National Operations Center of Excellence

Integrated Corridor Management Peer Exchange

PURPOSE AND OVERVIEW

NOCoE's Integrated Corridor Management (ICM) Peer Exchange was intended to host both practitioners experienced in developing and implementing ICM deployments as well as practitioners looking to develop new ICM sites.

The peer exchange was virtual. While specific locations were invited to both speak and attend, the peer exchange was also open to observation to all TSMO stakeholders.

AGENDA

Tuesday, August 23, 2022

Time	Topic	Speakers
10:30 am – 10:45 am (15 min.)	**Module 1 – Welcome and Introduction** • Facilitator Welcome, time lines, and outcomes • Agenda Review • Roundtable Introductions • Summary of Advance Questionnaire	· Welcome from Faisal Saleem, NOCoE · All · Douglas Noble, ITE
10:45 pm – 11:15 (30 min.)	**Module 2 – ICM Defined / Organizing for ICM** Presentations on: • Planning / collaboration / charter / organization • Concept of operations • Other Influences (resiliency, political risk, on-going funding for O&M, alternate modes, etc.)	· Neil Spiller, FHWA and · Bob Sheehan, ITS-JPO
11:15 am – 11:30 am (15 min)	**Module 3 – What is Readiness?** Summary introduction to ITS-JPO's: *Integrated Corridor Management (ICM) – 10 Attributes of a Successful ICM Site*	· Neil Spiller, FHWA and · Bob Sheehan, ITS-JPO
11:30 am – 12:15 am (45 min.)	**Module 4A- Elements of Readiness** 1. Institutional Support (org / finance / politics) 2. Successful Procurement Practices *Format: 7.5 min. presentations followed by half hour rapid fire discussion.*	Susan Anderson, AZDOT
12:15 pm – 12:45 pm	**BREAK**	

12:45 pm – 1:30 pm (45 min.)	**Module 4B- Elements of Readiness** 3. Public Engagement 4. Open-mindedness for Change *Format: 7.5 min. presentations followed by half hour rapid fire discussion.*	Natalie Bettger, NCTCOG
1:30 pm – 2:15 pm (45 min.)	**Module 4C- Elements of Readiness** 5. Infrastructure Availabilities 6. Centralized Data Hub *Format: 7.5 min. presentations followed by half hour rapid fire discussion.*	April Wire, Maricopa County
2:15 pm – 3:00 pm (45 min.)	**Module 4D- Elements of Readiness** 7. Readily Available Alternative Transit Options 8. Multimodal Capabilities *Format: 7.5 min. presentations followed by half hour rapid fire discussion.*	Todd Plesko, AECOM
3:00 pm – 3:15 pm	**BREAK**	
3:15 pm – 4:00 pm (45 min.)	**Module 4E- Elements of Readiness** 9. Optimization of Existing Transportation Systems 10. Significant Congestion and Unreliable Travel Times *Format: Presentations followed by half hour rapid fire discussion*	Nick Compin, Caltrans
4:00 pm – 4:15 pm (15 min.)	**Day Wrap Up**	

Thursday, August 25, 2022

10:30 am – 11:20 am (50 min.)	**Module 5 – Roundtable Discussion from Sites' Reps** • Have reps from listed agencies for 4A-4E and some other agencies considering ICM talk in the big picture about their individual path of the readiness elements, and what was already in place, where they have gotten to now	All
11:20 am – 12:00 pm (40 min.)	**Module 6 – Decision Support Systems and Processes Enabled by Technology** Presentations on: process/tactics enabled by technology associated with ICM	Candice Gibson, Virginia DOT Dan Lukasik, Parsons

12:00 pm – 12:30 pm (30 min)	**Module 7 – Are we prepared? How will we know?**
	• Preliminary assessment (or table top exercise stress test) to identify gaps in processes, infrastructure, personnel, etc. (relationship to Con Ops creation)
	• Goals, objective, strategies, actions to achieve intended outcome (begin with the end in mind)
	  ○ Recognizing existing infrastructure and systems for each modal network and identifying whether these can be effectively integrated into ICM
	  ○ Distinguishing whether existing transportation systems are being fully optimized
	  ○ Knowing whether the corridor contains alternative routes and modes for travelers
	• Intro to *Traffic Management Capability Maturity Framework*
		Douglas Noble, ITE
		with Neil Spiller, FHWA

12:30 pm – 1:00 pm	**BREAK**	
1:00 pm – 1:15 pm (15 min.)	**Module 8A – Instructions for Breakout Groups to Explore Own Agency's Readiness** Provide overview of readiness exercises: • Each breakout group should discuss where they stand vs. the readiness attributes, long term planning objectives, goals and barriers. • List any needed resources to advance each of the readiness elements • *Each group should plan to provide a 10 min report-out on above 2 bullets at the conclusion of their breakout round robin with each agency stating their prospective action items.*	Douglas Noble, ITE
1:15 pm – 2:45 pm (90 min.)	**Module 8B – Breakout Groups to Explore Own Agency's Readiness (or Alternatives)** Facilitated breakout(s)	Lead by Facilitators
2:45 pm – 3:00 pm	**BREAK**	
3:00 – 3:45 pm (45 min.)	**Module 8C – Breakout Groups' Reports** Report-outs of from each breakout group • 10 minute report-out from each of 3 breakout groups • 15 minute open discussion on report-outs	All
3:45 pm – 4:15 pm	**Day Wrap Up** • What do you intend to do with the information you have learned?	All

(30 min.)	• Have the participants create a self-accountability / reporting mechanism. • Closing thoughts and next steps	Faisal Saleem, NOCoE

** All times list as Eastern Standard Time.*

SESSIONS

Introduction

The *Integrated Corridor Management* peer exchange was conducted in a virtual format as a two day meeting. There was an introductory session and eight content sessions organized around ICM "Readiness" described in the FHWA *10 Attributes of a Successful ICM Site* each followed by a breakout discussion/question and answer period as well as a three breakout discussion groups to explore individual agency's ICM readiness.

In advance of the peer exchange participants were sent a brief questionnaire with three questions with responses as noted:

How does your agency define Integrated Corridor Management?

- All modes of transportation working in conjunction with one another in an efficient manner.
- The increased efficiency of the region's transportation system through inter-agency collaboration and acquiring of data to make informed decisions on traffic operations and opportunities for multimodal solutions.
- Promotes sharing of data and systems amongst corridor stakeholders. ICM also promotes planning, design and systems engineering to define and program integrated transportation projects with regional stakeholders.
- Traveler information and routing for parallel highways or designated preferred alternate routes.
- Managing recurrent and non-recurrent congestion and events in the travel shed along an impacted corridor using a variety of technological and traffic engineering strategies.
- A collaborative approach to Traffic Incident Management.
- The integrated management of freeway, arterial, transit & parking systems within a corridor for the benefit of the customer (motorists). Management of the corridor as a system, rather than the more traditional approach of managing individual assets
- The joint management of a transportation corridor as a complete system to address recurring congestion, improve incident management operations, leverage alternate routes and modes.
- Ability to manage transportation systems/modes holistically regardless of institutional boundaries with focus on transportation users/travelers.
- The holistic approach of coordinating the management of different transportation subsystems to improve the overall flow of people and goods.
- Determining a corridor's transportation operational needs and identifying an integrated management concept for addressing those needs based on existing capacity, characteristics, modal distribution.
- A collection of preplanned TSMO strategies that help with quick clearance and traffic management.

- Coordination between multiple agencies and disciplines in managing transportation needs of a corridor across various modes.

What stage of consideration of Integrated Corridor Management is your agency? Your region?

Table 1: Stage of Integrated Corridor Management Consideration.

	Agency	Region
Interested	1	3
Concept	3	2
Planning	5	5
Design	1	0
Construction	1	0
Operations/Maintenance	2	1
No Answer	4	7

What is your self-rating in each of the ten Integrated Corridor Management readiness attributes on a scale of 1 to 10 for your agency? Your region?

