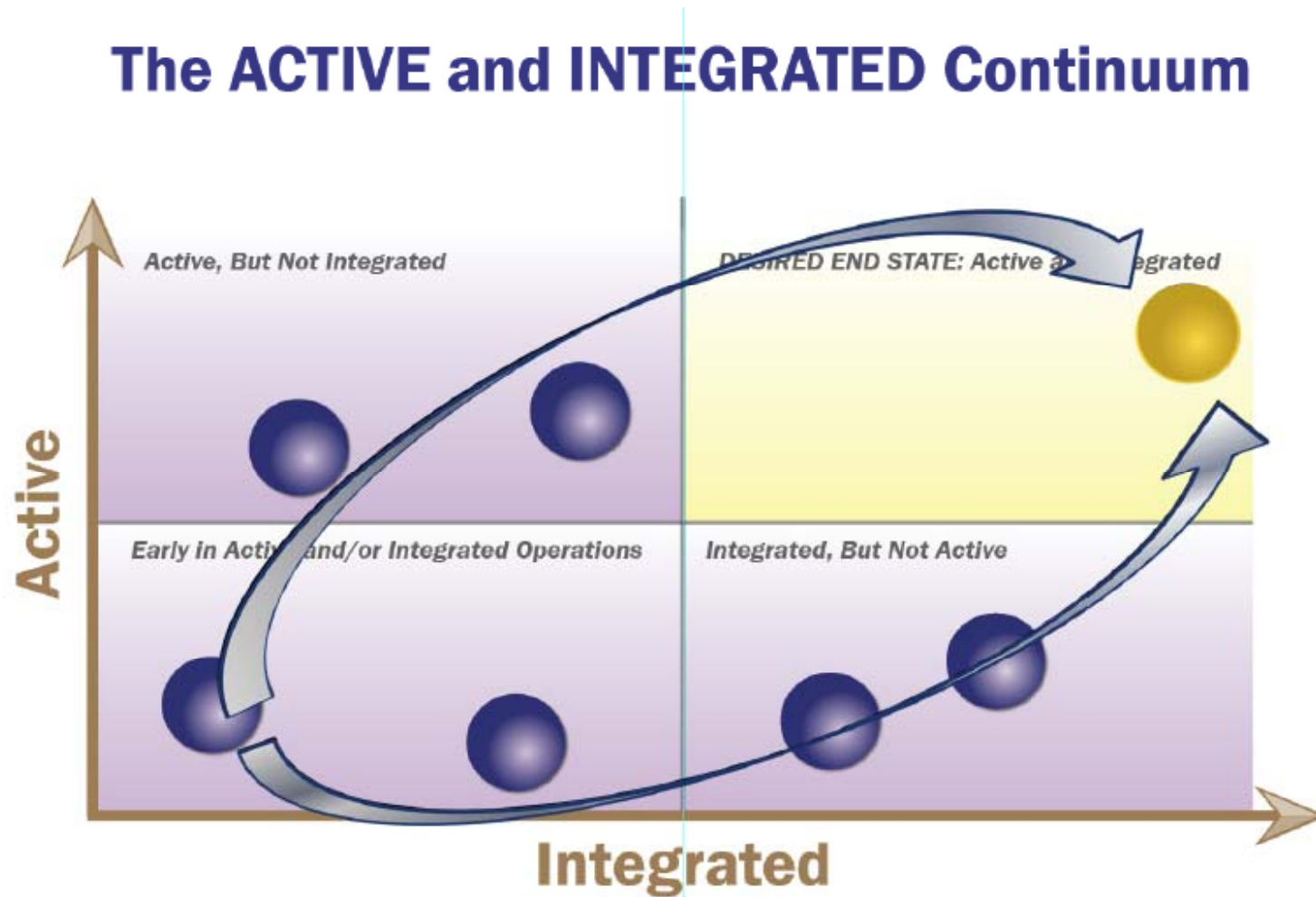
- Travelers view the transportation network as a whole
 - Provides them with options
- When faced with congestion on one facility, travelers may respond by
 - Selecting a different facility (transit or roadway),
 - Adjusting their trip to another time of day, or
 - Remaining on their current route
- Should we manage the corridor to reflect how travelers use it?

Corridor Management

- Corridors offer opportunities to operate and optimize the entire system
 - As opposed to the individual networks.
- Transportation corridors often contain unused capacity
 - Parallel routes
 - Non-peak direction
 - Single-occupant vehicles
 - Underutilized transit services
- Managing the corridor can more fully utilize this capacity
 - Management approaches like ramp metering
 - Traveler information and outreach

Managing a Corridor

The ACTIVE and INTEGRATED Continuum



Corridor Management and TSMO

- TSMO is the collection of activities (incident management teams) and supporting infrastructure (signs, signals, communications) used to ensure that the available supply of roadway capacity is used as efficiently, effectively, and safely as possible
- Corridors are the molecular unit where TSMO activities and infrastructure can be implemented

Corridor management is integral to TSMO

Near Term Actions for Managing a Corridor

From FHWA Corridor Traffic Management website:

- Develop protocols, procedures, operational strategies and control plans
 - ICM
- Deploy traffic control systems
 - ATM and ICM
- Coordinate traffic
 - ICM
- Use managed lane strategies within corridors
 - Managed Lanes

Examples of Corridor Management Components

- **Active Traffic Management (ATM)**
- **Managed Lanes**
- **Integrated Corridor Management (ICM)**
- Freeway management
- Arterial management
- Bus Rapid transit
- Real-Time Traveler Information

We will cover the first three in this session

Group Discussion

- How does your agency define a corridor?
- What types of corridor management programs do you have?
- What is the biggest challenge in managing a corridor?



Active Traffic Management

What is Active Traffic Management?

Traffic management concepts intended to:

- Enhance roadway safety
- Reduce congestion,
 - Variable speed Limits and lanes control primarily non-recurrent
 - Hard shoulder running primarily recurrent
- Provide reliable trips
- Provide enhanced information to motorists
- Provide additional capacity during periods of congestion or incidents



M 42 Speed Harmonization and hard shoulder lane in England. (UK Highways Agency)

Objectives of ATM

- Depends on the goals and objectives of the region/agency
- Depends on the problems
- ATM is a set of tools that can meet a set of objectives
 - Improved safety
 - Reduced congestion / enhanced mobility
 - Work zone traffic control / maintenance of traffic
 - Enhanced traffic incident management

Examples of ATM

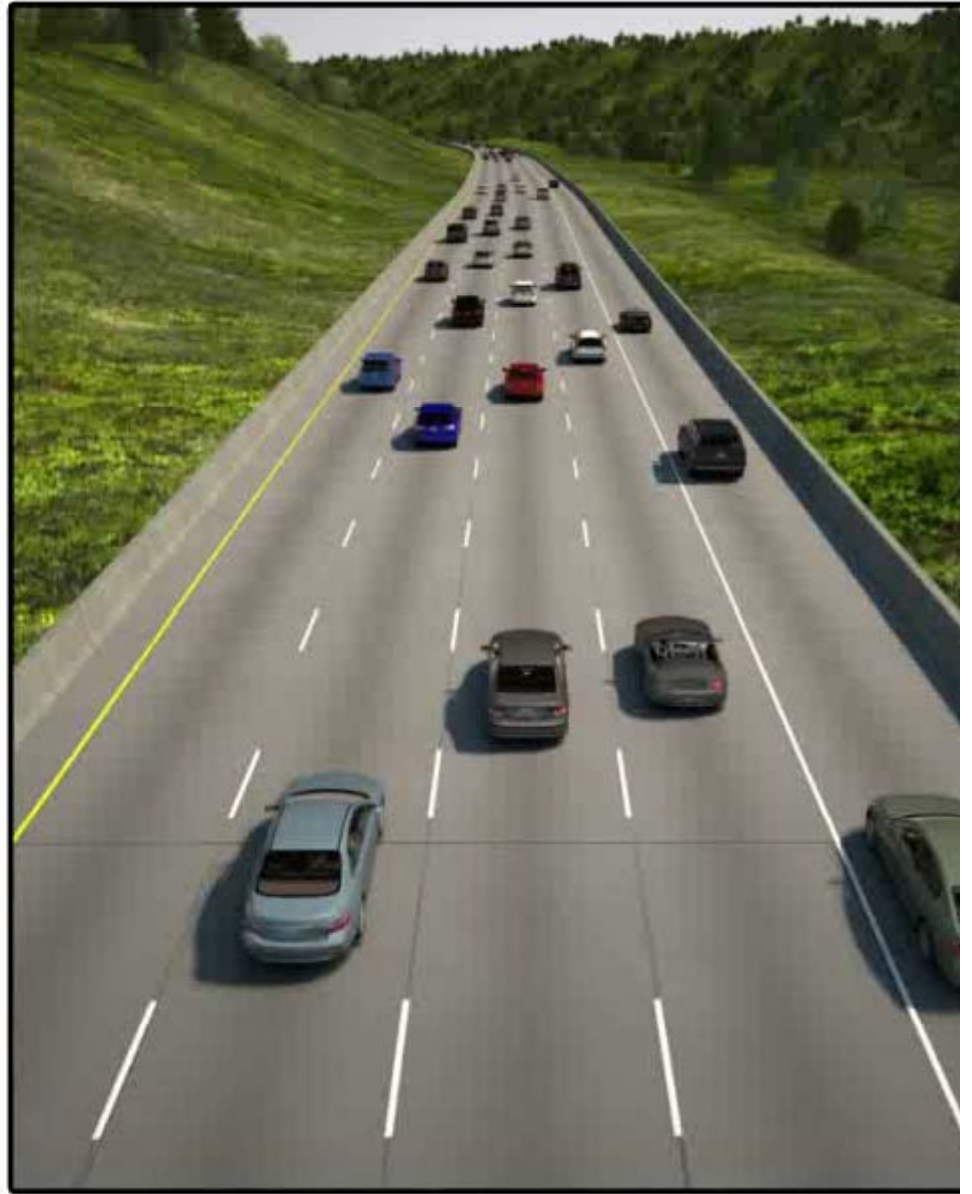
- Lane-use control
- Variable speed limits / advisories
- Queue warning
- Hard shoulder running
- Dynamic re-routing
- Junction control

