



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

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

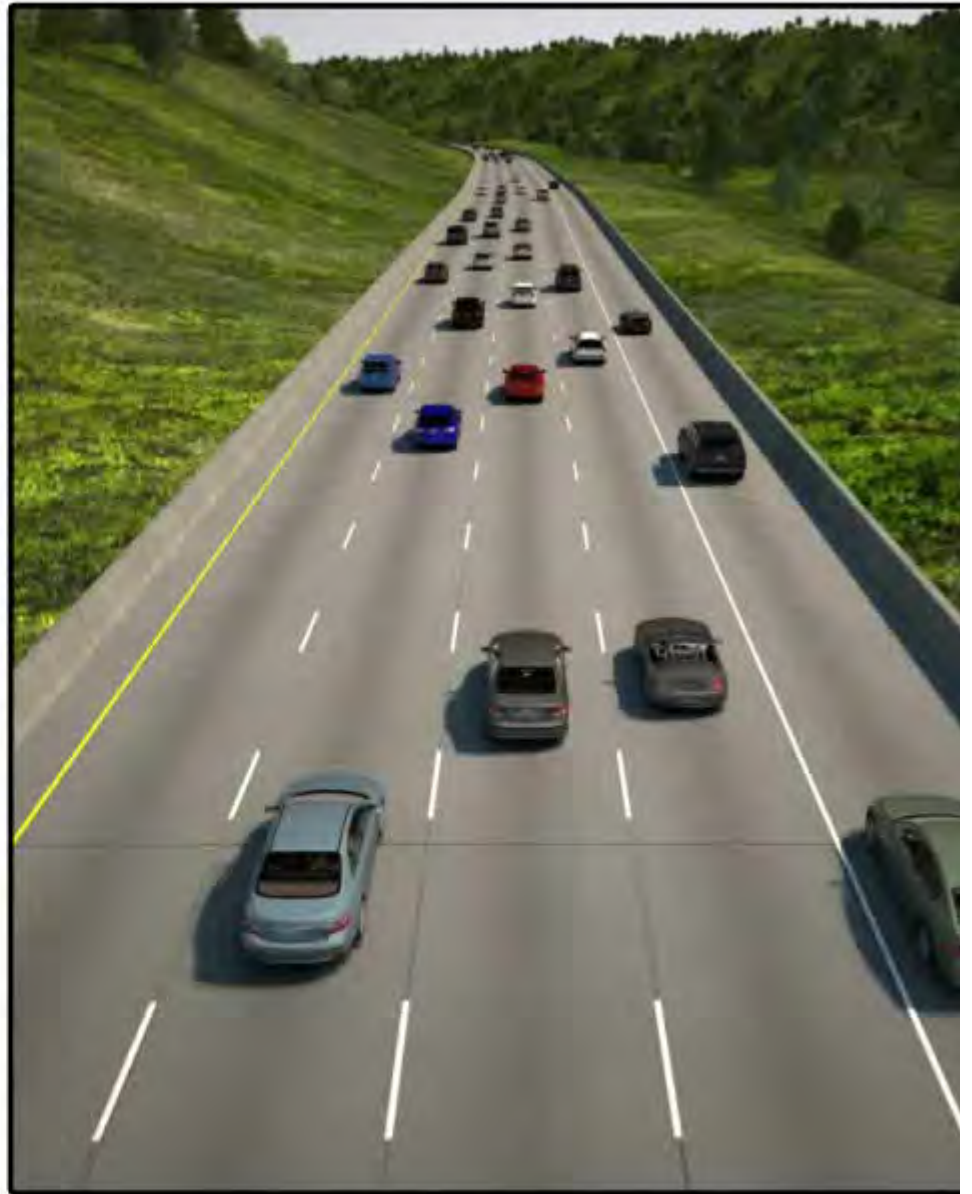
- Lane-use control
- Variable speed limits / advisories
- Queue warning
- Hard shoulder running
- Dynamic re-routing
- Junction control

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

PARSONS
BRINCKERHOFF

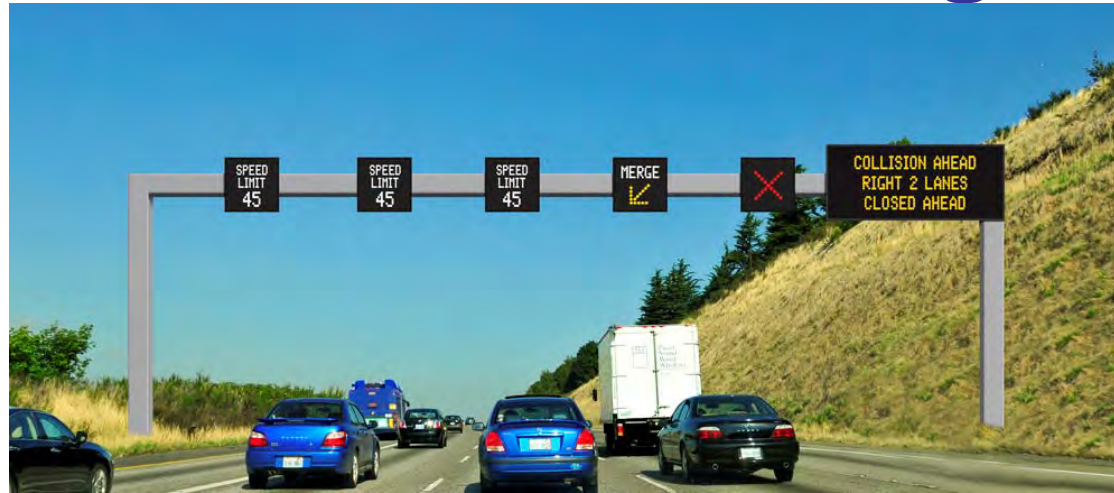
Scenario 6A: Add Lane and Drop Lane - C

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

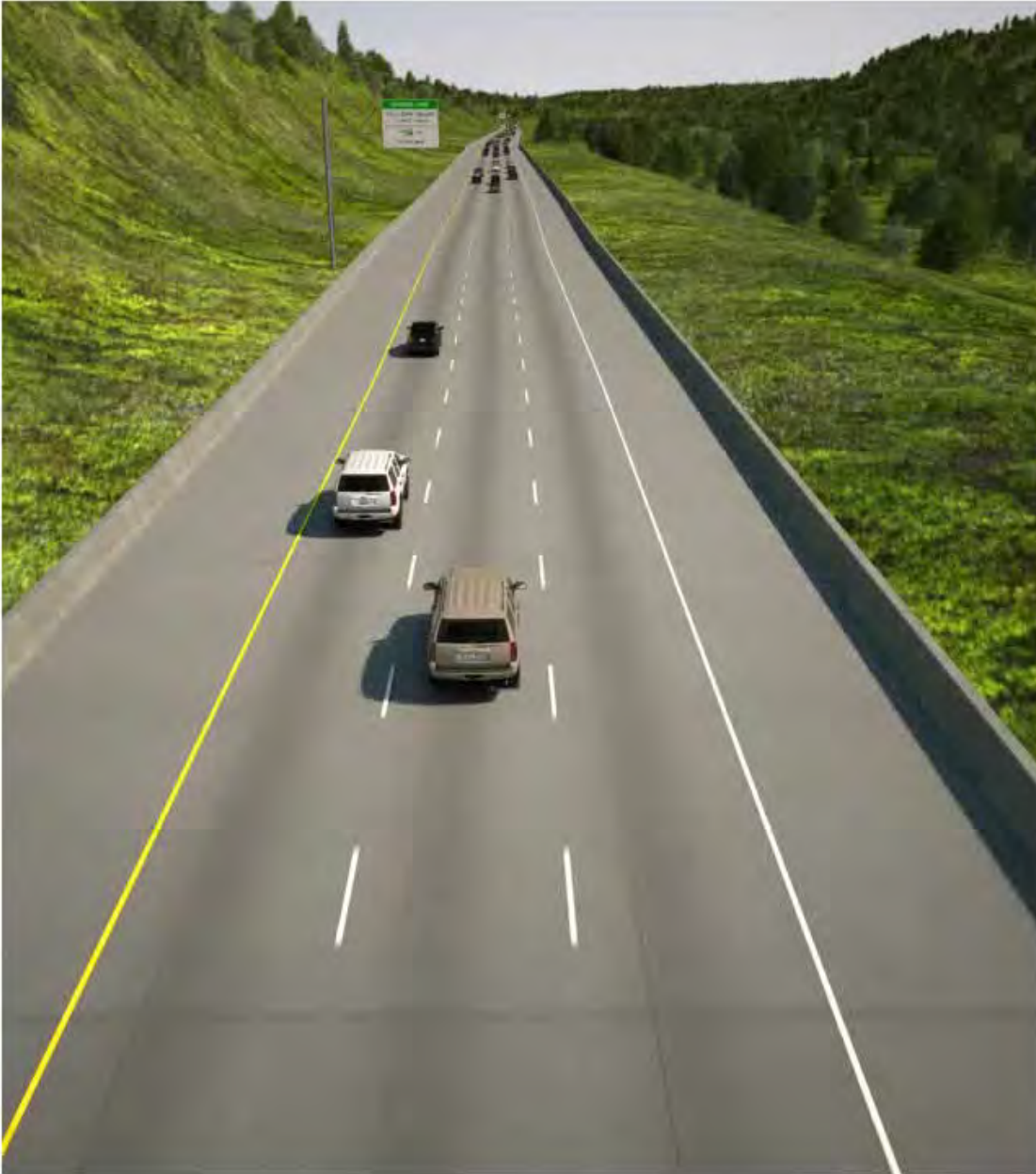
Dallas Horseshoe Design-Build Maintenance of Traffic Concept
WB I-30