Table 2: Average Self-Rating of Integrated Corridor Management Readiness by Attribute

Readiness Attribute	Agency	Region
Institutional Support	6.6	5.6
Successful Procurement Practices	5.8	5.5
Open Mindedness for Change	7.5	5.8
Public Engagement	4.9	4.9
Optimizing Existing Transportation Systems	7.3	6.6
Readily Available Alternative Transit Options	5.3	5.4
Centralized Data Hub	6.4	5.8
Multimodal Capabilities	5.7	4.9
Infrastructure Availabilities	6.3	5.8
Significant Congestion and Unreliable Travel Times	6.4	6.6

ICM Defined / Organizing for ICM

Neil Spiller of the Federal Highway Administration (FHWA) and Bob Sheehan of the U.S. DOT ITS Joint Program office introduced Integrated Corridor Management (ICM) and its core concepts. Pulling apart "Integrated Corridor Management" as a term the individual elements are defined as:

- Integrated – combining or coordinating separate agencies so as to provide a harmonious, interrelated "whole."
- Corridor – a travel shed of trips anchored by one or more highway, arterial, or rail line.
- Management – the coordination of jointly managing **all** the travel therein in order to achieve defined objectives.

FHWA identifies "readiness" for ICM by:

- Recognizing existing infrastructure and systems for each modal network and identifying whether these can be effectively integrated into ICM.
- Distinguishing whether existing transportation systems are being fully optimized.
- Knowing whether the corridor contains alternative routes and modes for travelers.
- Verifying that relevant agencies are in support of corridor operations.

Based on the two ICM demonstration sites' implementation and 13 pre-implementation sites, ten key attributes of successful deployment were identified as being important for effective implementation. These attributes were used as an organizing approach to this peer exchange. Importantly, not all 10 need to be present as ICM is a coordination overlay to enable pieces to be operated as a complete system.

ICM is premised on, and therefore best utilized, where there is a robust auxiliary network that can be leveraged as alternate routes and modes to absorb impactful events or duration to a major facility that in the prior years would paralyze a region. The joint management of a transportation corridor as a complete system (rather than an individual facility) can address recurring congestion and improve incident management operations beyond reacting to events.

Areas with the largest success include:

- Inter-agency cooperation and coordination
- Situational awareness / response and control
- Mobility
- Traveler information and satisfaction
- Decision Support Systems
- Alternate routes / signal timing changes

To streamline choices between sets of actions in an ICM context a Decision Support System (DSS) monitors for atypical congestion to alert triggers that would invoke DSS response(s). ICM managers then accept or decline recommended actions in a response plan to mitigate that atypical event. Acceptance then initiates the pre-agreed business rules amongst the varying agency partners in the multi-agency, multi-modal, and multi-jurisdictional ICM regional working group.

A chess analogy is useful to describe the interaction between Integrated Corridor Management, Decision Support Systems, and Business Rules:

• Integrated Corridor Management (ICM) – The board ("context")	*Region*
• Agencies/jurisdictions/operators – pieces (e.g., king, queen)	*Stakeholders*
• Business Rules (BRs) – rules governing action (e.g., pawn moves one square, knight can jump pieces in L shape, etc.).	*Permissions and Assignments*
• Decision Support System (DSS) – strategies to make moves within the rules most effectively (e.g., Stonewall Attack)	*ICM Event Management across all agency resources*

In practice administering an ICM program has three stages surrounding response to an event.

ICM Pre Planning

- Engage stakeholders.
- Collect data.
- Identify corridor boundaries, issues, and needs.
- Adopt vision, goals, and objectives.
- Develop business rules and Decision Support System (DSS).

During ICM Event

- Event meets ICM threshold.
- Business rules engine triggered.
- Response suites created for approval.
- Implementation of response suites of individual action plans.

Post ICM Event

- Data collection from event.
- Recalibration of underlying traffic simulation models.
- Tweak ICM event thresholds.

ICM is neither nominal traffic management nor traditional incident response. In response to an event a combination of action plans defines an individual response plan (see Figure 1) based on an agreed upon response posture that could include such actions as changing signal timing, display messages, promote alternative travel modes, relax HOV restrictions, or change ramp metering rates. The end result is to effectively flex the entire region to absorb the closure or severe reduction of the mainline highway capacity.

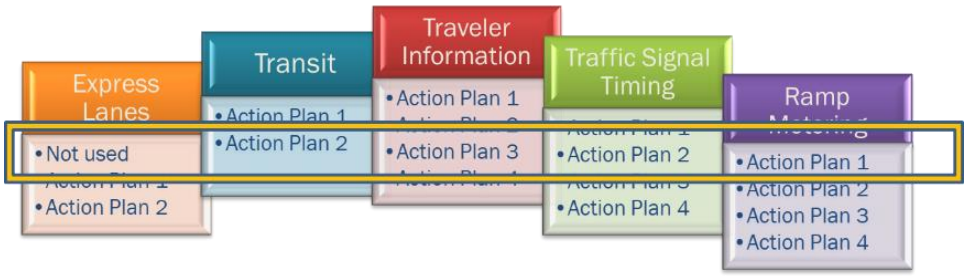

Figure 1. Sample ICM Multimodal Response
Source: Federal Highway Administration

In closing the speakers noted what ICM **is not** and what ICM **is**.

ICM is not…

- (not) a static detour; maybe a dynamic one
- (not) siloed decisions using the individual agency's system of freeway, arterial, or incident management
- (not) a planned work zone or transportation management plan
- (not) reactive, ad hoc, or individualistic

ICM is…

- Multi-agency responses, via business rules, optimizing a corridor as a whole.
- Working the problem
- Proactive, planned, predictive, cooperative

Elements of Readiness

The peer exchange continued with a series of presentations from agency representatives of their perspective of the readiness elements followed by discussion.

Elements of Readiness – Institutional Support and Successful Procurement Practices

Institutional Support – One of the most critical pieces of successfully implementing ICM is interagency and institutional support. Without the coordination of transportation agencies and organizations, multimodal communication and coordination is extremely difficult. Deployment of the required ICM technologies can be severely delayed or even immobilized without the support of local and regional transit agencies and the ability to send information across jurisdictions. Strong leadership is also important. ICM implementation not only requires the coordination and support of external agencies and organizations, it also relies heavily on the ability to coordinate and make decisions from an internal perspective. Like most systems, ICM implementation can only fully succeed when all parties involved work together, and a strong sense of leadership is necessary to keep all of those aspects organized and the end goal on track.

Successful Procurement Practices – The most successful ICM sites are able to identify the processes and practices that work, and the personnel needed to perform the job correctly and proficiently. For example, integrating traffic systems together requires a different set of skills and expertise than typical traffic engineering. Intelligent transportation systems (ITS) experts may need to be involved in the integration process to ensure it is completed effectively, and knowing this information in advance eliminates wasted time spent on troubleshooting. Efficient ICM sites are fully aware of expertise requirements and act accordingly during the procurement and integration processes.

Summary

Institutional support is critical for program success by helping gain interagency buy-in and cooperation which allows the combined program team to leverage their collective powers to achieve administrative and operational efficiencies as well as cost savings. Best practices[1] cited by FHWA include:

- Build on an existing collaborative group
- Committed champion
- Establish a lead coordinator
- Multiagency support
- Executive-level support
- Organize and train staff
- Engage participants
- Coordination and communication are key

Susan Anderson of Arizona Department of Transportation (ADOT) shared that their experience in the Phoenix metro area has involved existing collaborative groups in ITS planning (Maricopa Association of Governments ITS Committee) and operations (the AZTech Partnership). In addition there has been a history of ICM initiatives including the I-10 ICM plans to evaluate strategies, detour routes, and operational improvements, and the Loop 101 Scottsdale program of incident management, freeway/arterial coordination plans, and emergency response support.

[1] Jocelyn Bauer, Deena Platman, et al., *Planning for Transportation Systems Management and Operations Within Corridors: A Desk Reference*, Report No. FHWA-HOP-16-037 (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, 2016). Accessed March 30, 2023.