Active Traffic Management is not limited to urban areas!



Active Traffic Management Simula

Scenario 3: Two-Lane Incident Closure with Congestion



Active Traffic Management Simulation

Scenario 5A: Add Lane To Drop Lane - Closed

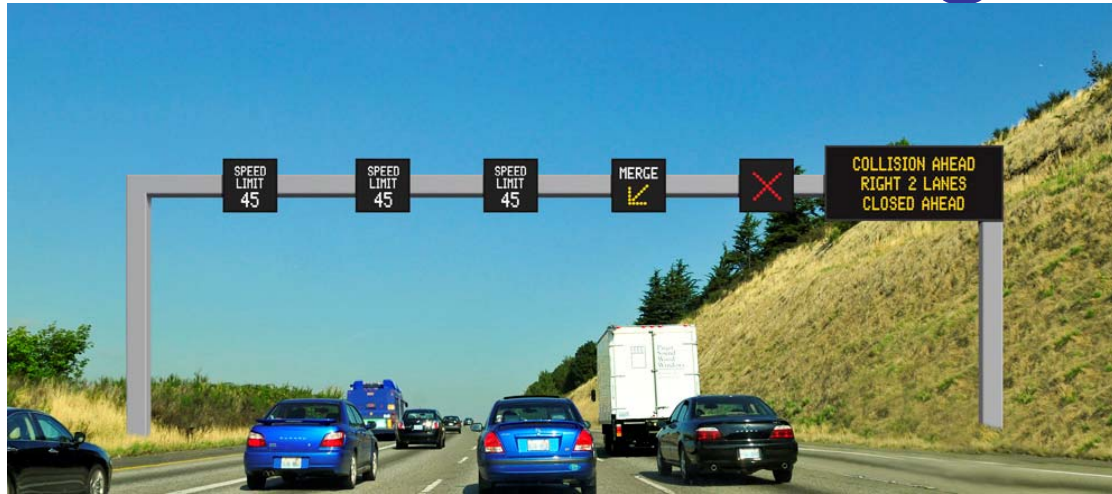
Scenario 6A: Add Lane and Drop Lane - C

Examples of ATM in the US

- Seattle
- Minneapolis
- I-66 (Northern Virginia)
- Los Angeles
- Dallas “Horseshoe”
- Denver
- San Francisco Bay Area
- New York Long Island Expressway
- Philadelphia I-95
- Portland, OR
- New Jersey

Many examples in Europe and around the world!

WSDOT's Smarter Highways



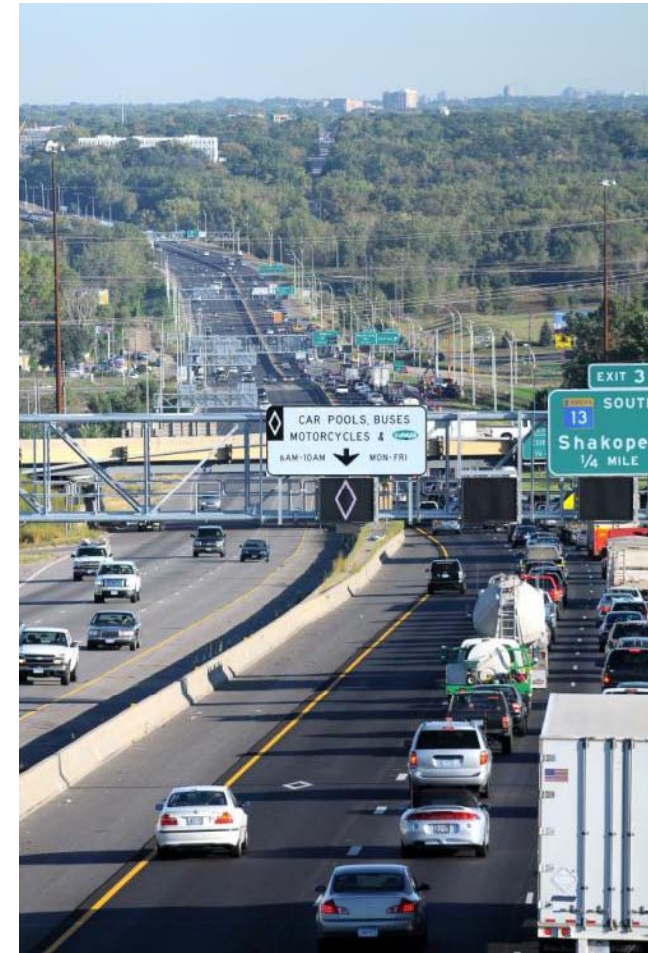
- Variable speed limits, lane control, traveler information
- Reduce speeds approaching congestion, crashes, work zones
- Warn motorists of downstream queues
- Display which lanes are open, closed, and closed ahead
- Primary objective is safety improvement

ATM in Action in Seattle Area



Minneapolis I-35W Intelligent Lane Control Signals

- ILCS located every 1/2 mile over every lane.
- ILCS are a 4ft x 5ft full color matrix signs.
- Use of the ILCS is primarily for incident management and speed harmonization.
- Designates when the priced dynamic shoulder lane is open or closed along with additional signing.



Variable Speed Displays

- Advisory Only
- Detection measures traffic speeds downstream
- Speeds are posted up to 1 ½ miles upstream



ATM on I-66

- Design-Build project
- Enhances existing I-66 managed lane / hard shoulder running
- Major ATM deployment
 - Hard shoulder running
 - Lane control
 - Speed displays



Los Angeles Junction Control

- NB SR 101 to NB I-5 connector
- High collision experience
- Congestion
- High ramp demand



Re-stripe connector to two-lanes



Replace Crash Attenuators



Extinguishable Message Signs



The Use of ATM is Expanding

- ATM has moved beyond stand alone implementations
- ATM supports and is compatible with other combined, integrated approaches
 - Traffic incident management
 - Work zone traffic management
 - Managed lanes

Dallas Horseshoe Maintenance of Traffic

- Three levels of management
 - Within the Work Zone
 - Approaching the Work Zone
 - Entering the Work Zone Region
- Each level will utilize a combination of physical, operational and electronic strategies
- Focus on ATM approaching and within work zone

Dallas Visualization

Dallas Horseshoe Design-Build Maintenance of Traffic Concept
WB I-30



ATM and Managed Lanes

- ATM is a type of lane management
- Supports other lane management approaches
 - HOT/express toll lanes
 - HOV lanes

ATM and Managed Lane



Active Traffic Management Simulation

Scenario 7: Managed Lane
with shoulder closed

Group Discussion

- What other examples of ATM have you heard about?
- What technologies or activities does your agency have that you would consider active traffic management?
- Where you have deployed any of these technologies or systems, what lessons have you learned?