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?

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

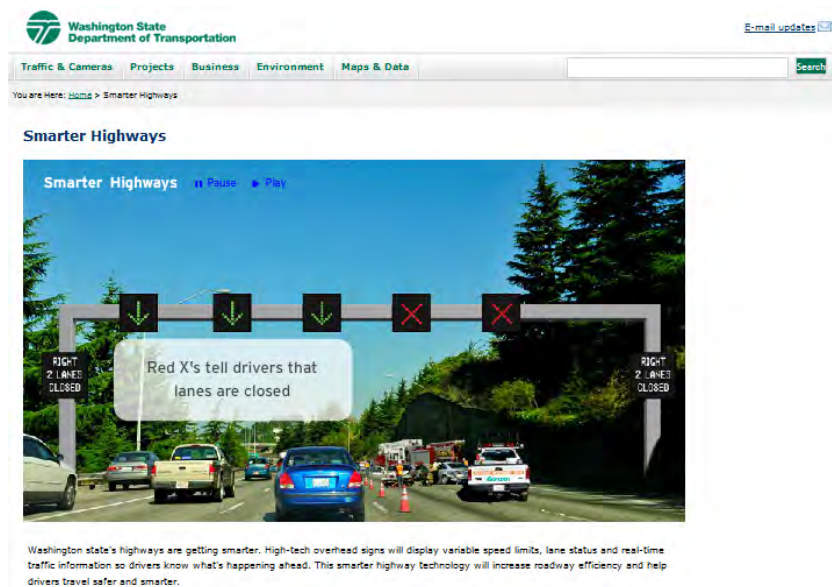
- High traffic volumes
- Changes in prevailing conditions
- High prevalence of crashes
- Bottlenecks
- Adverse weather
- Variability in trip reliability
- Construction impacts
- Financial constraints
- Limitation in capacity expansion

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

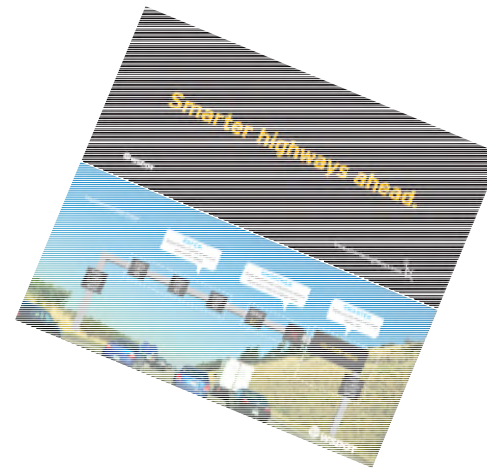
WSDOT Outreach Examples

- 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



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?

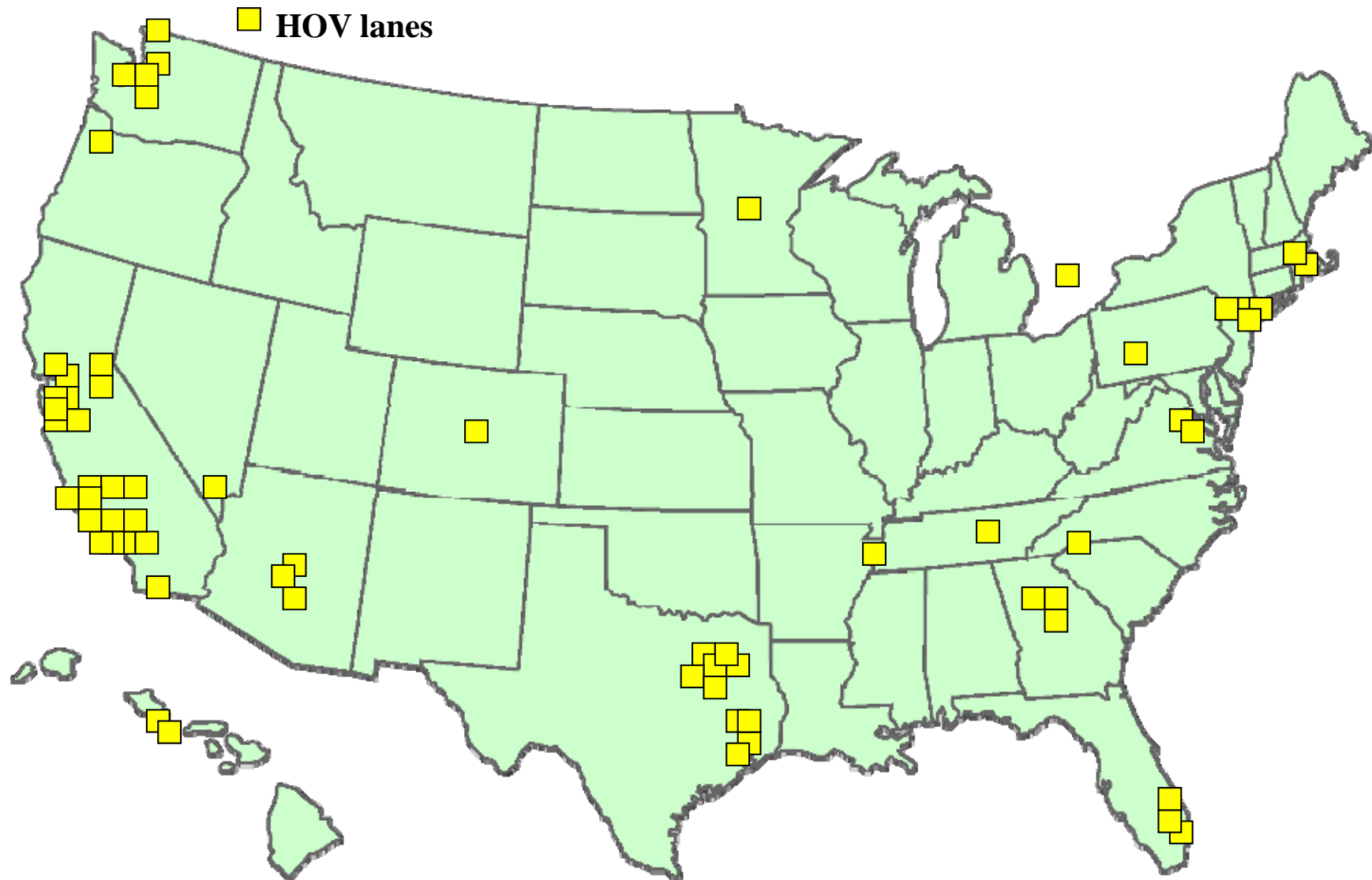
- Greater throughput
- Transit & carpools
- Travel time reliability
- Decreased fuel consumption
- Improved air quality
- Revenue generation

The First HOV Lanes were Demonstrations.