The current Loop 101 Mobility Project involves 61 mile freeway corridor in the Phoenix region with an Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant of $6M and in-kind match with staff time and projects. The Loop 101 Mobility Program organization includes involvement from key partners in all aspects of technical tasks, management, and administration, as well as overall governance and decision-making. Technical teams engage partner agencies in needs and concepts, system planning and will be involving stakeholder agencies as part of all project technical decisions. The project includes an administration team comprised of ADOT and Maricopa County DOT senior staff, and the project management team includes representatives from ADOT, Maricopa County DOT, Valley Metro and FHWA. The overarching outcome is that the program organization aligns roles, responsibilities, and ICM strategies and ensures that there is engagement across all modes of transportation and potential stakeholders within the corridor.

Maintaining institutional support requires regular on-going communication and clear focus on the project vision and goals. The Loop 101 Mobility Project maintains a project specific website, reports monthly, quarterly, and annually to US DOT and FHWA reporting, quarterly executive gGovernance meetings, weekly project and technical team meetings along with the Maricopa Association of Governments ITS Committee and AZTech meetings.

An organization's collaboration and understanding of the project enables options for gaining feedback from stakeholders throughout the development process. This is supported by decision-making approval from each agency's authority for specific decision points (e.g., recently completed the Operations Plan, Systems Engineering Management Plan, and current development of the Concept of Operations and High-level System Requirements). As in many broad multi-agency programs, the Loop 101 Mobility Project is identifying and seeking a detailed understanding of the opportunities and constraints of the participating agencies. Understanding their requirements as the project develops the systems requirements and specifications for the DSS is important to creating one system that will work for everyone involved. The other facet of opportunities and constraints the team faces is participating agency's commitment of staff expertise and lifecycle funding for the costs of ICM.

ADOT has found in the context of ICM deployment, it was necessary to identify key processes and practices such as business rules and existing agreements. Business rules and existing agreements can define aspects of operations and assist with developing strategies between organizations. An ICM DSS can often incorporate these agreement terms, as the terms will define the boundaries in which the system must work. Some of these may or may not exist, or may need to modified to make ICM sucessful. Each participating gency will need to assess their respective policies and assess if internal practices are in need of revisions to best support ICM. In a similar manner contract management to support ICM involve defining roles, responsibilities, levels of accountability, and measures of performance to support long-term sustainability of ICM.

With the Loop 101 Mobility Project in the Phoenix metro area a number of key factors supported successful procurement. Initially, a project charter was established and other addtional agreements will be initiated to address various responsibliities. The approach utilized existing procurement processes. However, this decision was the result of an in-depth review by the Arizona Attorney General's Office to determine whether Maricopa County DOT could act as a co-lead on the project since USDOT contract was directly with ADOT. The process verified that there were no restrictions in the USDOT contract and Maricopa County DOT operates as a certification acceptance agency under Arizona law, with delegated authority to administer federal-aid projects. This meant both agencies could make procurements as co-leads, which has benefitted the overall project.

As a result, ADOT's role in the project was to procure the gerneal engineering consultant as well as the development and delivery of adaptive ramp metering in the project area and the Glendale adaptive signal system. Maricopa County DOT had the connected vehicle deployment and decision support system elements.

Institutional support and procurement practices such as interagency agreements and cooperatively funding deployment and operationsare important for the long-term success of an ICM program because the can enable institutional integration.

Discussion

In the ensuing discussion Susan Anderson (ADOT) emphasized the longstanding existence of the Maricopa Association of Governments ITS Committee and the AZTech Partnership and their associated subcommittees. In addition, it has been very important that ICM is a key component identified in the Maricopa Association of Governments *System Operations and Management Plan* which has led to regional support including the arterial diversion approach. As a result, TSMO and interagency support is part of the culture in the region. There is an even more collaborative approach between agency staff at the technical committee level where different ideas are brought forward, piloted at one agency, then shared to others. April Wire (Maricopa County DOT) observed that the collaboration aspect works because, not only are there champion(s) for the region, there are champions in each individual agency.

In northern Virginia, Virginia DOT (VDOT) and Northern Virginia Transportation Authority (NVTA) had been developing individual TSMO / ITS technology plans but that evolved into a coordinate program due to a number of factors. The Virginia General Assembly created a Smart Roadway Fund (now called Innovation Roadway Fund) which required agencies to work together more collaboratively. The legislation was Introduced and supported by Northern Virginia delegates who recognized need for options beyond capacity expansion in the region. When the ATCMTD grant applications were released the two agencies came together to advance a submission which support VDOT's ICM program called the *Regional Multimodal Mobility Program* (RM3P).

One of the challenges is procurement of technology which needs to advance from the typical brick and mortar approach in transportation agencies. Scoping should be more flexible for technology applications. Another challenge is that technology in narrow markets and with existing installations, is more appropriately purchased sole source with due diligence justification versus competitive bidding. Unfortunately, the justification process for sole source procurement is slow to resolve the special approvals needed.

VDOT, for example, is examining cooperative agreements to purchase ITS devices, traffic management systems, traffic signal controllers, etc. that would allow localities to purchase from the agreement. The agency is also looking at prioritized funding with corridor projects to allow application across jurisdictional boundaries.

Todd Plesko shared the Dallas ICM project was primarily funded through the Dallas Area Rapid Transit agency (DART) beginning in 2007 through 2014. Strong support initially though staff was constantly briefing the DART board on why it was important to fund a project that had a large highway element. The real challenge to the project momentum and the champions' support was the substantial change in external economics associated with the 2010 recession that made funding prioritization difficult. The ICM project as managed by DART ended in 2014; Texas DOT has since taken over the ICM management aspect and the 511 system and other elements are now with the North Central Texas Council of Governments (NCTCOG).

Elements of Readiness – Public Engagement and Open-mindedness for Change

Public Engagement – Keeping stakeholders and the public engaged provides the public with better understanding of expected changes and better enables them to make more informed travel choices. A dedicated public-facing website that houses all of the corridor information and serves as a one-stop shop for project information can keep the public knowledgeable of recent ICM developments. It also provides the media access to all images and videos and reminds the public that the system is still in place—even after all physical changes and construction have been installed and forgotten.

Open-mindedness for Change – Change is not always easy. While some people are more susceptible to change, others may see it as a threat to the familiar routine and be less receptive. Successful ICM sites are able to encourage an open mind and acceptance to changing solutions for congestion and traffic. Encouraging the public to support the changes for the betterment of congestion and travel times is an extremely important— and sometimes difficult—task.

Summary

Natalie Bettger of NCTCOG shared her perspective that the critical items necessary to support public engagement and an open-mindedness for change include identification of transportation partner roles from both the user and operator perspective, engagement with all stakeholders, understanding their issues, incorporating their feedback into solutions, and development of key messaging. The partners include, in more detail:

Operators	Users
Local Governments	Travelers
Fire, Police, Transportation, 911	Daily Users
Freeway/Tollway Operators	Occasional Users
Texas Department of Transportation	Out of Towners
North Texas Tollway Authority	Media
P3's	Screen
Emergency Response	Social Media
Sheriff's Office	Online
Towing and Recovery	Audio
Transit Operators	Third Party
Dallas Area Rapid Transit	WAZE
Trinity Metro	Google Maps
Denton County Transportation Authority	Special Event Venues

Approaches to engaging partner groups will vary. Operating agencies will appreciate staff resources to coordinate workshops, share best practices, and develop contact list(s). Specific funding and project resources to support agencies in implementing projects as well as provide consultants' assistance through NCTCOG cooperative procurement(s) encouraged staff level buy-in and participation. Policy level buy-in at the regional and executive level can be developed by meeting with those groups' leaders and members along with regular updates to the assembled groups. Lastly, seek to identify gaps related to ICM delivery in operating agencies, and seek to bridge them from your own agency.

On the user side, define how does ICM applies to them and helps them using varying approaches for outreach (i.e., social media, web, audio, video) and types of content for agencies to use (e.g., press

releases, briefs, paid interviews, etc.). Provide incentives to encourage users to change their behavior. Do not forget connecting to local community and neighborhood associations.