Conclusions from Europe

- Political support, enabling legislation/plans
- Maximize the existing roadway footprint and roadway system
- Performance-based approach to operations and facility design decisions – rather than standards
 - Like “practical design”
- Successful operations - Integrated approach to design, operations and incident response

Examples of ATM Outside the US

- The Netherlands
- England
- Denmark
- Australia

Many other countries also use ATM

The Netherlands – Hard Shoulder Running

- Traditional outside lane operation
- Inside lane operations – Plus Lane
- Changes in over-lane sign operations



Source: Rijkswaterstaat Ministerie van Verkeer en Waterstaat

ATM in Work Zones - Denmark



- Special design gantries
- Movable signs
- In use throughout construction phases
- Permanent after construction

England – Managed Motorways

- New design and operating regime



Factors Contributing to ATM Feasibility

- Deployment area characteristics (see next slide)
- Construction activity and opportunity
- Supporting infrastructure
- Data availability
- Cost/benefit estimates
- Transportation priorities, agenda, support
- Institutional policies and issues
- Legislative environment
- Community support and acceptance

Characteristics Indicating Potential ATM Deployment Success

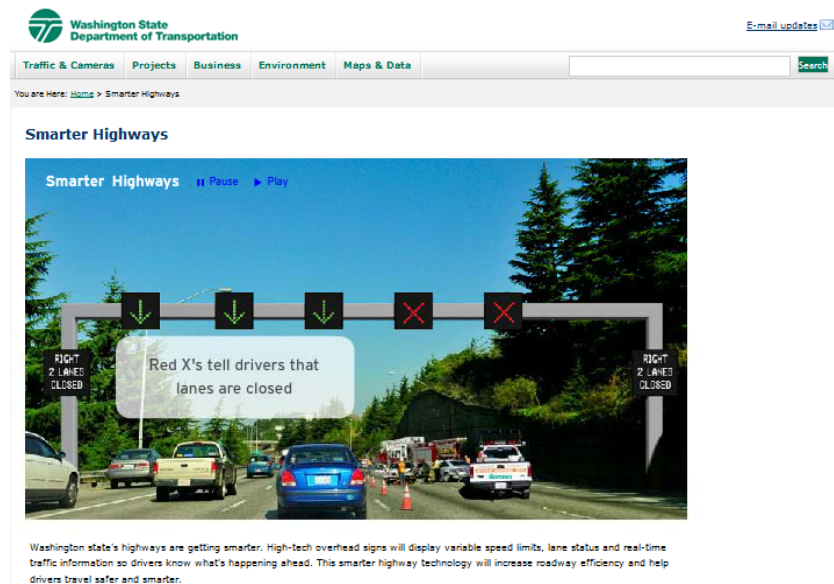
- High traffic volumes
- Changes in prevailing conditions
- High prevalence of crashes
- Bottlenecks
- Adverse weather
- Variability in trip reliability
- Construction impacts
- Financial constraints
- Limitation in capacity expansion

Outreach and Education

- Promotion
 - Encourage use and acceptance
- Education
 - Internal and external stakeholders
 - Institutional training
 - Awareness raising
- Outreach
 - Outreach campaigns
 - Branding
 - Media support and cooperation

WSDOT Outreach Examples

- Smarter highways video on Youtube
<http://www.youtube.com/wsdot#p/u/12/cd0doR0Ga-I>
- Smarter highways www.smarterhighways.com
- Posted links on Twitter, Facebook and WSDOT blog.



WSDOT Outreach Examples

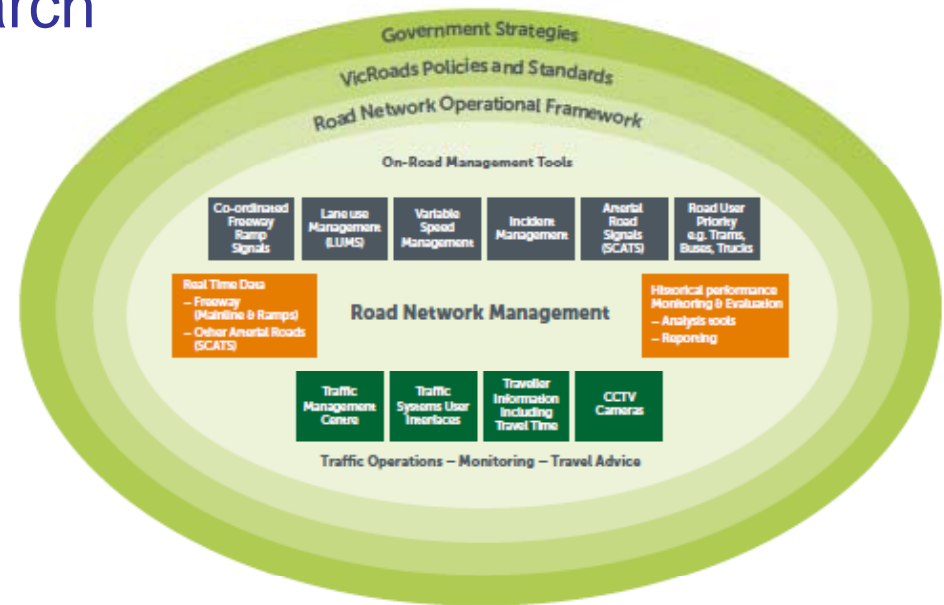
- Developed short animations for educational PSAs.
- Handouts: folios, postcard sized handouts, visualization of signs and explanation of symbols
- Outreach to cities, counties, businesses colleges



Getting Back to the Corridor: Integrating the Pieces

Example from Melbourne, Australia

- Managed freeway application
- Systematic approach
- Based on worldwide research



Melbourne's Managed Freeways

- A set of complementary technologies to achieve optimal performance
 - Arterial message signs
 - Ramp metering
 - Variable speed
 - Lane control
 - Freeway message signs
 - CCTV
 - Vehicle detection
 - Traveler information

ATM Take Aways

- Think about whether ATM is really any different from what your agency has been doing, except maybe applying technology in a different way. Or, does it represent a different way of doing business?
 - What does the “Active” in ATM mean to you?\
- Is there a difference in philosophy between ATM and ICM? If so, what is that difference?
- What are the most effective ways to communicate to stakeholders
 - ATM concept
 - Benefits
 - How to react to ATM when driving



Managed Lanes

What Are Managed Lanes?

- Preferential lanes or roadways
- Supporting facilities and programs
- Optimize efficiency, performance and throughput
- Offer travel time savings and reliability
- Apply management strategies including
 - vehicle occupancy,
 - vehicle eligibility,
 - pricing, and
 - access control
- HOV lanes were the first widespread managed lanes in the US



What Are the Benefits?