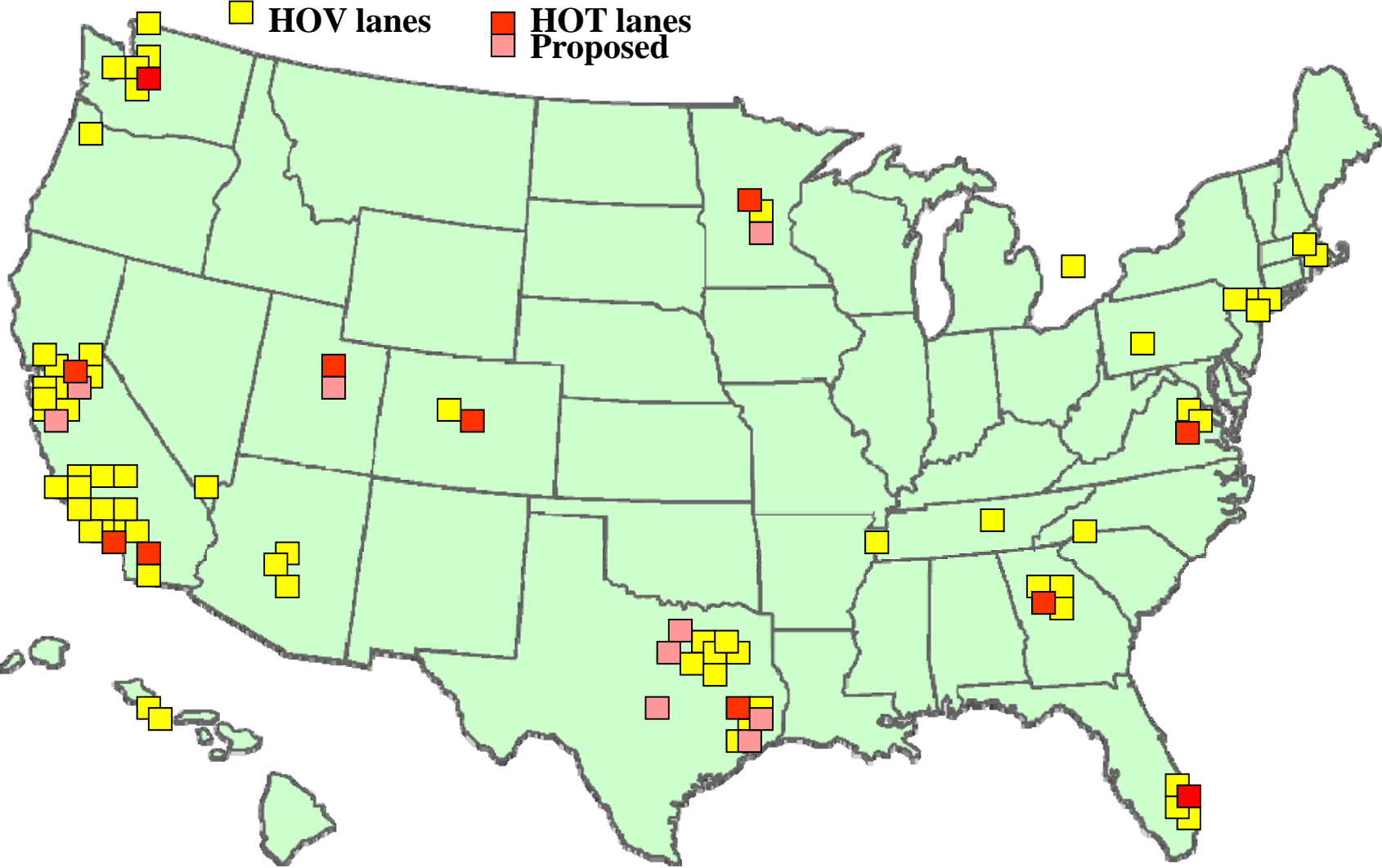
- Shirley Highway
- Blue Streak express bus lanes
- El Monte Busway
- XBL Lane, NJ