Changing mindset and messaging is about connecting the dots between what items are important to your area and how does ICM solve them. If an issue is safety, ICM reduces crash response and clearance times improving health outcomes. If an issue is air quality, ICM provided alternatives to driving alone reducing emissions. If an issue is congestion, ICM improves reliability of travel times. Talking points on these and other issues can be developed and shared with partners to connect ICM focus areas to solutions affecting important challenges to the region.

Discussion

It was noted that in the past people would get their travel information from one or two sources. Now there are a multitude of options which is why the US 75 built a website and associated app. The ICM approach requires that motorists follow the intended detour/rerouting/mode shift for strategies to be successful. Unfortunately, because of the variety of options for information motorists don't always follow along with the intended plan. A secondary issue on US 75 was the reluctance of the state DOT to move traffic from the freeway and frontage roads to local streets.

Virginia has found that localities struggle with the financial resources side of projects which is part of the reason the state legislation mandates support from the state agency to localities. Skill sets vary widely with local agencies, some are quite good, others manage traffic signals in a "set and forget" mode. The other two challenges working with localities has been interoperability and cybersecurity readiness for integration into VDOT systems. There is also some hesitancy of transfer of control for traffic signal management. The agency is working on MOUs that incorporate thresholds for transfer as well as cybersecurity.

Elements of Readiness – Infrastructure Availabilities and Centralized Data Hub

Infrastructural Availabilities – ICM sites must also have the appropriate infrastructure in place to support ICM, such as parallel arterials and additional transit options. For ICM to work properly, there must be alternative means of transit to which people can shift based on the information and traffic data the system provides.

Centralized Data Hub – A localized transportation management center is critical for housing all communication and traffic data in one centralized location. This makes it easier to organize and analyze the different traffic data and information in a consolidated manner.

Summary

Maricopa County DOT has responsibility for a system of 3,300+ signalized intersections 88 percent of which are connected through the Regional Community Network. The agency also hosts the SmartDrive connected vehicle test bed in partnership with the University of Arizona. The Phoenix metro area has large seasonal fluctuations in population and overlay of 223 spring baseball Cactus league games across 10 stadiums in addition to the professional sports franchise games and a flagship state university.

April Wire summarized various aspects of the AZTech partnership led by ADOT and Maricopa County DOT for traffic management and operations that includes 24 public agencies including universities, county and state DOTs, transit, public safety, and metropolitan planning organization (MPO). The region has an institutionalized approach for collaboration whose premise is that agencies are stronger working together. As a result, AZTech regional partnership has evolved as ideas and focus areas have changed to make many TSMO initiatives happen.

Since 2015 AZTech has developed implementation plans to guide the organization's work from year to year with a 5 year horizon with projects defined organically as regional priorities change. AZTech issues a *Performance Indicators Book* to summarize changes in travel time and transportation volume, projects completed, and new initiatives.

Maricopa County DOT's role in its traffic management center focuses on arterial mobility, real-time signal operations, work zone activities, traveler information, and supporting arterial incident management. There is a future need to add on an element addressing ICM operations. Two foundational supporting elements for an ICM DSS is the Regional Archive Data System data repository and the AZTech Regional Information System which converts the data into information for partner agencies. Additionally, AZTech has published a WZDx feed based on regional work zone data. AZTech regionally collects high resolution signal data used in the regional automated traffic signal performance measures system that would support DSS using this data. The region needs more TSMO dashboards to summarize data on one platform.

As noted earlier Loop 101 Mobility Project is co-led by ADOT and Maricopa County DOT, currently with five projects included in an ATCMTD grant moving from planning to project development:

- Freeway Interchange Adaptive Ramp Metering
- State Farm Stadium (Glendale) Adaptive Signal Control Technology
- Scottsdale Trolley Transit Priority CV Deployment
- Integrated Traveler Information Mobile App
- ICM Design Support System

The ICM project is identified as a priority for the region and was selected based on the outcomes of a successful pilot that the agency led in 2012 in Scottsdale. As the first large-scale ICM implementation in the metro area there is anticipation for lessons learned for future ICM projects. A large portion of the development of the project is focused on the development of a DSS for supporting ICM. However, this is being seen as a phased approach so partners can be comfortable with the approach as full automation isn't desired by the stakeholders today.

Discussion

In North Carolina, the state agency held meetings every couple of months with staff and consultants to document ICM practices, standard scopes of work, and assessments as a way to generate more understanding throughout the agency beyond champions to try to institutionalize ICM concepts.

Elements of Readiness – Readily Available Alternative Transit Options and Multimodal Capabilities

Readily Available Alternative Transit Options – Alternative transit options are a necessity for successful ICM sites. These options could include bus rapid transit, HOV lanes, alternative commuter options, commuter rail, heavy rail (e.g., subway), and light rail. Effective ICM sites already have these options in place before ICM is implemented, and therefore can more easily integrate the options together.

Multimodal Capabilities – ICM corridors must also have the ability to connect in a multimodal fashion. This means that the different transit organizations and agencies must be able to communicate with one another, such as bus transit, rail transit, high-occupancy- vehicle (HOV) lane management, etc. Full implementation is nearly impossible without open communication—both technologically and organizationally—between the different modes of transportation.

Summary

The US 75 ICM in the Dallas/Fort Worth region had the overarching vision to: Operate the US 75 Corridor in a true multimodal, integrated, efficient, and safe fashion where the focus is on the transportation customer. There were two operating goals: 1) the integrated management of freeway, arterial, transit & parking systems within a corridor and 2) management of the corridor as a system, rather than the more traditional approach of managing individual assets.

Todd Plesko (formerly with DART, now with AECOM) provided an overview of the key transit and multimodal elements of the project. This included three light rail lines with the ability to add/subtract cars, various bus lines, and multiple park n ride lots. The corridor has bi-directional HOV lanes with CCTV and ATMS sensors connected to the DSS. Real-time information includes transit ridership load reporting, parking lot occupancy/available capacity, dynamic messages signs, and 511 and mobile app travel information. The presentation included a step-by-step example of the morning commute major accident scenario showing the context of the event, the various data screens and DSS decision elements.

A number of Dallas-specific lessons learned were shared. There is a need to factor in risk and plan for the unexpected. The ICM's 511 system requires multi-agency financial commitment and traveler information must have a highway and arterial sign physical presence. ICM requires long term executive and governing board support for multi-modal multi-agency investment and a one year pilot operation is not enough time to generate results to spur continuing interest.

More generally, ICM must be in a region's ITS strategic plan and this can allow resolving institutional issues early on. All the participating agencies need see what is in it for them, to have a "win" from ICM. Data sharing programs are a useful starting point that can lead to more advanced ICM components. However, planning for future expansion is necessary at the outset in location, systems, agency participation, and applications development. Maintaining transit agency financial support over multiple years is essential to continue an ICM program, but must be cognizant of goals and funding priorities of transit in relation to the region and ICM deployment.

The US 75 ICM project with the supporting DSS processes ended in 2014, partly because of transportation network changes need to be updated in DSS strategy model. DART as the regional transit agency decided to focus its financial and management resources on more traditional transit rather than ICM which required major investment in highway systems. The experience with ICM working across multiple agencies and multiple modes in actual operation was very beneficial. DART learned that the use of technology, decision support, and automated communication to the public could overcome some of the modal silo's common within public transit.

Discussion

In early years of the ICM project, DART did not have real-time data for transit vehicle occupancy/capacity. The information was really only "near" real-time. Today, there is newer cellular technology with Bluetooth to transmit real-time transit data. Providing similar data for parking lots is a good business tool in general that has an ICM benefit.

Todd Plesko noted that there was a better chance for diversion to transit if travelers were alerted before they left home or, if in route, near a park and ride lot. This worked well if travelers were going downtown, but less so for non-downtown destinations. The challenge was for people to know quickly enough to make the decision. Transit needs to be part of but not the only solution in an ICM strategy matrix.