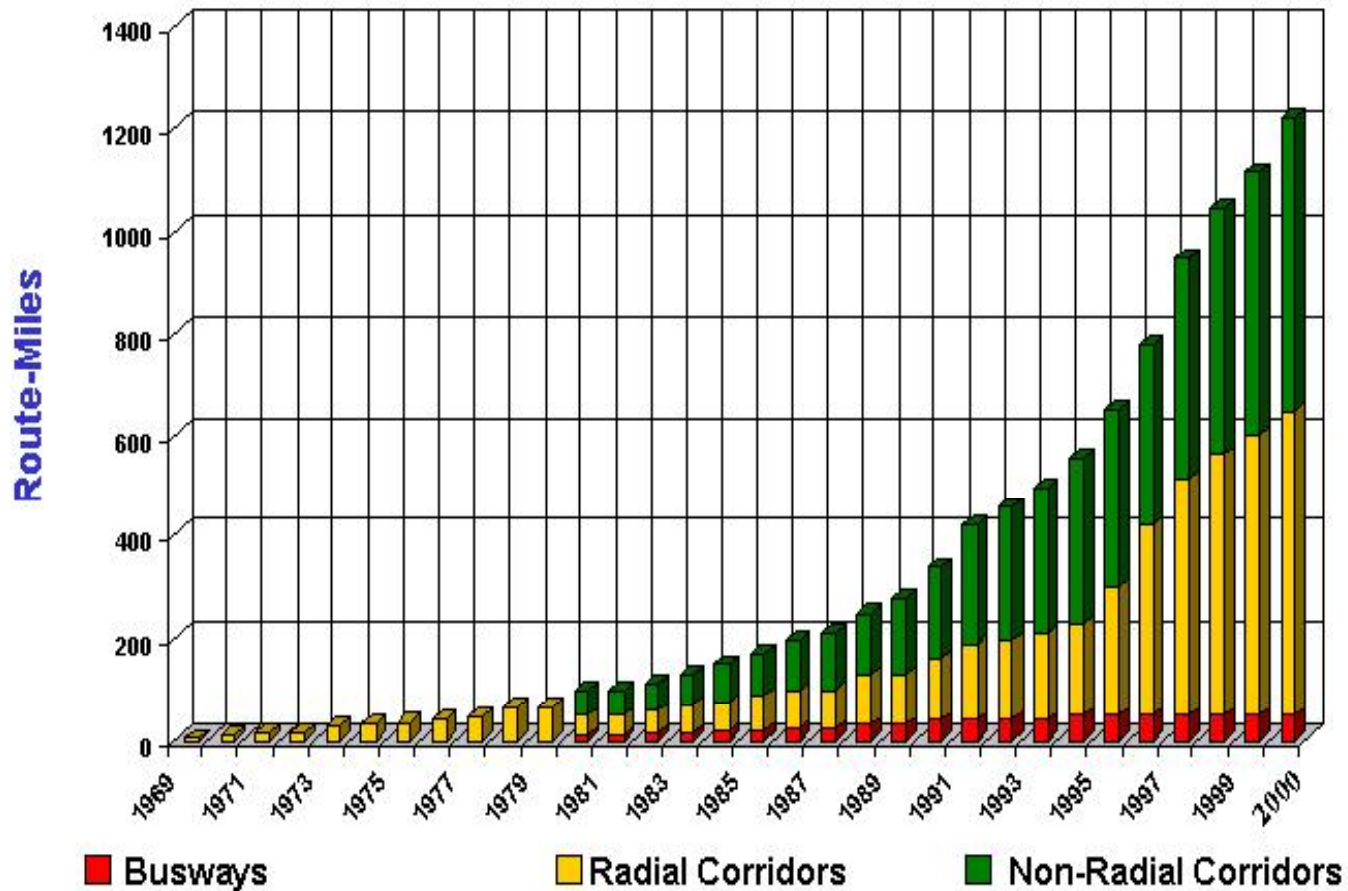
- Greater throughput
- Transit & carpools
- Travel time reliability
- Decreased fuel consumption
- Improved air quality
- Revenue generation

The First HOV Lanes were Demonstrations.

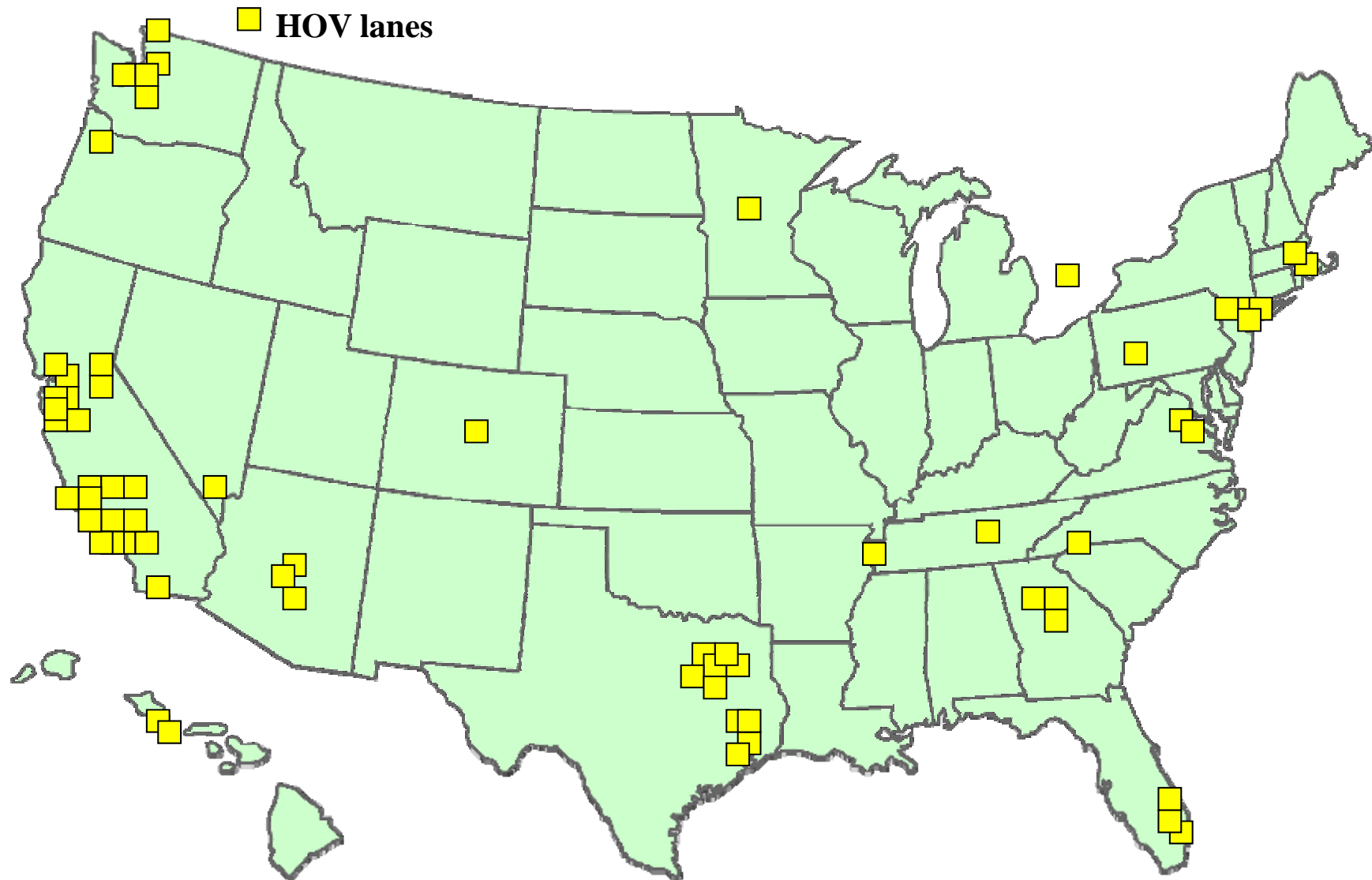
- Shirley Highway
- Blue Streak express bus lanes
- El Monte Busway
- XBL Lane, NJ