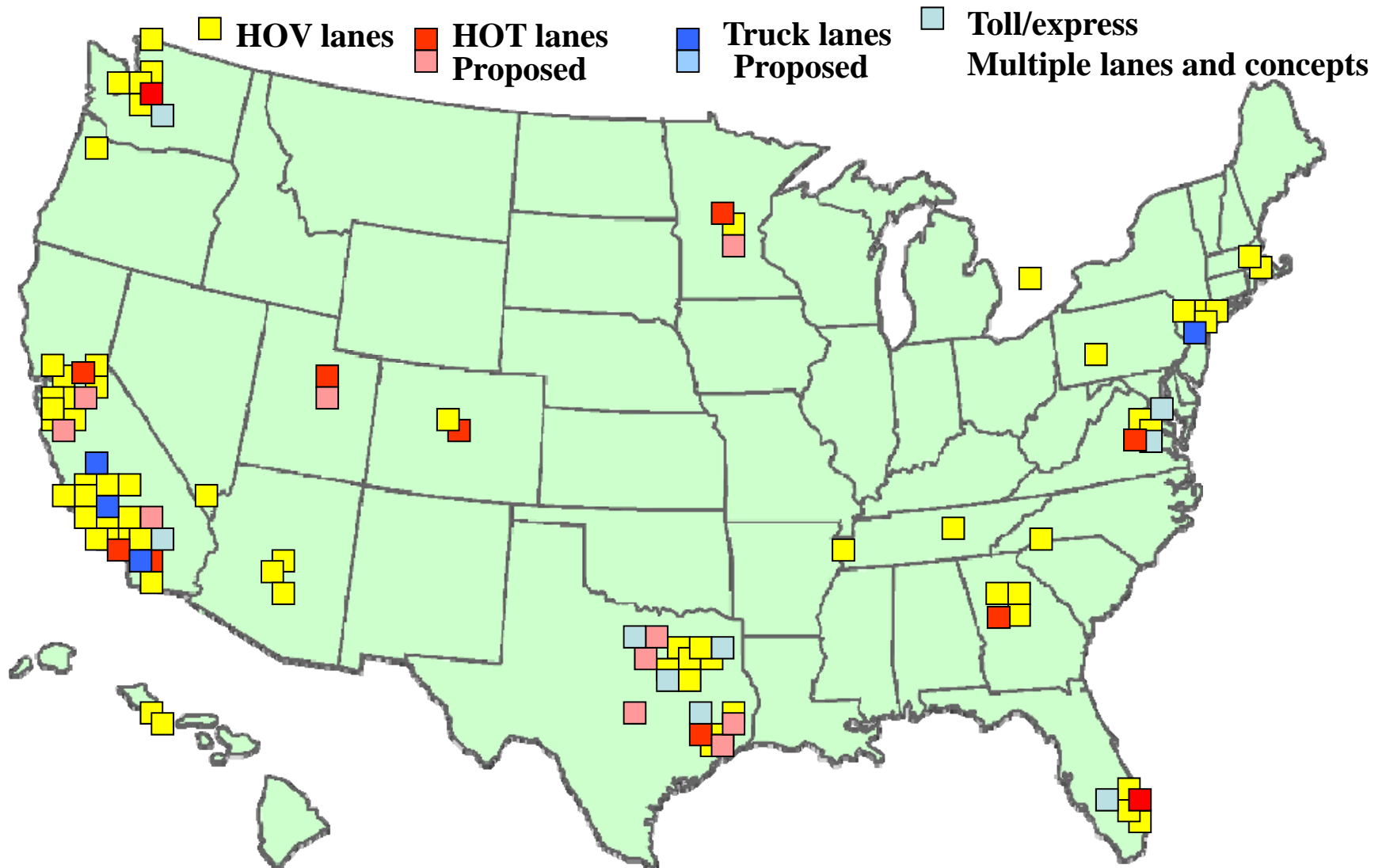
Where Freeway HOV Lanes Are Located



Where HOT Lanes Are Located



Where Other Types Managed Lanes Are Proposed



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



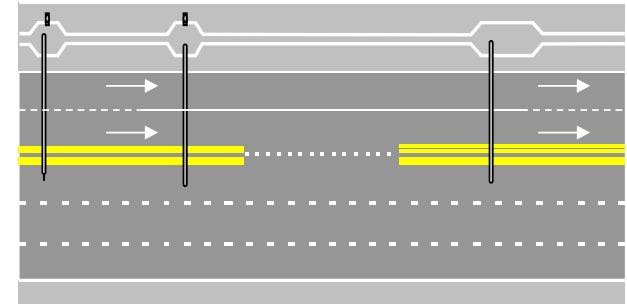
I-85



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

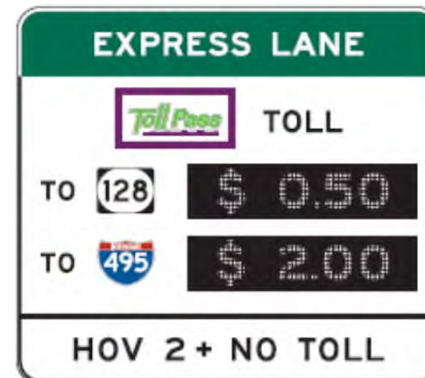
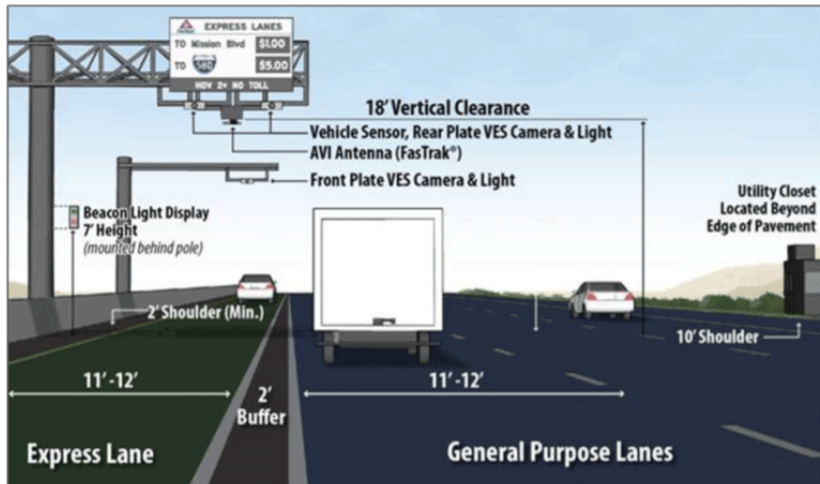


Enforcement

- 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?

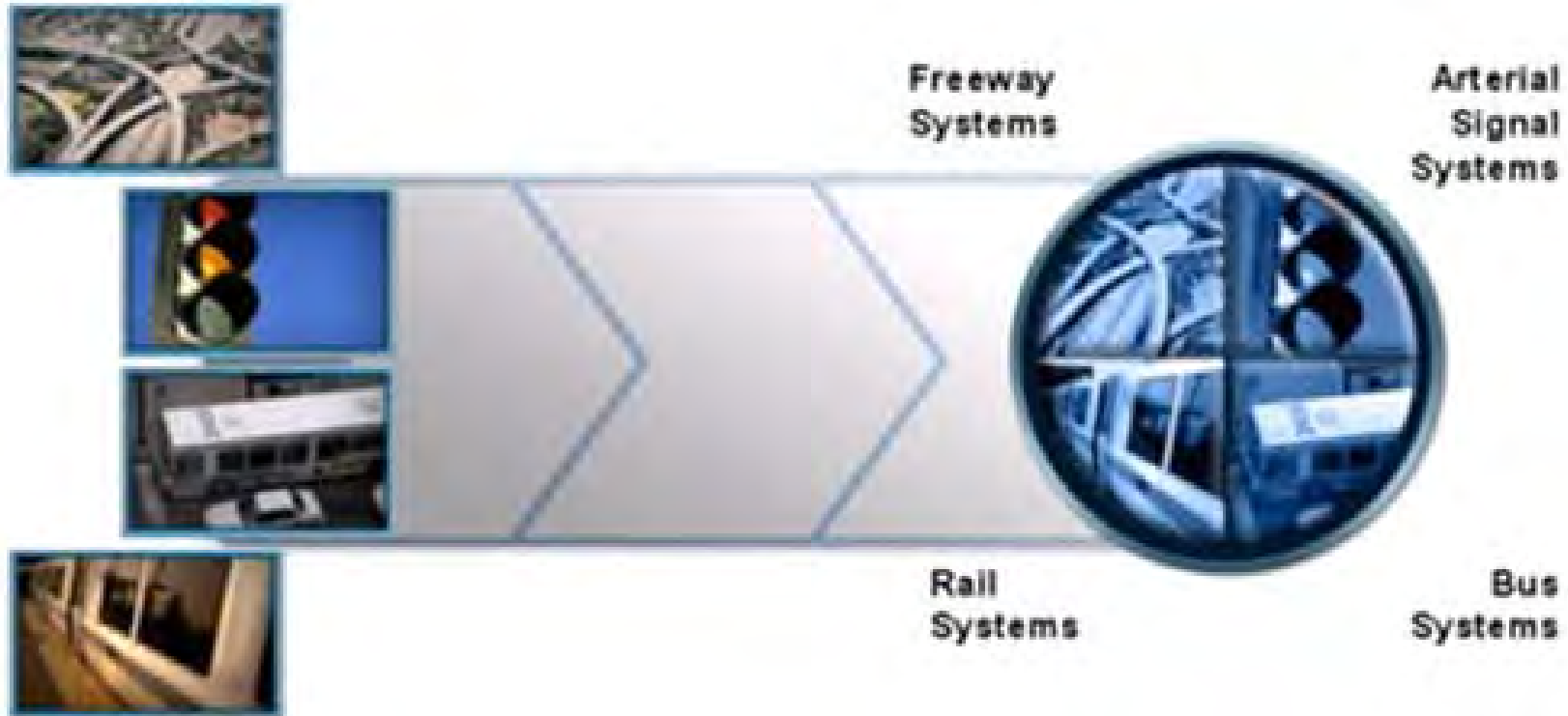


Integrated Corridor Management

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



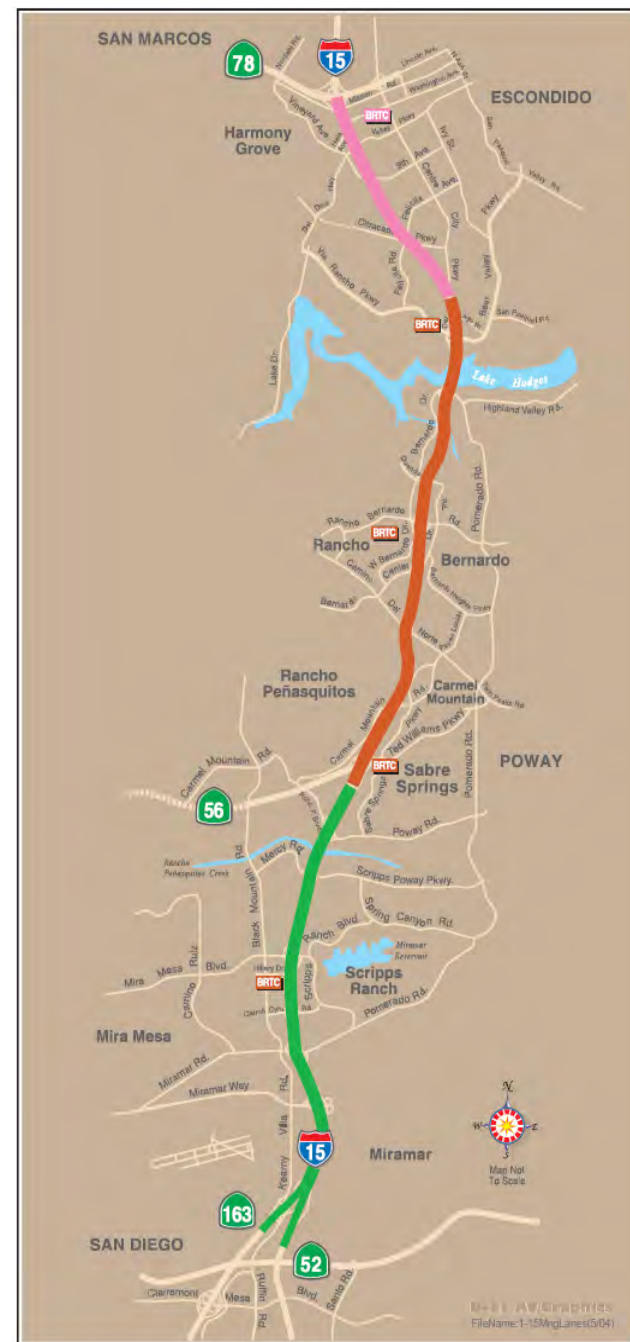
- New institutional models
- New technology
- More dynamic operational strategies
- “Network” vs. Individual corridors
- Maximize corridor capacity