DART from its inception in 1983 had major HOV lanes and other highway projects in its funding portfolio and as a result it made sense for the agency to lead the ICM effort at the time. This changed in the 2010 recession when strategic decisions were made in where resources were allocated to be more focused on transit specifically.

In the context of work PennDOT is doing in collaboration with SEPTA on parking space availability in garages and travel time information to City Center Philadelphia, the agency is looking for software to identify throughput between transit and roadway in real-time to know if an ICM strategy is making a difference. Todd Plesko shared that technology for parking availability information is now more focused cloud-based to let people know in advance of availability. In the US 75 ICM transit was big part of the project, but there were few incidents that called on transit component, so it was hard to measure how much benefit from the transit diversion. Those throughput choices are an outcome so strategy modelling used to support a DSS choice sets.

Elements of Readiness –Optimization of Existing Transportation System and Significant Congestion and Unreliable Travel Times

Significant Congestion and Unreliable Travel Times – The most critical—and obvious—attributes of a successful ICM site are noticeably high congestion and unreliable travel times. The impact of ICM is more noticeable in areas with significant congestion and delay, as improved traffic flow in these areas can be more attributable to ICM strategy implementation than in areas that experience inconsistent congestion.

Optimization of Existing Transportation Systems – Successful ICM sites are able to determine whether the currently existing transportation systems are being fully optimized to ensure that there are no additional underlying problems with traffic networks. For example, a site must verify that roads cannot be widened any more due to surrounding infrastructure or physical location, or validate that all additional alternative routes are being utilized in a manner that cannot otherwise be improved upon without ICM.

Summary

Nick Compin of the California Department of Transportation (Caltrans) shared information about the ICM sites in San Diego, Los Angeles, the San Francisco Bay area, and Orange County, California that all bring ITS and TSMO together in different variations on the theme.

San Diego I-15

https://www.sandiego.gov/.../cpc/agendas/2013/icm.pdf

The project is one of the two original deployment sites and covers a 20-mile section of I-15 incorporating the following elements involving regional transit agencies, cities, the MPO, state DOT and federal partners:

- Intermodal Transportation Management System (IMTMS)
- Regional Arterial Management System (RAMS)
- Advanced Freeway Traffic Management System (ATMS)
- Regional Transit Management System (RTMS)
- 511 advanced traveler information system
- FasTrak®

San Francisco Bay area I-80

https://www.alamedactc.org/programs-projects/highway-improvement/80smart/

This 20 mile project runs along I-80 from the San Francisco-Oakland Bay Bridge Toll Plaza in Alameda County to the Carquinez Bridge in Contra Costa County and incorporates the following ICM strategies

- Automatic Incident Detection
- Management (AID)
- Enhanced Traveler Information
- Information Display Boards
- Adaptive Ramp Metering
- Active Traffic Management
- Lane Use Signs (WB Only)
- Variable Advisory Speeds
- Trailblazer Signs
- System Monitoring
- Transit Signal Priority
- Signal Coordination
- Interagency Coordination
- Incident Management
- Traffic Data Sharing

Los Angeles I-210 Connected Corridors Pilot Project

Website: https://dot.ca.gov/caltrans-near-me/district-7/district-7-projects/d7-i210-corridor-pilot-project

This is 12.5 miles of the I-210 corridor in Los Angeles County on various regional arterial routes parallel to I-210 between SR-134 and I-605. Caltrans is working on project deployment with LA Metro and California Partners for Advanced Transportation Technology (PATH) at UC Berkeley County of Los Angeles, the Cities of Pasadena, Arcadia, Monrovia, Duarte, the San Gabriel Valley Council of Governments, the Southern California Association of Government, s and Foothill Transit. The goals of the project include:

- Improve real-time monitoring of travel conditions within the corridor.
- Enable operators to better characterize travel patterns within the corridor and across systems.
- Provide predictive traffic and system performance capabilities.
- Evaluate alternatives and recommend strategies in response to planned/unscheduled events, and incidents.
- Improve decision-making by transportation system managers.
- Improve collaboration among agencies operating transportation systems within the corridor.
- Improve the utilization of existing infrastructures and systems.
- More efficiently use spare capacity to address non-recurring congestion.
- Reduce delays and travel times along freeways and arterials.
- Improve travel time reliability.
- Help reduce the number of collisions occurring along the corridor.
- Reduce congestion resulting from an incidents or events.

Orange County Connected Corridors

The intent of the Orange County Connected Corridors ICM will be to create a high performing, cooperatively managed transportation system that improves safety, promotes a multi-modal system, improves traveler conditions, provides robust traveler information, and reduces greenhouse gas emissions reducing congestion related to events, incidents, nd daily traffic. The ICM project has goals spanning safety, operations, and environmental sustainability. Specific actions span the entire county (Caltrans District 12) to deploy or upgrade field devices to improve roadway surveillance and traveler information, and upgrade TMC Systems. The project will deploy a district-wide ICM system with a TSMO data hub, DSS and information exchange network, as well as integrated connected vehicle technology across the district.

The project will also involve data standardization and link data systems across DOT agencies and regional partners to provide real-time situational awareness and to support analytics for future state prediction/estimation.

TMC operators currently are required to make many assumptions on the potential impacts of operations responses/strategies. Included in the work is "Offline" modeling for corridor operations to test full network scenarios across thousands of model simulations in order to determine the "best" strategy for a given combination of conditions an agency might have occur. A change in any parameter will change the results and potential benefits of response plans. "Online" modeling with real-time data results and prediction-based scoring creates reliable scores for strategies based on real-time operations not assumptions that offers confidence that a recommended response/ strategy is the "best" plan. Prediction is not simply the comparison of one response plan against doing nothing, but the result of running multiple potential responses/strategies and providing real-time results. Responses/strategies that are not required to be "all or nothing". This would result in fewer concerns that a response/strategy is appropriate for *current conditions* rather than a *typical day*. Continuously updated predictions allow new responses/strategies to be regularly developed and when a predicted impact of a new response/strategy reaches a target improvement level, the recommended response/strategy can be implemented.

ICM readiness recognizes existing infrastructure and systems for each modal network and identifies whether these can be effectively integrated into ICM. The process of moving toward ICM verifies that relevant agencies are in support of corridor operations. The process of planning for ICM helps to determine whether existing transportation systems are being fully optimized and identifies whether the corridor supports alternative routes and modes for travelers.

Discussion

Another aspect of the Los Angeles and Orange County projects is to use the ICM as an element of overall TSMO practice to reroute arterial traffic before it gets to the freeways.

Roundtable Discussion from Sites' Reps

Representatives from the agencies presenting on the readiness elements and other agencies considering ICM talked about the big picture perspective on their individual agency's path in the context of the ICM readiness elements, what was already in place, and how far they have gone so far. These statements are high level observations and are not to be construed as agency direction. This discussion was intended to be an open sharing opportunity to exchange ideas. The conversation concluded with an issue raised in discussion earlier on contracting for technology.

Wisconsin

State DOT has more of a traffic signal focus and is working with Milwaukee County on transit signal priority which would include detection and data elements. There are bus rapid transit projects in Milwaukee and Madison and mature data tools statewide with a lot of integrated 511. State DOT and County both have good working relationship with MPO. These are supportive as a starting point for ICM concepts, but the agencies have staff availability and resource constraints with other more focused areas of interest.

Oregon

Oregon's first experience with ICM will focus on a complex freeway interchange with alternatives looking toward implementation. Oregon DOT is negotiating a contract with a consultant toward an award. There is good data sharing and interagency coordination in the Portland metro area. There are some questions regarding arterial routes and data gaps. There are gaps in transit coverage due to topography. *A significant difference is in the definition of multi-modal which is interpreted for ICM as including pedestrians and bicycles in Portland.*

Pennsylvania

Recognizing the need for ICM, the question is where to implement. Currently looking at I-76 in the Philadelphia metro area. Pennsylvania DOT (PennDOT) recently took over ownership and maintenance of parallel traffic signals through transfer agreements and is also looking at variable speed limits in the corridor. The agency is also opening a new TMC in 2023. There is a lot of positive agency engagement through the MPO (Delaware Valley Regional Planning Commission, DVRPC), but everyone has their own interest.