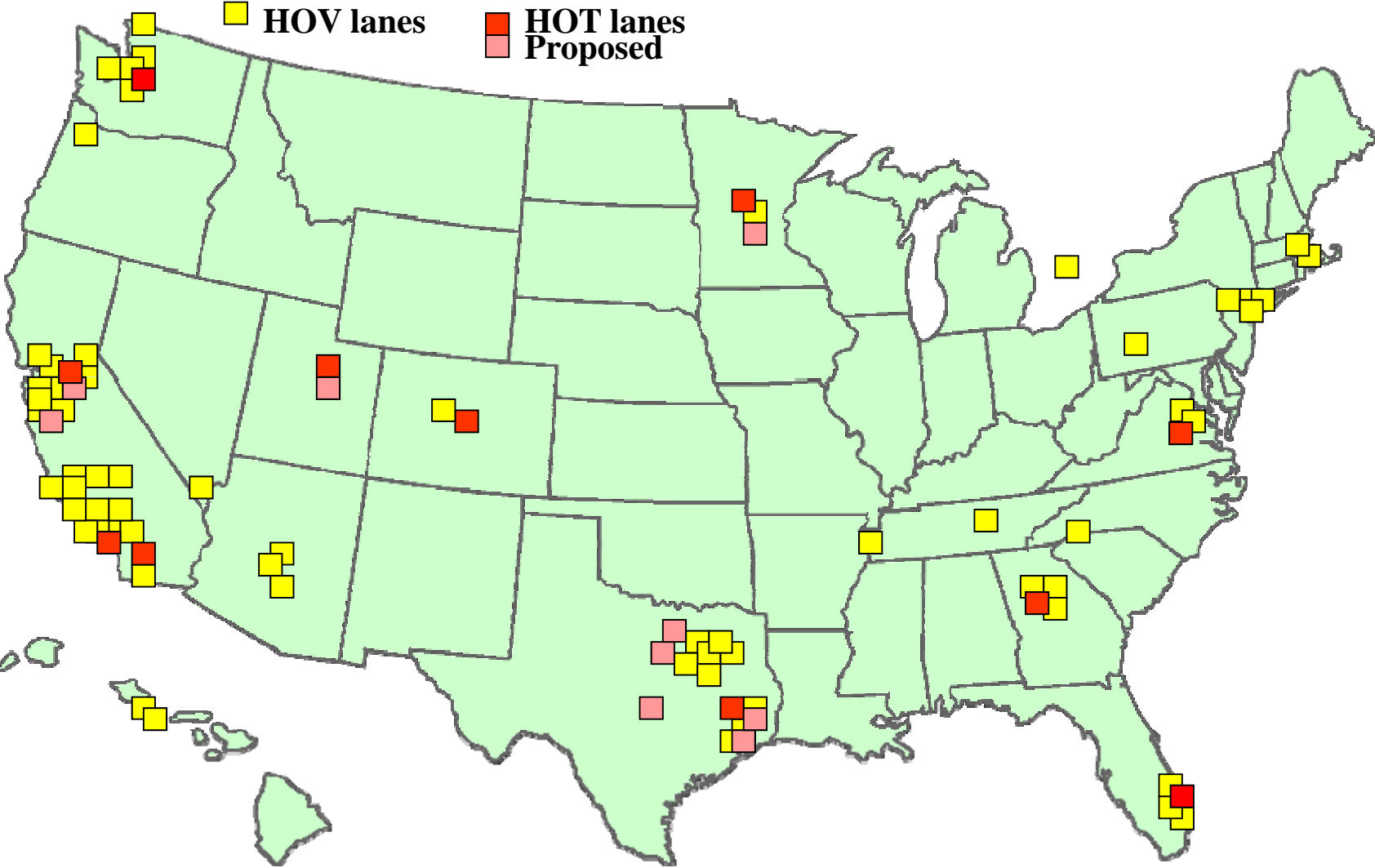
HOV Lanes Became Popular.



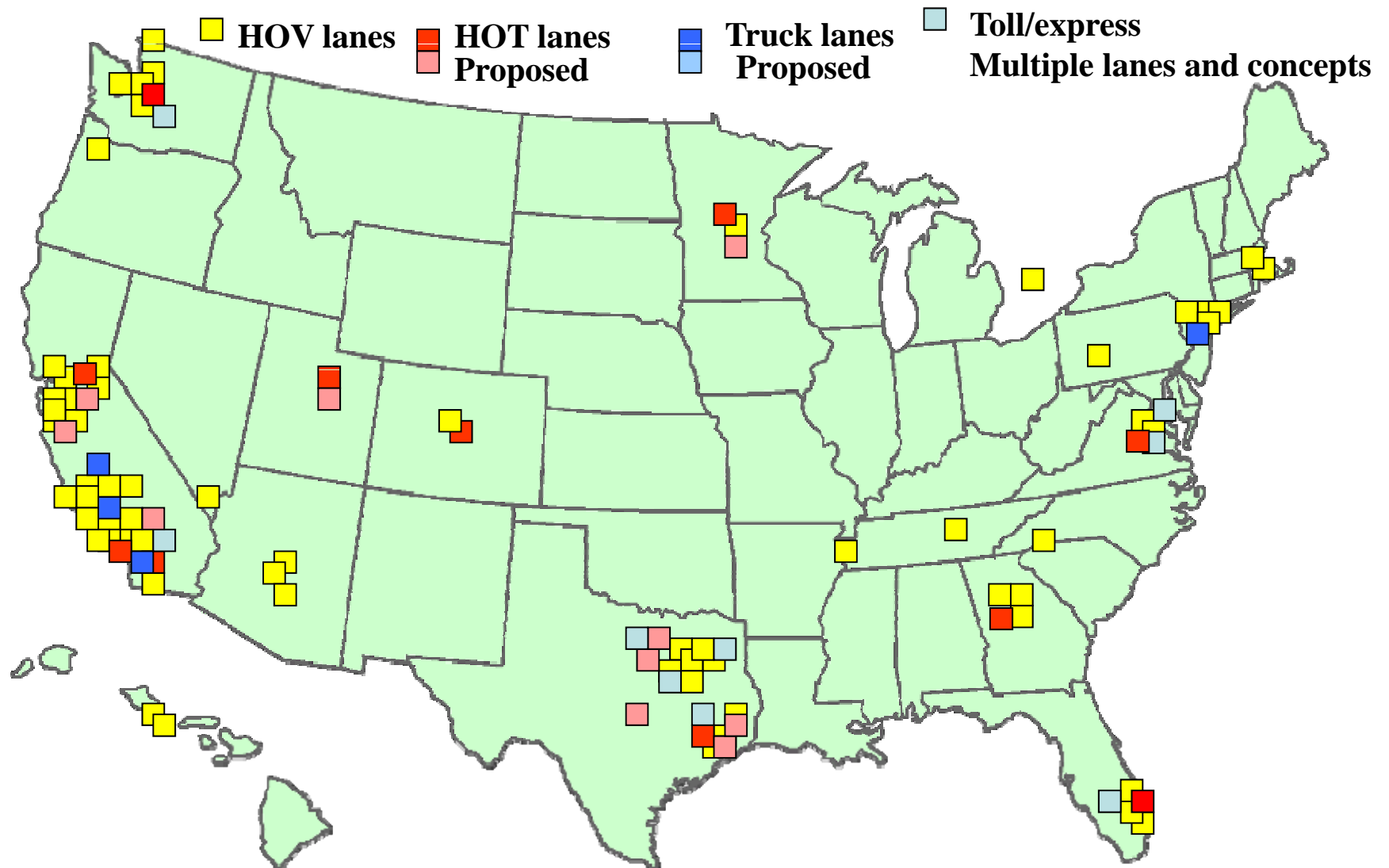
Where Freeway HOV Lanes Are Located



Where HOT Lanes Are Located



Where Other Types Managed Lanes Are Proposed



Managed Lanes Deployment

- Application
 - Expands capacity
 - Shifts demand
 - Uses pricing
- Outcome
 - Congestion-free lanes
 - Safety & Reliability
 - Long term Return on Investment

I-495, Virginia



Managed Lanes Design

- Initially tolled managed lanes were fully-separated facilities.

SR-91



I-25



I-15



I-10



Managed Lanes Design

- New Managed Lanes are more integrated into the freeway with less physical separation.



SR-167



I-95



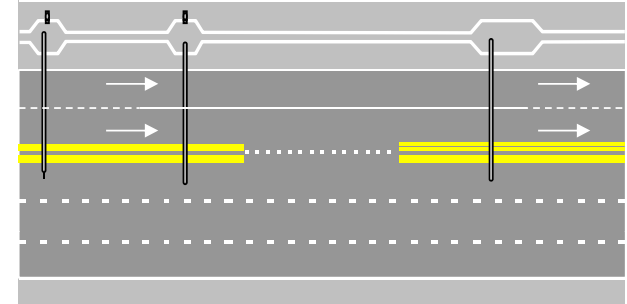
I-85



I-35W

Access Options

- Open or continuous access
 - Drivers can enter the lane at any location
- Access zones
- Slip ramps
- Direct access ramps



Group Discussion

- Has your agency considered implementing managed lanes?
 - If so, what type?
- How is access controlled?

General Prerequisites for Managed Lanes

Significant recurring congestion

Multimodal mobility policy

Limited spatial resources to address congestion

Existing use of ITS / operations

Willingness to create differential services

Lack of conventional capacity expansion options

Desire to flexibly address demand over time

Desire to recover operating and maintenance costs over time

National Trends in Managed Lanes

Congestion pricing to manage peak allocation of limited freeway capacity

Active Traffic Management (ATM) to reduce the number of incidents and smooth the effects of congestion

Flexible design principles to maximize the use of available pavement and rights of way

Targeted capacity expansion where confluence of financial, social, and environmental benefits

Managed Lane Technologies

- Toll tags (transponders)
- Roadway tolling equipment
- Enforcement
- Toll rate signs
- Back office / customer service center

Often, these technologies are new to a DOT and to the Operations staff.