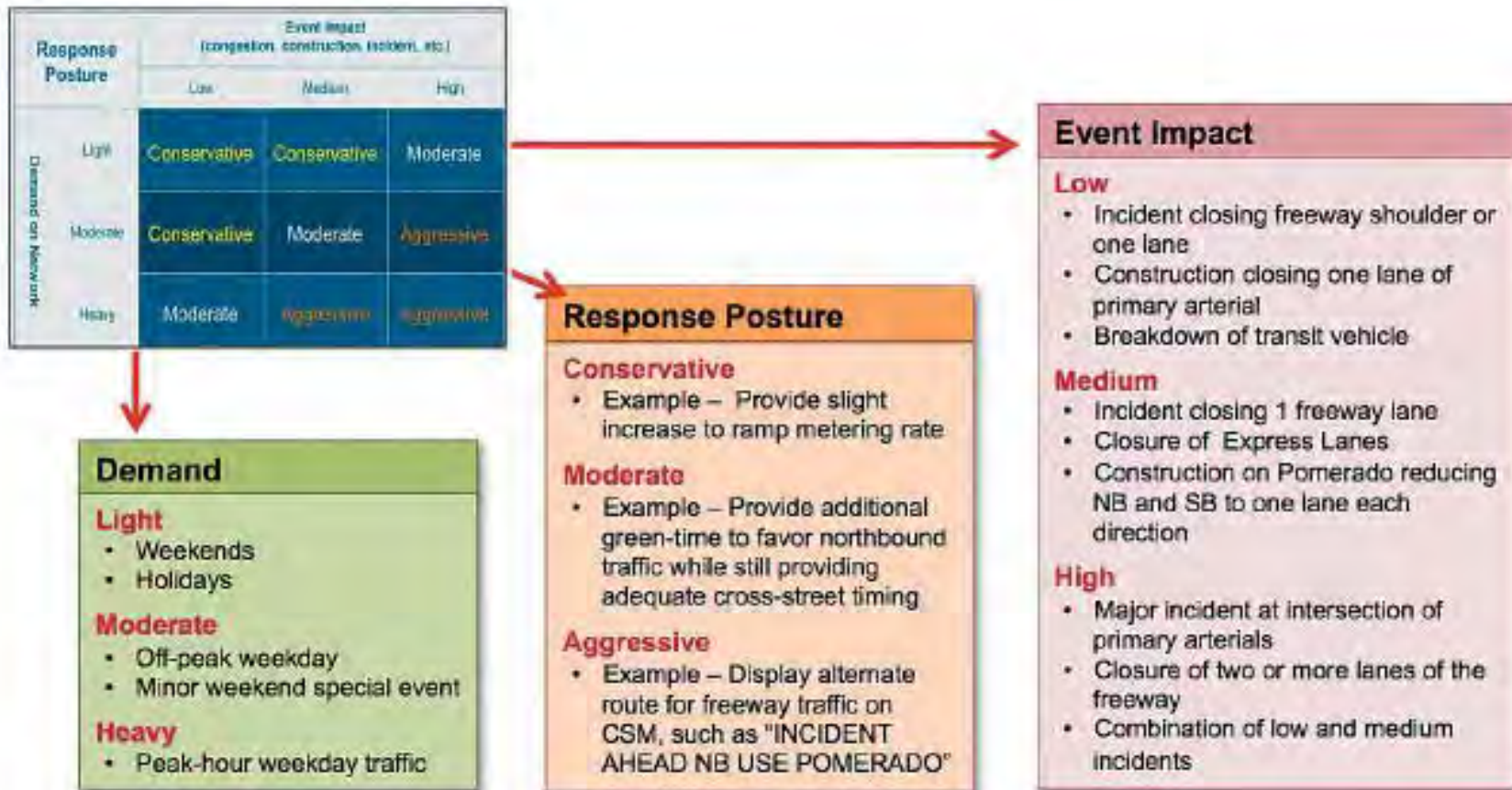


SANDAG I-15 ICM

- 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



I-15 ICM Decision Support “Response Postures”



I-15 ICM Response Plans

- 156 Alternate Routes
- 260 Local Arterial Intersections
- 18 Metered Interchanges
- 20 Dynamic Message Signs
- 5 BRT stations
- 20 miles HOT – reversible lanes
- 30 miles Traffic Responsive
- 511 (including app)

= 1.5 billion combinations!

Limited set of “point-in-time” Response Plans by:

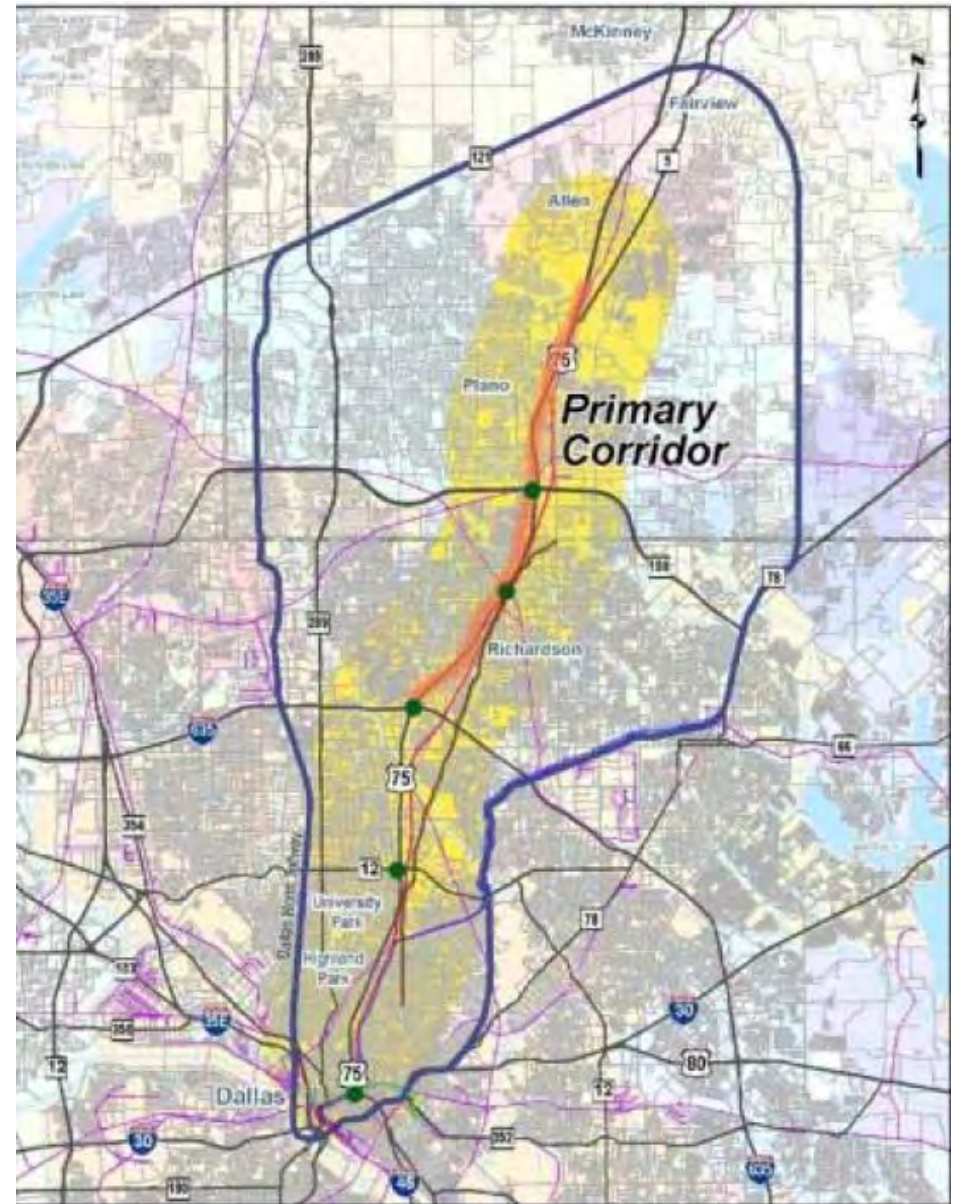
- Using Asset Restrictions
- Using Availability Conditions
- Using Thresholds to select “next move” relationships