Austin, Texas

I-35 working with TxDOT would be managing the mainline and frontage roads along with traffic incident management plans. The next step for maturity would be start data integration planning and deployment like AZTech's program.

Minneapolis

There is an existing transit signal priority program. However, data sharing is lacking between state, city/county, and transit agencies, but those agreements are being pursued. The primary events are driven by football games, but have really haven't had the transit service conversation yet directly. The region has had extensive experience with traveler information and detour management due to the reconstruction following the I-35 bridge collapse.

Michigan

The state DOT has some parts of the corridor response element on interstates and U.S. routes, but not active ICM type management. In the Detroit metro area they do use active traffic diversion.

General Issue – Contracting for Technology

The Virginia Information Technologies Agency historically has treated transportation technology as exempt, but as cybersecurity concerns have become more prevalent, they are now involved in VDOT technology contracting. Information technology (IT) staff are not used to working through procurement of ITS technologies and are learning as they go with understanding transportation technology language. On the other side of the conversation is defining ITS requirements at the state agency and FHWA district office with staff who are more used to concrete and steel. One approach they have taken is to use information from other states and be judicious on which projects use federal monies and which ones use only state monies to advance a project quickly.

In Arizona they are running into similar challenges with project grants where the IT staff do not understand transportation engineering design, and younger IT staff do not understand infrastructure construction. Fortunately, the agencies in AZTech can identify which one would be the best host agency for a contract and can use quality-based selection rather than pure low bid typically required to used federal monies for construction.

NCTCOG has also had similar issues and has tried a number of different strategies. ICM can be placed in the regional transportation improvement program as a Congestion Mitigation and Air Quality (CMAQ) funded project. Alternatively, one can use professional services contracts to deliver hardware and software, or in NCTCOG's case, developed the DSS internally with staff and on-call consultants. Others have used a design-build process to move these TSMO/ITS projects forward.

With respect to contracting for technology NCTCOG handles software procurement because the agency can do qualifications-based selection. In addition, field hardware is purchased by the local agencies and they moved into the ICM program through interagency agreements. This avoids some of the restrictions in the state procurement process.

Observations from California noted that the policies, procedures, and manual for IT forward projects in transportation needs to be entirely revisited across procurement, project development and standards/specifications. IT projects are typically delivered with a "moving agile approach" which is not well understood and is challenging for state DOT procurement because it is an iterative process and "not a bridge." Another part of the challenge with ICM project delivery is who can purchase hardware for local partners (who may be capital program poor, relatively). In California, purchases are made at the state level and then allocated to districts, rather than directly by a district to a local agency, which can mean at allocation shortage to a district with an ICM project need.

Decision Support Systems and Processes Enabled by Technology

What is a "DSS" (Decision Support System)?

- A computer-based ***information system*** that supports business or organizational ***decision-making*** activities, typically resulting in ranking, sorting, or choosing from among alternatives.
- A **communication-driven DSS** supports more than one person working on a shared task. (e.g., meetings, webs, client servers, **instant messaging**)
- A **data-driven DSS** emphasizes access to and manipulation of a data library. (Medical diagnosis; executive **dashboards**, i.e., visual presentations of performance metrics and efficiencies)
- A **document-driven DSS** manages, retrieves, and manipulates unstructured information in a variety of electronic formats. (i.e., a **research library**)
- A **knowledge-driven DSS** provides problem solving expertise stored as decision trees, facts, rules, or procedures. (e.g., **electrical grid allocation**, resource allocation, **finance**, trucking, and product delivery efficiencies)
- A **model-driven DSS** emphasizes access to and manipulation of a statistical, financial, optimization, or *simulation* model. Model-driven DSS uses data and parameters provided by users to assist decision makers in modeling a situation. (e.g., "what if" scenarios", **military planning**, scheduling)

Candice Gibson of VDOT and Dan Lukasik of Parsons shared their perspectives on process and tactics enabled by DSS and other technology associated with ICM to streamline the strategy selection and other processes associated with multi-modal corridor multi-modal management.

VDOT Regional Multi-Modal Mobility Program

ICM in northern Virginia evolved from early concept and implementation plans the incorporated foundational initiatives of real-time condition monitoring, data store warehouse, enhanced decision support, next-generation traveler information, and advanced incentivization. Key ICM precepts were to

manage at a corridor level, operate multi-modally, and balance the network load. This approach was more viewed as infrastructure-light (or free)… there was a conceptual shift over time from corridors to the region in the agency.

What is now branded as the Regional Multi-Modal Mobility Program (RM3P) is the VDOT, NVTA, and Virginia Department of Rail and Public Transportation (VDRPT) ICM program in northern Virginia building on prior studies and the NVTA's long-range regional plan, *TransAction*. A Federal ATCMTD grant allows expansion of geographic scope into the Fredericksburg area. The program's core elements are:

Data-Exchange Platform (DEP) –cloud-based, continuously updated data storage and exchange system to be used by regional partners and third-party providers to collect, process, and share information on real-time and historic multi-modal travel conditions.

AI-Based Decision Support System (AI-DSS) – software to predict the impact of travel disruptions to the transportation network and provide coordinated response strategies to participating agencies. This is a tool for staff in the TMC that will use data on congestion, incidents, and events evaluate emerging conditions and recommend strategies for coordinated, multi-agency response.

Dynamic Incentivization (DI) – a data-driven system to offer the public incentives to modify their travel choices and behaviors in response to real-time travel conditions.

Commuter Parking Information System (CPIS) – a real-time, app-based information system that provides reliable information about parking space availability at lots serving transit, vanpool, and carpool commuters.

Currently the Data-Exchange Platform is under development with significant data already stored and outputs readied for data users (https://rm3p.ritis.org/). With Virginia information Technologies Agency's executive approval, the remaining three RM3P program elements are moving forward with service vendor procurement and award. Looking forward the next two elements will be 1) a Next Gen Traveler Information system to supply on-demand, real-time and predictive, multi-modal trip guidance personalized to the needs of travelers and assist in choosing travel mode options, and 2) preparation for Mobility as a Service (MaaS) with agency service providers with the current intent of creating a Multimodal Mobility Analytical Platform (MMAP).

DSS for Integrated Corridor Management

DSS incorporates input, processing, and outputs as a network of systems to support informed transportation strategy decisions.

- DSS – Basic Definition: A decision support system (DSS) is a computer program application that analyzes business data and presents it so that users can make business decisions more easily
- Transportation Decision Support System (DSS) – A transportation Decision Support System (DSS) is an information system that supports operational decision-making activities in real-time or non-real-time. A DSS is an interactive, software-based system that extracts useful information from a combination of modal data sources and knowledge bases (operational rules) and converts these into actions and/or recommendations that influence performance of the transportation network. Its purpose is to detect network anomalies and to produce

recommended and/or automated decisions, based on accepted operational rules, targeted to system managers.

There are a range of types of DSS used in practice:

- Tables-Based – Series of tables loaded into a relational database with lookups based upon event/incident locations.
- Knowledge Driven DSS
- Expert System – Based on pre-defined set of rules using reasoning technologies including rules, workflows and procedures. Input details provided by operators and the DSS provides recommendations as outputs.
- Custom Rules-Based – Similar to expert system or scenario driven, but uses "custom" rules for seeking resolution rather than implementing a specific rules methodology or engine.
- Scenario Driven – recommendations based on scenarios defined by a combination of location, characterization, and event type.
- Data Driven – a type of DSS that focuses on the provision of internal (and sometimes external) data to aid decision making. Most often this will come in the form of a data warehouse.
- Model Driven --Leverages microscopic, mesoscopic and macroscopic traffic simulation tools have been developed for the purposes of analyzing roadway networks.
- Hybrid – a combination of various characteristics described in the other DSS types.