Toll Tags / Transponders

- Identifies the account for toll charging
- Uses radio frequency
- Read by antenna and reader at toll points
- Common types
 - EXPass
 - Title 21
 - 6(c)
- May include mechanism to “declare” carpool



Roadway Tolling Equipment

- Antenna
- Reader
- Controller
- Cameras (enforcement and photo tolling)
- Detectors
 - Vehicle detection and axle count

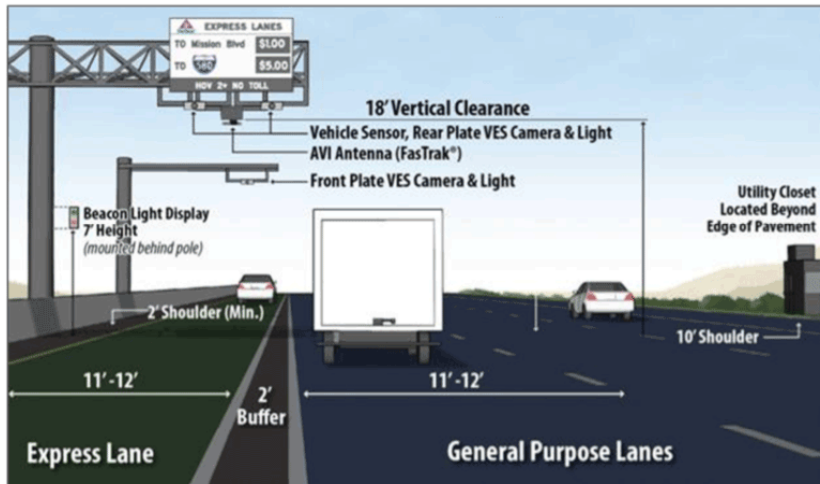


Enforcement

- Toll enforcement often by license plate recognition
 - If no toll tag,
 - Violation
 - Pay-by-plate
 - Pay-by-mail
- HOV enforcement is generally by law enforcement
 - Must observe violation
 - Declaration mechanism
 - Beacons at toll points
 - Registration and mobile license plate reader

Toll Rate Signs

- Spread along managed lane
 - In advance of designated access points
 - Distributed more evenly in continuous or near continuous access systems
- Displays the toll charge to destination(s)



Back Office / Customer Service Center

- Toll rate calculation
- Transaction processing
- Toll tag sales
- Customer service interface

General Lessons Learned

- Different types of feasibility:
 - Technical
 - Institutional
 - Financial
 - Public/political
- Speed differential: lane separation
- Enforcement
- Partnering and governance

General Lessons Learned

- Be realistic with expectations.
- Trips are highly discretionary.
- Not all congested corridors are candidates.
- Institutional issues take longer to address than expected.
- Transit can benefit (or at least not be adversely impacted).
- Don't take anything away (that will be missed).

Pricing/Revenue Lessons Learned

- What goal is the most important?
 - Better management, transit/rideshare promotion, revenue generation.
 - Improved lane management is primary reason for adding pricing to HOV lanes.
- Public/political support is greatest challenge
- Adding pricing requires many changes (it's not just about pricing).
- Highly discretionary demand caused revenue forecasts to be overestimated on early projects.
- Most HOV conversion projects only cover O&M costs.
- Revenue generation requires 2 or more lanes and/or restricting free use to 3+.

Managed Lanes Take Aways

- What are the advantages or disadvantages of migrating from HOV to HOT lanes?
 - Do HOV lanes have a role in the long run?
- How does the approach to managed lanes differ if revenue generation is the primary goal vs traffic management?
 - Once revenue starts to be generated, will the importance of revenue become paramount regardless of the initial goal?

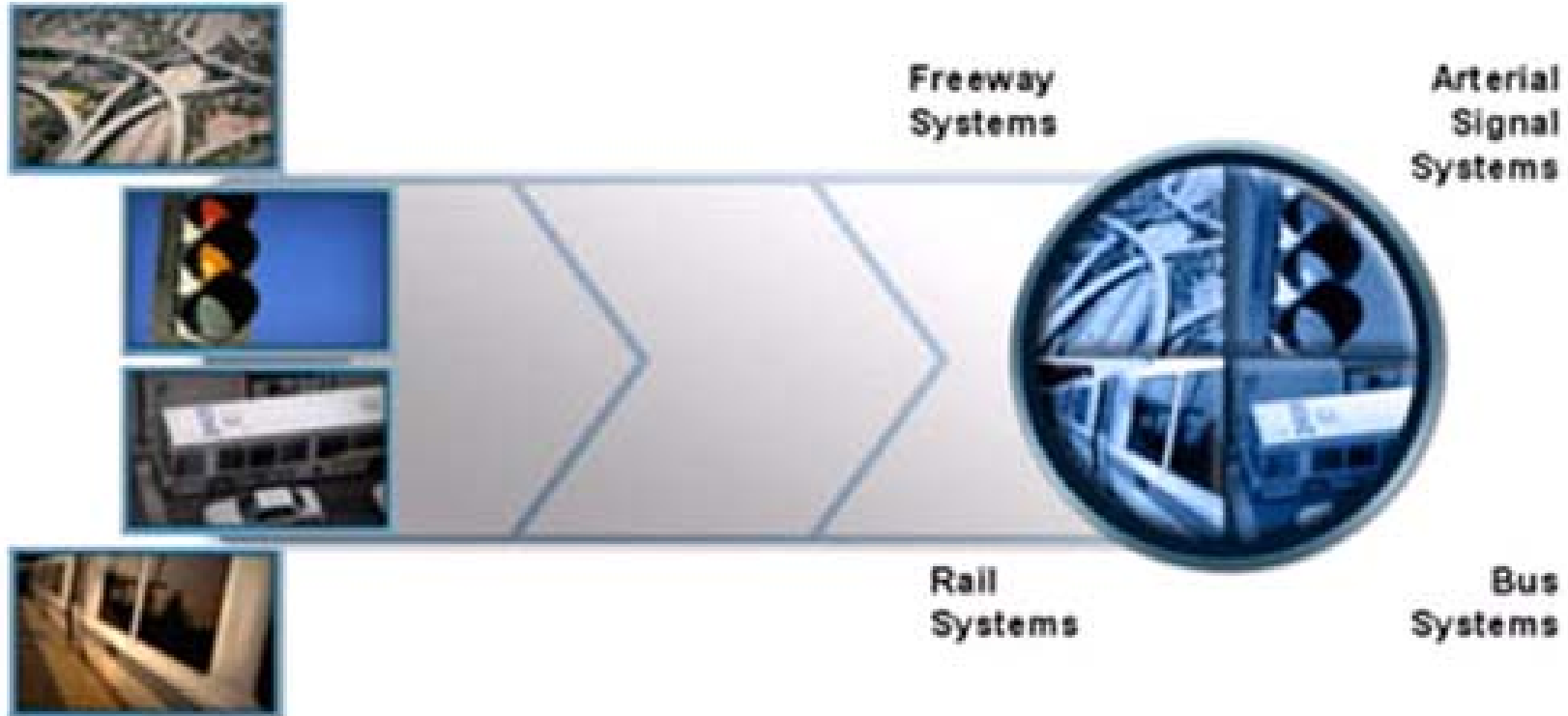


Integrated Corridor Management

Integrated Corridor Management

- ICM Background and Concepts
- Status of the Federal ICM Initiative and Sites
- Planning for ICM
 - Stakeholders
 - Integrating with existing plans and programs
 - ICM Concept of Operations
 - Agreements
- Integration to Support ICM Strategies

What is ICM?