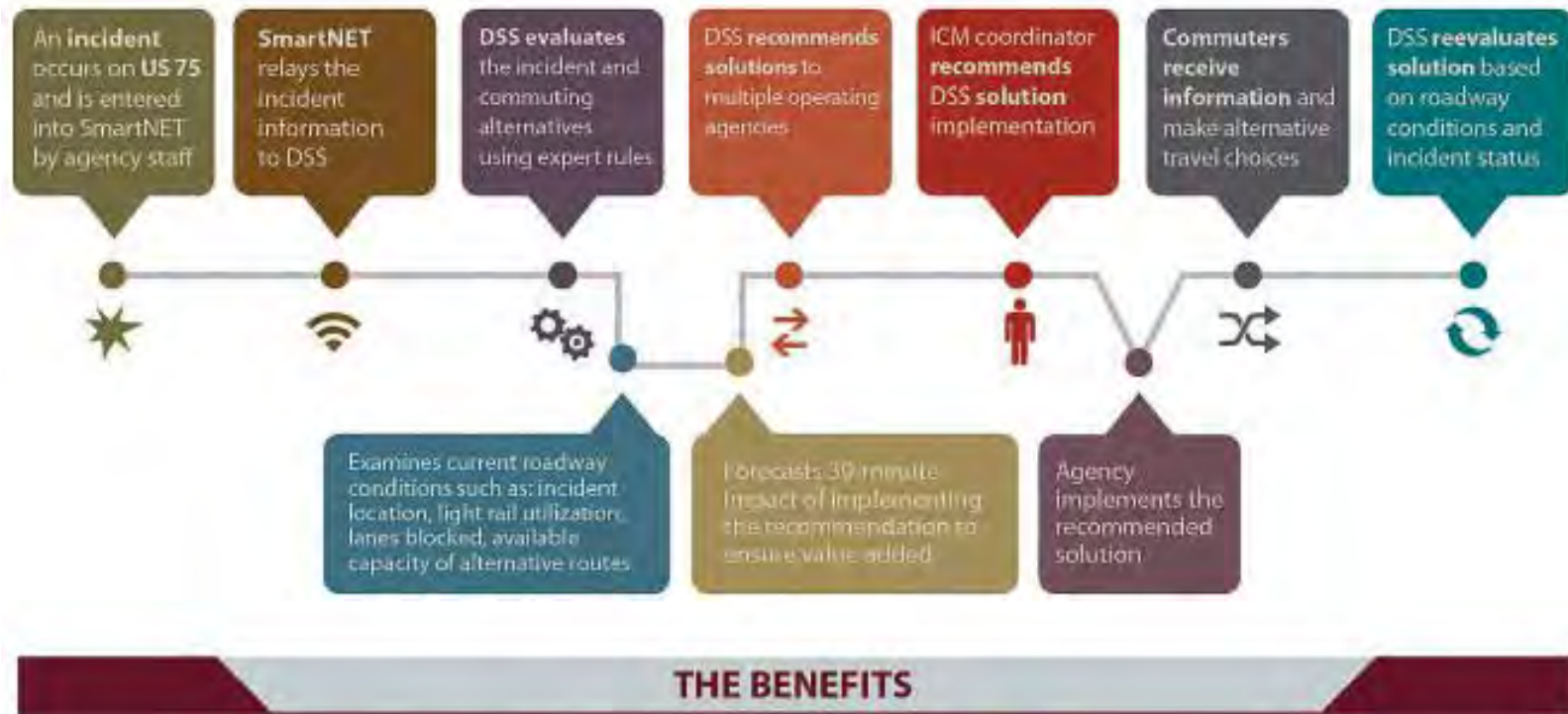


Dallas US-75 ICM

- 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)



US 75 ICM Decision Support



Improved travel time reliability for commuters

Enhanced decision making support for operating agencies

Achieves a 20:1 return (\$278.8 million) on the project's cost over 10 years

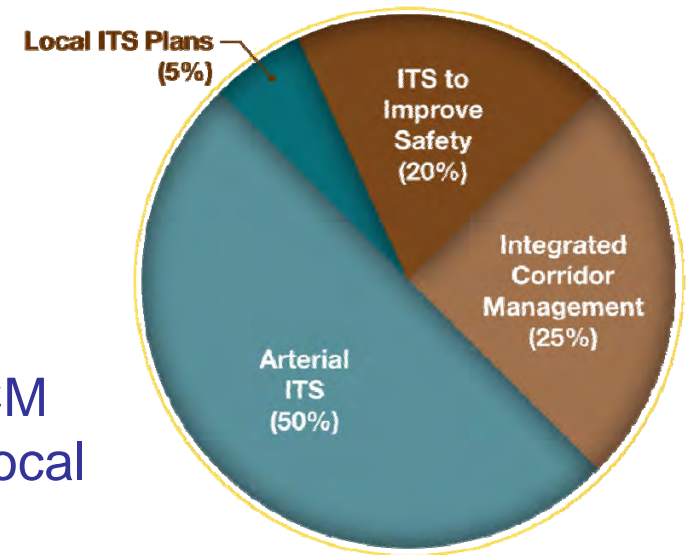
Less pollution from idling vehicles in congested traffic

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

Phoenix Area ICM

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



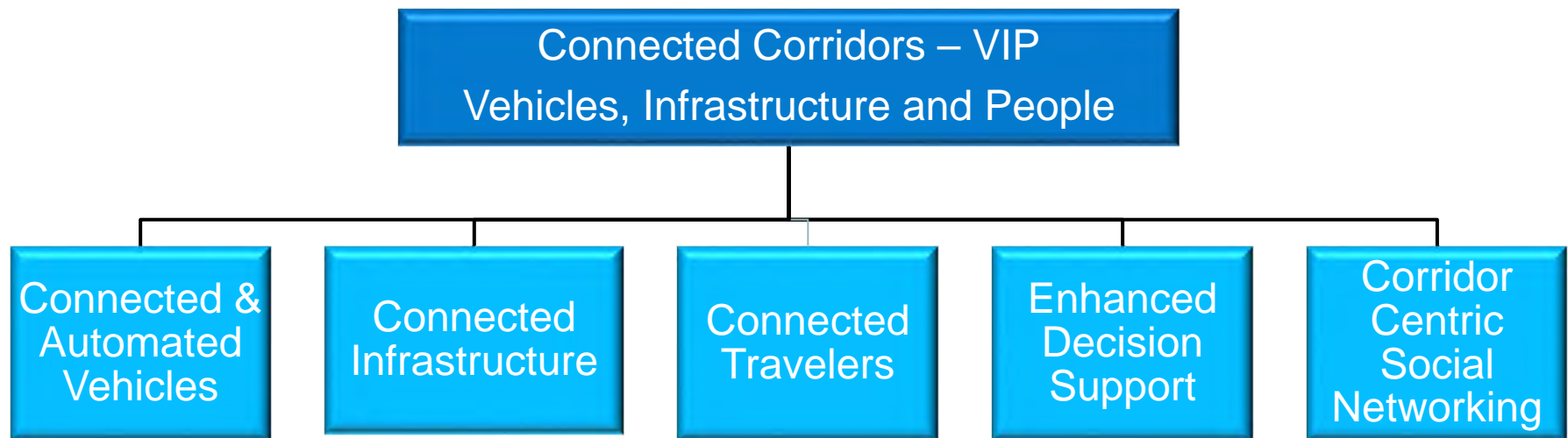
AZ Loop 101 ICM

- Arizona DOT, Scottsdale, Maricopa County
- Event-driven ICM – freeway closures
- Positives:
 - Dense arterial ITS
 - Experienced TMC staff
 - Provide arterial alt route
 - REACT to support arterial traffic diversions
- Focus on process improvements
- No new infrastructure