San Diego I-15 ICM system uses a hybrid system that incorporates element of the data driven and model driven approaches with an expert system to create solution clusters based on these functions. Solution clusters follow a repeating lifecycle as follows:

Monitor
- Jurisdiction/Mode
- Normal/Failure

Predict
- Recurring/Non-Recurring
- Freeway/Arterial/Transit

Propose
- Response
- Posture

Evaluate
- Performance
- Person Based Delay

Control
- Automatic
- Requested

…repeat

The DSS scores the internal evaluation and recommends DMS and traffic signal responses among other strategies.

A question was asked of the two speakers whether third party data sources would eliminate the need for microsimulation and resulting predictions. Dan Lukasik indicated that they haven't been able to identify one with the breadth in real-time, but as a background data source, yes. Candice Gibson stated that agency is encouraging vendors to bring in third party data into their Data Exchange Platform

Are we prepared? How will we know?

Neil Spiller of FHWA shared additional information on ICM that has been learned by agencies through the various deployments since the program began. Douglas Noble concluded this session with brief overview of the FHWA *Traffic Management Capability Maturity Framework*.

Top 10 Challenges when deploying ICM over time[2]

1. Getting an early ICM win.
2. Key Stakeholders will not participate.
3. Zero-sum mentality among stakeholders.
4. No ICM owner results in no ICM momentum.
5. ICM benefits are not clear on a day-to-day basis.
6. ICM value-proposition might be difficult to demonstrate.
7. Champion attrition.
8. Traditional revenue models are in decline.
9. Public Indifference.
10. Perception of ICM as a paid-for commodity.

Survey responses from an ICM user questionnaire in the *Build Steady: Winning Strategies for Building Integrated Corridor Management Over Time* report cover cross section of topics including:

- Definition of "corridor" for ICM
- List of ICM program names
- Definition of success by agencies
- How are multiple modes coordinated and managed in a corridor
- List of lead organizing agency types
- List agency types involved in ICM
- Funding method

It is noted in the responses that ICM is not (merely) incident response (i.e., detouring), ramp metering, HOV lanes, information on dynamic message signs, traveler alerts. Lastly the report notes the from the responses the following lessons learned:

- …requires an on-going team-oriented process.
- Support at all levels of all the agencies is needed.
- Must also have support of design and structural engineers since they often control the scope of project-builds.
- Development of or employment of data sharing and data resources is crucial.
- Pick the right corridor(s) that can be helped; not just a demo project "anywhere."
- The corridor has to demonstrate need (i.e., congestion) in the first place, and also has to have opportunity to disseminate that congestion.

Breakout Groups to Explore Own Agency's Readiness (or Alternatives)

[2] Karl Wunderlich and Meenakshy Vasudevan, Build Smart, *Build Steady: Winning Strategies for Building Integrated Corridor Management Over Time*, Report No. FHWA-HOP-19-039 (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, 2019). Accessed March 30, 2023.

The peer exchange participants broke into three groups to discuss where their agencies stand in the context of the ICM readiness attributes, their long-term planning objectives, goals, and barriers. Resources to advance readiness were also discussed. The questions used to prompt conversation were:

Where does your agency/metro area currently stand? What are the agency / metro areas goals / objectives that ICM would advance? What agreements do you have in place/need to create sustainable ICM?

Group A

Georgia DOT – The agency is expanding towing and recovery incentive program (TRIP) on freeways for commercial vehicles. I-285 / GA400 project in downtown Atlanta has the roadway reduced to three lanes while replacing concrete with detour routing. Connecting traffic signals staff for arterials and the TMC will be important. Planning for hurricanes, flooding, and occasional snow is a regular part of the agency's operations program for emergency operation from the TMC. The agency is facing legislative issues on funding.

The agency has signal coordination and joint use agreements along with a data purchasing program in place coordination with the Atlanta Regional Commission

Minneapolis – Generally, the metro area has a level of traffic, snow, cold weather (i.e., resulting crashes and closed roads) and special events that could support an ICM program. Moving to cloud-based traffic signal priority with active data sharing link(s) between City of Minneapolis/Minnesota DOT ATMS. Working on data sharing aspects, but engaging cities and counties is more challenging to set up agreements.

PennDOT – In the Philadelphia area the Delaware Valley Regional Planning Commission (DVRPC) has had a long range TSMO plan since the early 2000s. Each region in the state has a regional TSMO plan at the MPO level now. This part of the regional congestion/air quality model at the MPOs. Projects coming on-line in the near future to support traffic management with devices through capital projects and partnerships with localities. The agency uses their TMC as an incident command center for special events and snow operations. Unfortunately, there is no direct feed to the transit agencies in Philadelphia or Pittsburgh. The agency's big need is to quilt things together with the regional vision and establish a culture of operations as well as coordinate better with local agencies. In the short-term PennDOT is looking to implement cameras for incident management, formalize agreement(s) with local agencies, see delays in real-time, moving into new TMC spring 2023. The next step plans would be to begin development of an AI-DSS and be able to provide the public with train versus car travel times to convince traveler to model shift to public transit.

San Diego – The I-15 project is in operation with positive results and improved throughput. San Diego has toll lane facility which can open for more capacity to reroute. There is interest in expansion to other corridors such as the I-5 project which will have ICM elements, but parallel routes are not well defined. Some concern whether cities are a ready as they say they are… as they may have different definitions of readiness.. some had no elements, some had 70 percent. Funding levels between cites are different.

It was *important to the success of the I-15 project that regional planning organization took the lead* in San Diego; much more difficult for local leaders to give state DOT money.

Contra Costa County – Working on project for I-680 corridor that will begin east of the Bay Bridge using a joint system operations and maintenance network manager approach with sustainable funding source.

The project will be a more traditional freeway active traffic management system initially. Open questions are whether there will be an enhanced operations center, joint county operations or ownership.

General Discussion – There was a general conversation around whether "Integrated Corridor Management" is the right name or is there some other description. Some view this more as a lack of understanding, or should we be treating ICM as an overall umbrella for TSMO.

There is a necessary place for MPO involvement to address local jurisdictions coming into a project with non-technical aspects that are not ICM-related.

Group B

Group B used the questions as initial prompts for what became a wide-ranging discussion. Agencies noted that TSMO technology resources have been built up over many years, some on general roadway projects and others in ITS projects.

Some agencies still rely on handshake agreements between known partners. Others establish corridor-specific or device type agreements (e.g., video sharing, fiber optic communications, etc.), but not larger multi-agency regional agreements.

Georgia DOT noted that their corridor management is more locally-focused and arterial roadway corridor specific. Combined freeway and arterial management is somewhat more ad hoc though the agency is investigating a decision tree structure response alternatives. PennDOT on the other hand uses 24/7 TMC operator coverage to have eyes on the road and to determine response.

The larger focus on the discussion was on resources for the future, focusing on personnel and skill sets. Advancements ITS and ICM rely substantially on IT elements such as fiber optics, systems, communications. Most traditionally educated transportation engineers come from a civil engineering background, and there now a need to bridge the gap in the future as these new applications and issues (e.g., network sharing, cyber security, data management, etc.) require IT specific knowledge.

Group C

Where does your agency/metro area currently stand?

Wisconsin DOT – The agency is involved with transit coordination with Milwaukee County. The agency has ramp meters, but would like to learn more about adaptive operation. Ramp meters have been operating as site responsive and are discussing how corridor adaptive could be tried.

Maricopa County DOT – In the ICM pilot the agency is collaborating with other agencies to prepare signal timing plans for when events happen and coordinating with ADOT on notification. The agency has established foundations in data sharing and collaboration with agencies at regional and state level. Noted that everyone needs to be working together and understand everyone's roles. They are reengaging agencies since people are leaving agencies or taking different roles. As result documentation is important.

Oregon DOT – The agency has good interagency coordination in the Portland metro area. In the ICM multimodal definition bicycles and pedestrians are included. Current gaps are traffic count data and

availability of networks… finding real-time data is very challenging. The agency has been doing adaptive ramp meeting region-wide.