USDOT ICM Initiative



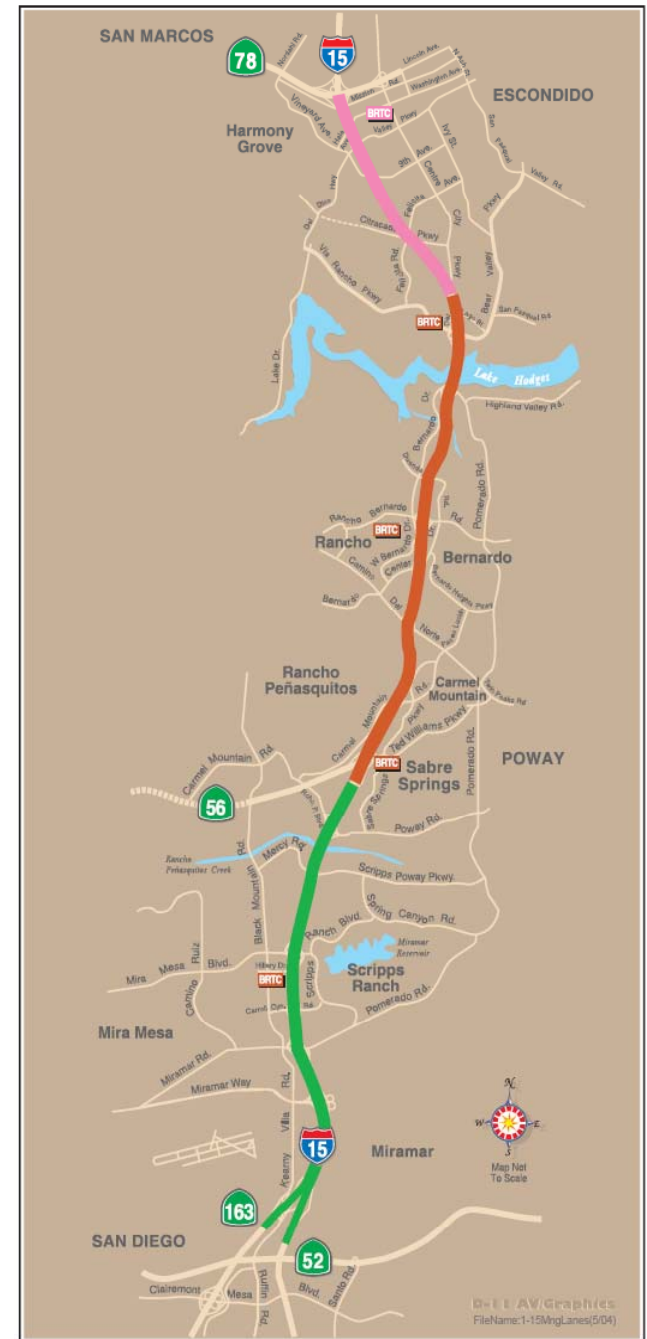
- New institutional models
- New technology
- More dynamic operational strategies
- “Network” vs. Individual corridors





SANDAG I-15 ICM

- Primary artery for the movement of commuters, goods, and services from north San Diego County to downtown.
- I-15 Managed Lanes System
- Multi Institutional Cooperation/ Partnerships
- Multi-modal Transportation Improvement Strategies and Mode Shift – BRT, TSP
- 511, including transit information



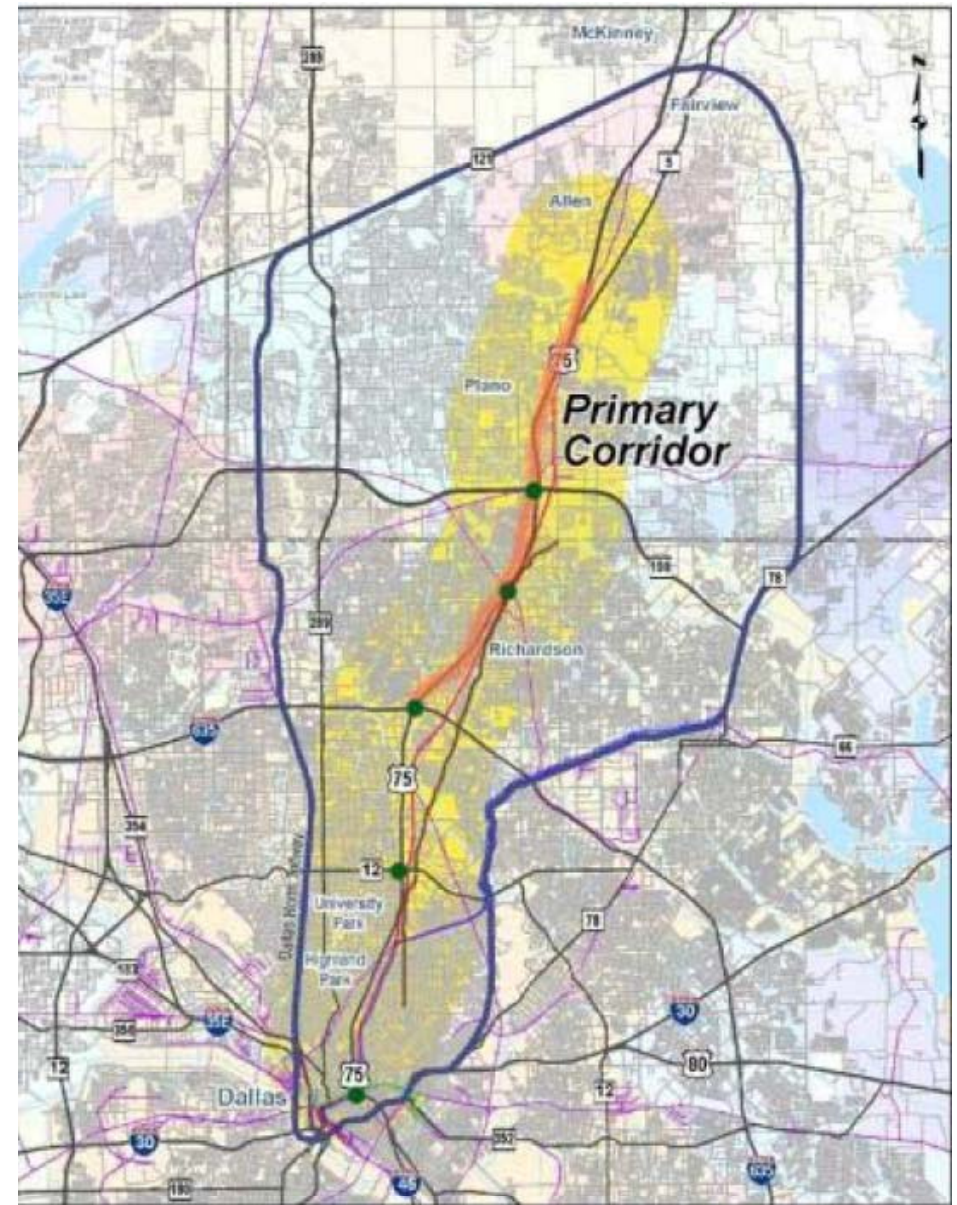
SANDAG ICM Goals/Needs

- Collect and process data in real-time or near real-time
- Share and exchange real-time or near real-time data
- Monitor corridor travel conditions, gauge network conditions, and report on status
- Make available real-time or near real-time information on corridor travel conditions to the general public
- Manage corridor traffic flow
- Manage occurrence of events
- Coordinate the operation of corridor networks and management systems



Dallas US-75 ICM

- Freeway with continuous frontage roads
- Managed HOV lanes
- Dallas North Tollway
- Arterials
- Bus Network, Light Rail
- Approx. 900 traffic signals
- Multiple TMCs
- Regional ATIS (511)



Dallas US-75 ICM Goals/Needs

- Robust detection strategy for freeways, frontage roads, arterials, light rail, park and ride lots and HOV lanes
- Decision Support System for operators to select appropriate combination of strategies
- Share incident, construction and special event information among agencies
- Dynamic management capabilities for signal timing on arterials and frontage roads
- Improve multimodal traveler information for the public

USDOT ICM Status Update

- San Diego and Dallas went “live” in early 2013
- Testing and evaluating the DSS in both regions
- Independent evaluation
- Early lessons:
 - Agreements are tough. Most challenging part of ICM.
 - Data integration from multiple systems and multiple networks
 - Determining mode shift is difficult, working through how to evaluate effectiveness
 - Combinations of strategies also are challenging to evaluate

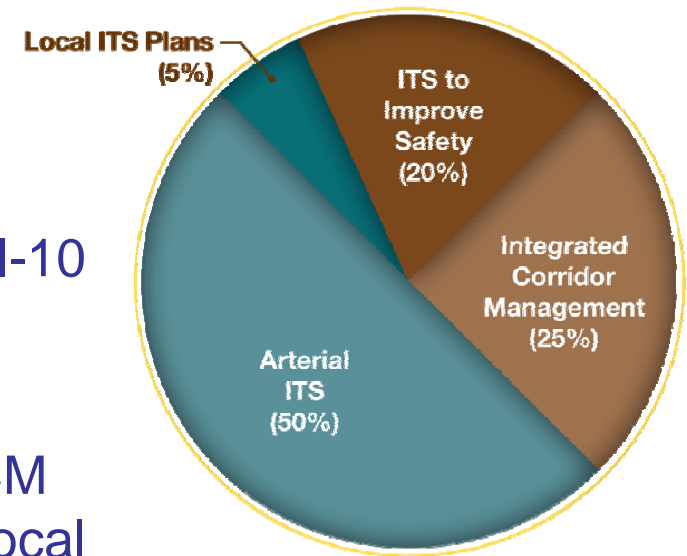
Other ICM Initiatives

- I-80 Corridor – Bay Area, California
- 20 mile segment of I-80
- Led by Alameda County Transportation Commission
 - Caltrans
 - MTC
 - Local Counties and Cities
- Adaptive ramp metering, incident management, FMS
- Improvements to San Pablo Ave and arterials connecting to I-80
- \$80M in federal, state, regional and local sources
- Initiated Scoping and Design 2007 - Summer 2015 target date
- Effort put toward multi-agency agreements