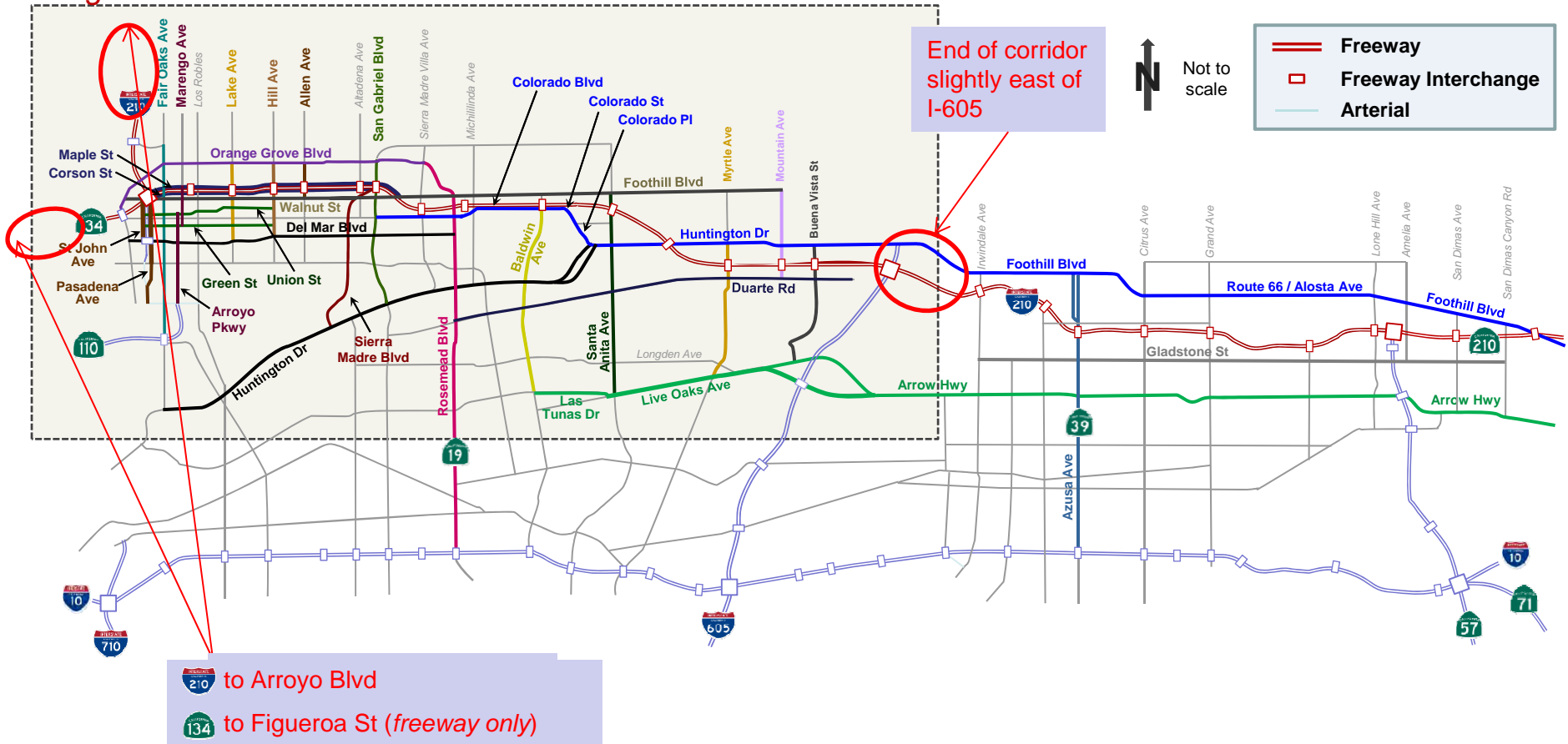
California Connected Corridors

- Initiated in 2011
- Focus on planning, implementation, O&M
 - Coordinate existing infrastructure
 - Deliver improved performance (safety, mobility, reliability)
 - Evolve Caltrans to real-time operations and management
 - Enhance partnerships



I-210 Project Corridor (Pilot)

Segment 1 Area of Interest



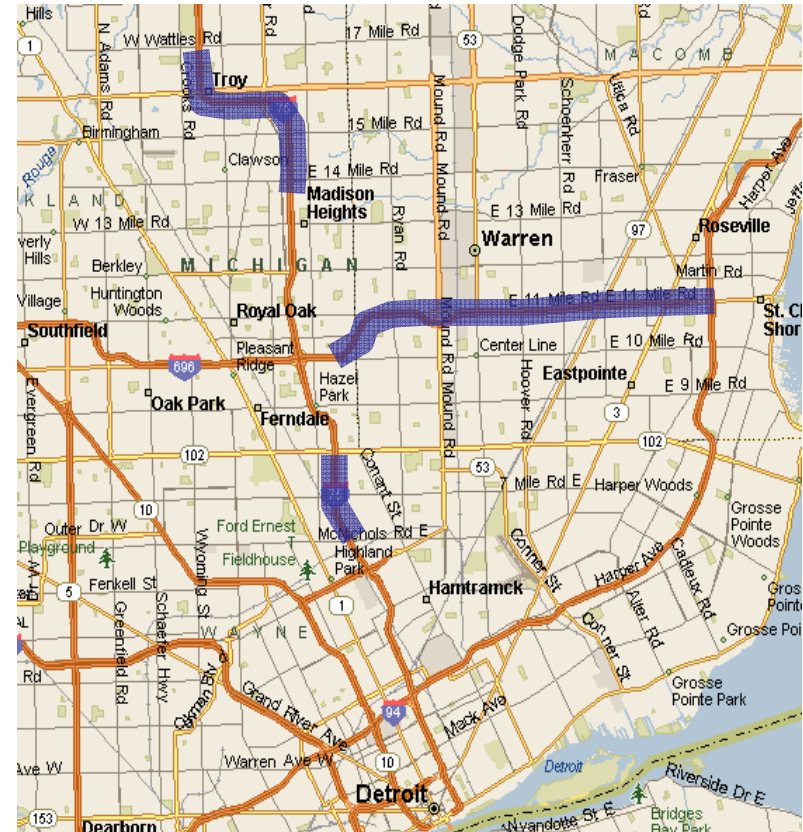
Michigan DOT I-75 Concept of Operations

- Travel time reliability within the corridor (freeways and arterials)
- Improved traveler information
- Incident response
- 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



MDOT ICM Pilot Corridors

- 2 Pilots on I-75 (Wayne and Oakland Counties); I-696 in Macomb
- Event-based
 - Improve response to major incidents
 - Traffic rerouting on arterials
- ITS equipment upgrades and infill
- Signal timing on alt routes
 - Models show freeway recovery times increasing by 15-30 minutes



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
- **Leadership commitment – key to sustaining partnerships**

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



Demonstration Site Measures

San Diego

- Travel Time
- Delay
- Throughput
- Reliability and Variance of Travel Time
- Safety
- Emissions and Fuel Consumption