Arizona DOT – The agency has been adding HOV lanes, spot widening , and adaptive ramp meters to their system. Traffic volumes since COVID pandemic are not triggering the adaptive ramp meters, so the agency is in the process of calibrating and fine-tuning them. The agency is interested in information on data quality and how to address issues with data collection.

What are the agency / metro areas goals / objectives that ICM would advance?

- Maximize existing transportation network through multi-agency cooperation and utilizing existing infrastructure and data sources.
- Agency is good at gathering data, but once in-house need tools to understand to create productive plans.
- An agency expressed the need to break down silos to operate as a system rather than individual agency operations.
- Data-related needs: How do you reach people that need the data? How do you fill the gaps in the data? How do you display multiple datasets?

Various agencies comments expressed a need to reach multimodal users, a goal of reducing congestion for the metro area and creating modal shift, an interest in expanding ICM concepts to other regions, and a need to understand different ICM strategies and how they can merge together.

NCTCOG – Get the most of the existing transportation system using operation improvement and demand reduction strategies

Virginia DOT – Short term goal is implementation of ICM in Northern Virginia region and implement traffic signal improvement on selected arterial routes to support ICM activities. In the mid- and long term their goal is to refine detour route plans when such infrastructure is in place and use the lessons learned from the Northern Virginia RM3P system to expand it to where it is applicable.

Multiple agencies expressed an interest in expanding university partnerships.

What agreements do you have in place/need to create sustainable ICM?

Virginia DOT – Developed an ICM agreement with a NVTA and the Virginia Department of Rail & Public Transportation for the ATCMTD grant. The agreement supports the ICM design and deployment activities.

Oregon DOT – Currently have formalized agreements for fiber sharing across agencies but not for ICM specifically.

NCTCOG – Data, video, and fiber sharing agreements with TxDOT and local entities.

NEXT STEPS

NOCoE will meet the FHWA and ITS-JPO staff to review the Integrated Corridor Management peer exchange findings and work on next steps. Based on participants' feedback, it is anticipated that priority topics that need to be further explored are:

- What is the role of connected vehicles and electrification in ICM? Can connected vehicles be used as sources of probe data?
- Agencies should identify the building blocks of ICM they may already have in, or planned for their program. This can be used to support an ICM project that may build integration.
- The is an importance to formalize agreements on roles and responsibilities (a handshake is not enough in the current environment).
- Recognize that technology capabilities have emerged and evolved substantially from the original ICM deployment projects. The approach and applications to achieve ICM success are different today.
- Institutional barriers still remain from technology integration and cybersecurity to business rules and organizational TSMO culture.
- Perception that for a project to be ICM that all the elements must be present. Agencies should focus on the projects that can be implemented and plan for the future (walk first, before running).
- The was on interested in expressed on finding consensus on what is working, and agencies getting their own work together with interoperable standards with regional partners.
- With the current emphasis on Safe System Approach, safety should be more integrated and benefits better explained in ICM programs.
- Need to have a focus on what is important to the public and using their input in an ICM project. How can ICM affirmatively impact the lives of the people being served?
- First mile and last mile integration into the ICM conversation.
- Where does diversity, equity, and inclusion fit into ICM?
- There as so many terms in the transportation space, does ICM have a messaging problem? Is it the same thing as "Smart Mobility?"
- There was a point made regarding what outcomes (versus outputs) has ICM achieved over the life of the US DOT program support versus what future outcomes should be planned for ICM implementation.
- There was interest expressed for a distilled summary document by topic, performance measure, and methodology that would show what do we get for ICM investment for an audience of senior managers and decision-makers.
- Need for information on IT workforce that is transportation terminology conversant to support ICM and ITS project more broadly.
- Support resources for MPOs to act as convener for ICM-related project development in metropolitan regions

It is anticipated that these points could be further expanded through the NOCoE's webinar program along with the potential ICM implementation support to connect agencies with each other. This could take the form of a standing quarterly facilitated Zoom meeting between peers to discuss project(s) status or particular challenges agencies are facing.

RESOURCES

ITS Joint Program Office

- Integrated Corridor Management (ICM) - 10 Attributes of a Successful ICM Site (web page)
- Integrated Corridor Management (ICM) - 10 Attributes of a Successful ICM Site (PDF)
- Integrated Corridor Management (ICM) Knowledge and Technology Transfer (KTT)
- ICM Demonstration Site Fact Sheet
- Intermodal Research - Integrated Corridor Management (landing page)
- ICM Knowledgebase
- Integrated Corridor Management Analysis, Modeling, and Simulation for the U.S.-75 Corridor in Dallas, Texas Post-Deployment Analysis Plan
- Integrated Corridor Management Analysis, Modeling, and Simulation for the Interstate 15 Corridor in San Diego, California Post-Deployment Analysis Plan
- Integrated Corridor Management Analysis, Modeling, and Simulation for the U.S.-75 Corridor in Dallas, Texas Post-Deployment Assessment Report

Federal Highway Administration

- Office of Operations program for ICM (Corridor Traffic Management) Program Website
- Integrated Corridor Management: Making the Case to Executive Leadership (Video)
- Mainstreaming Integrated Corridor Management: An Executive Level Primer
    - Chapter 6 ICM Resources for Next Steps, Table 7 Key ICM Resources and Topics
- What is Integrated Corridor Management (Flyer)
- Integrated Corridor Management (ICM) Ten Attributes Of A Successful ICM Site (Flyer)
- Integrated Corridor Management (ICM) Program: Major Achievements, Key Findings, and Outlook (Document)
- Integrated Corridor Management (ICM) – Mainstreaming ICM: An Executive Level Primer (Document)
- Elements of Business Rules and Decision Support Systems within Integrated Corridor Management: Understanding the Intersection of These Three Components (Document)
- Integrated Corridor Management and the Smart Cities Revolution: Leveraging Synergies (Document)
- Integrated Corridor Management and Traffic Incident Management: A Primer (Document)
- Integrated Corridor Management, Managed Lanes, and Congestion Pricing: A Primer (Document)
- Integrated Corridor Management, Transit, and Mobility on Demand (Document)
- Integrated Corridor Management and Freight Opportunities (Document)
- Leveraging the Promise of Connected and Autonomous Vehicles to Improve Integrated Corridor Management and Operations: A Primer (Document)
- Build Smart, Build Steady: Winning Strategies for Building Integrated Corridor Management Over Time (Document), Chapter 2 includes ICM Capability Maturity Model (CMM)
- Programming for Operations: MPO Examples of Programming and Funding (Document)
- Integrated Corridor Management: Implementation Guide and Lessons Learned

- Traffic Analysis Tools Volume XIII: Integrated Corridor Management Analysis, Modeling, and Simulation Guide (Updated 2017)

Transportation Research Board

- NCHRP Web-Only Document 287: Planning and Implementing Multimodal, Integrated Corridor Management: Guidebook
- NCHRP Research Report 899: Broadening Integrated Corridor Management Stakeholders
- NCHRP Project 20-68A, Scan 12-02: Advances In Strategies For Implementing Integrated Corridor Management (ICM)
- NCHRP 08-124: Quantifying the Impacts of Corridor Management (project underway)

Specific Agencies

- Maricopa Association of Gov'ts I-10
- Loop 101 Mobility Project 2017 ATCMTD Grant Application
- Broward County, FL I-95
- Caltrans Los Angeles Metro Area I-210
- Caltrans Connected Corridors Program (website landing page)
- Penn DOT I-76
- NC DOT I-95 / U.S. 70
- Florida DOT I-4
- Iowa DOT, Des Moines
- Tennessee DOT I-24 Nashville
- I-70 North Slope Project
- I-394 Minneapolis
- VDOT Northern Virginia Connected Corridor Test Bed originally started as an ICM-like approach and has morphed into a CV Deployed Fleet / V2X infrastructure / Apps and Interfaces. There are a number of VDOT presentations calling I-395/I-95 an ICM corridor over the past 6-10 years
- Northern Virginia Regional Multi-Modal Management Program (RM3P) grant award(s)
- VDOT Prepared to Use Artificial Intelligence to Predict Traffic