Phoenix I-10/I-17

- Initiated ICM planning during original Pioneer Site applications (not selected)
- Moved forward with ICM Plan focused on I-10
- Incremental implementation with available funds
- MAG 2012 ITS Strategic Plan identified ICM as a regional priority; funding support for local projects that advance ICM goals
- Freeway/arterial coordination during freeway incidents a key focus
- Combining arterial signal timing improvements and ICM
- Integrating ICM into a larger corridor master planning effort



Michigan DOT I-75 Concept of Operations

- Travel time reliability within the corridor (freeways and arterials)
- Improved traveler information
- Coordinated and efficient responses to incidents
- Improved agency coordination and joint use of resources and technologies
- Public outreach and education on multi-modal transportation options
- CVO through the corridor
- Developed a Concept of Operations and Requirements (2008)
- Corridor Integration CMM helped guide areas for improvement



Planning for ICM

- ICM Stakeholders and strategies for engagement
- Leveraging existing plans and programs
- Developing a Concept of Operations
- Performance Measures
- Agreements

Engaging Stakeholders in ICM

- Identifying the right partners
- Lead/co-lead
 - Freeway management and operations – TOC, freeway service patrol, freeway incident response
 - Arterial management and operations – TOC, signal operations
 - Transit
 - Incident response and management – freeway and arterial incident response/law enforcement
 - MPO – planning
 - Others to be determined on a regional level based on operational need

Strategies for Engagement

- ITS Strategic Plans or Updates
- Traffic Incident Management Coalitions
- Standing Committee Meetings (Operations, ITS)
- Large-scale freeway or arterial improvement projects
- TIP funding cycles
- RTP updates
- Follow up initiatives from RCTOs and other Ops Plans

Plant seeds, build interest, introduce ICM as a collaborative, regional effort

Defining YOUR ICM Program

- What is it that you (the region) wants ICM to address?
- What are the key gaps?
 - Institutional
 - Technical
 - Operational
- What is your foundation?
(established or soon-to-be-implemented system)
- What is your timeframe for achieving objectives?
 - Or timeframe for being able to implement
- Each ICM will be unique



ICM Concept of Operations

- There is a good ICM ConOps format established!!
- IEEE standard for ConOps provides a good go-by
- Key sections should address:
 - Operational objectives, and collaborating on new operational strategies
 - Roles and responsibilities
 - Systems and technology – connectivity among regional partners
 - Gaps – what needs to be addressed, implemented to achieve objectives
 - Timeline
 - Funding requirements and funding sources

ICM Performance Measures

- National evaluation is looking at the following MOEs:
 - Vehicle and person throughput
 - Travel times and travel time index
 - Standard deviation of travel time
 - 80th, 90th, and 95th percentile travel times
 - Buffer and Planning Indices
 - Traveler Response
 - Safety benefits
- Your ICM Objectives
 - Traveler information
 - TIM
 - Data sharing
 - Institutional participation



Interagency Agreements

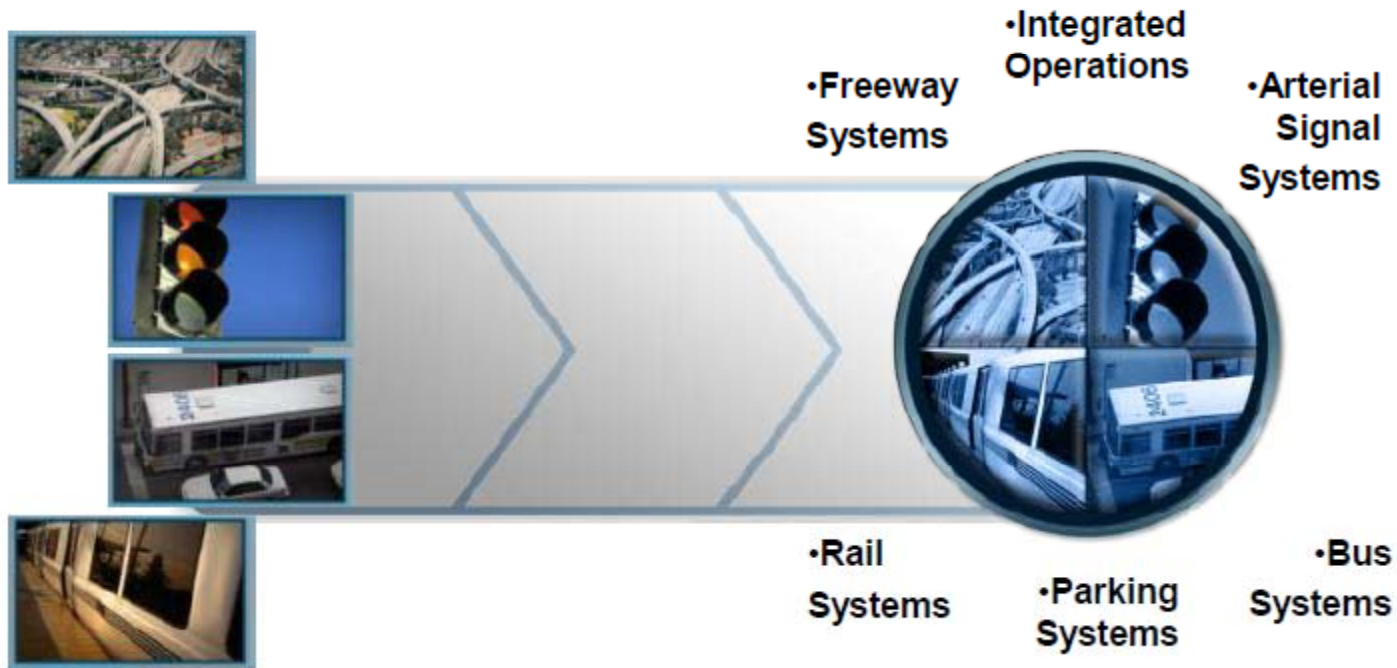
- Essential for ICM and multi-agency operations strategies
- New operations models, potential for joint operations
- Data sharing and system connectivity
- Often, the most complex part of an ICM program and strategy
- Examples – I-80, SANDAG



Discussion

- What are some key gaps participants see in developing an ICM strategy for their area?
- What are some ways to overcome these?

Integration to Support ICM



Real-time Data Sharing to Support ICM

- Regional strategies for sharing data
- What information do partners need?
- Operations data to support ICM
 - Real time freeway, arterial and transit operations
 - Real time strategy implementation information
 - Agency notifications
- Overcoming institutional barriers to effective data sharing
 - RITIS (I-95)
 - RADS (Arizona)

Staffing and Training

- Staff capacity building
 - Current staff vs. supplementing staff
 - Leveraging available regional technical staff resources
- Staff training needs for ICM and next-generation operations
 - New systems and new operational approaches

Lane Management Strategies

- Eligibility/Occupancy
- Access Control
- Pricing
- Active Traffic Management



Group Exercise Scenario

- Recall the collapsed bridge from yesterday:
 - Key commuting corridor, dense ITS device coverage
 - 4 lanes plus an HOV lane in each direction
 - Key interstate freight corridor
 - AADT > 250,000
 - Alternate freeway route 8 miles north (operates @ capacity)
 - Alternate arterial 1 mile south (4 lanes, signalized)
- Now the bridge has been rebuilt, with same number of lanes, but to current standards (e.g., full shoulders)
- From the bridge collapse experience, what do you think should be done to better manage the corridor?

Managing a Corridor Considerations

- What are your initial considerations?
- How would you go about developing a plan for corridor management?
- Who would you involve?
- What technologies/systems/actions would you consider?
- What are the major gaps or challenges you see in implementing the plan?
- What would you do to give your plan the best chance of success, especially considering the gaps/challenges?