Dallas

- Travel Time Reliability
- Increase Corridor Throughput
- Improve Incident Management
- Enable Intermodal Travel Decisions

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, AZ
 - Operating and operating authority
 - Data sharing parameters
 - Cost sharing
 - Decision making



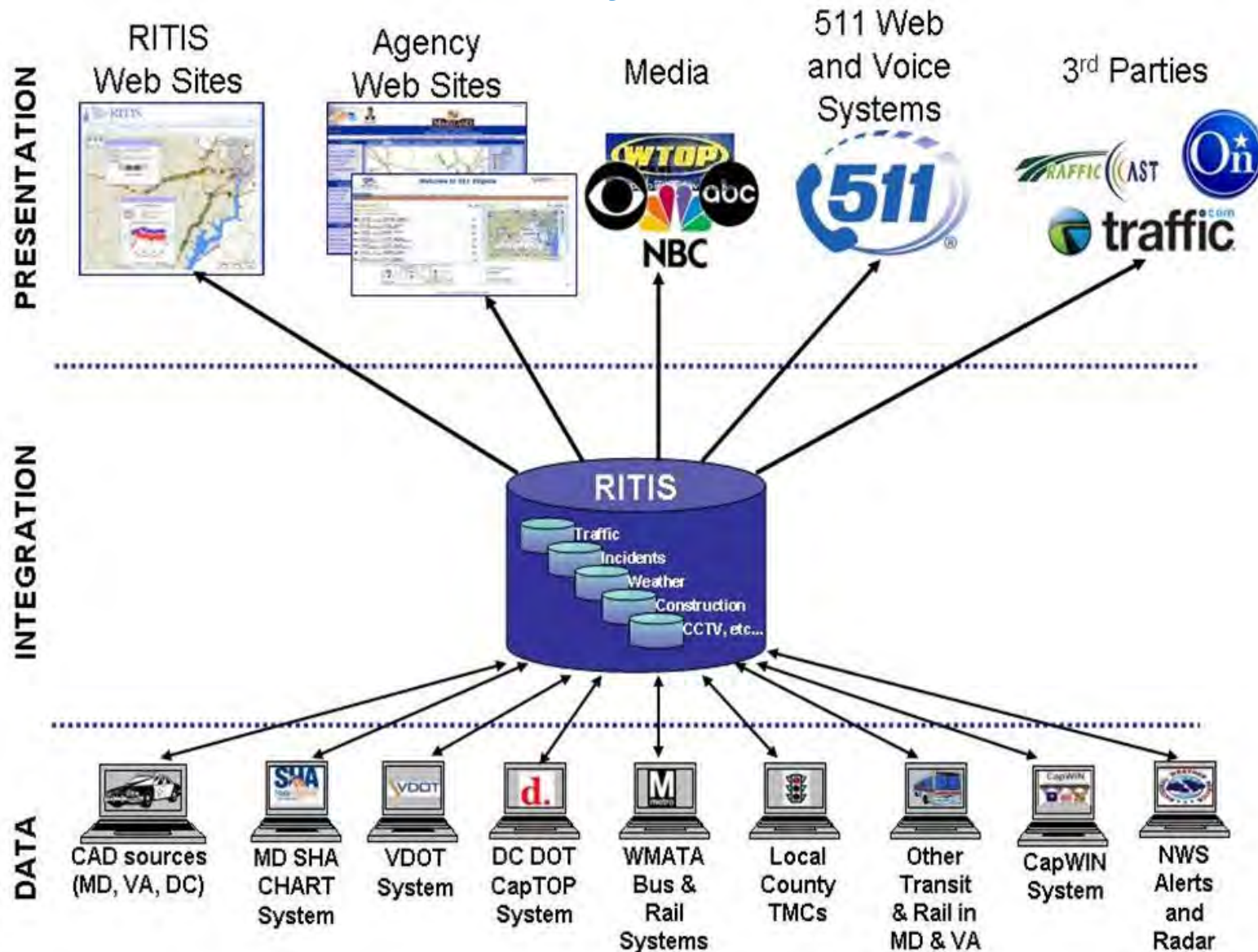
Discussion

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

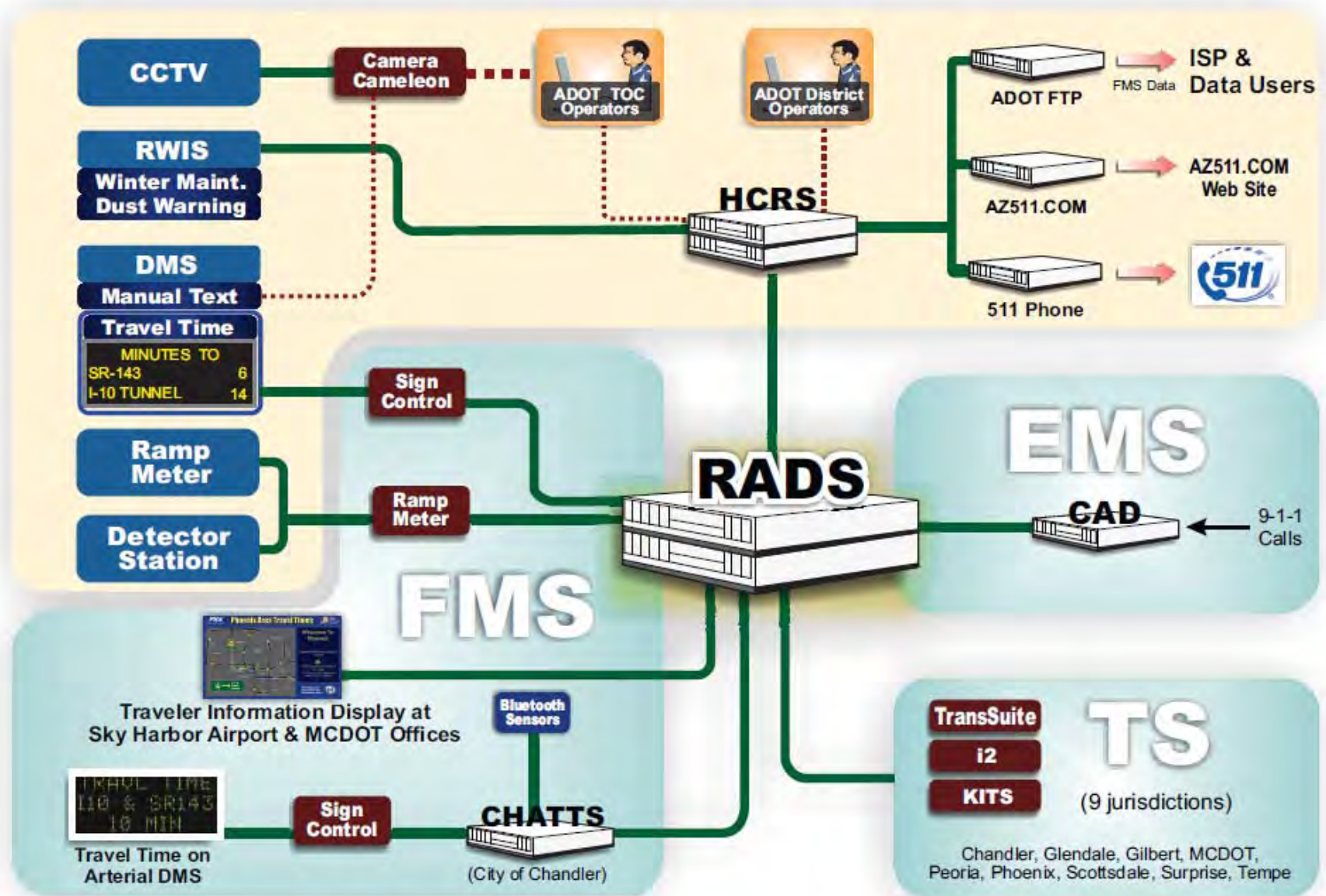
Real-time Data Sharing to Support ICM

- 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)

Regional Integrated Transportation Information System



Regional Archived Data Server



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
 - Multi-agency training strategies essential

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?