CHICAGO METROPOLITAN AGENCY FOR PLANNING | **ON TO 2050** STRATEGY PAPER

Highway Operations

CMAP

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Introduction

As part of the ON TO 2050 comprehensive regional plan development process, this paper explores ways to improve highway operations to enhance our region's mobility and accessibility. Besides federal requirements to include operations in long-range planning,[1] highway management and operations are important to regional planning for a number of reasons. Highway management strategies optimize the efficiency, safety, and reliability of the highway system through coordinated operations. Congestion due to incidents – rather than recurring congestion caused by predictable commute traffic – remains one of the largest causes of delay. Management initiatives may also facilitate better use of limited capacity, reducing the need for system expansion.

Increasingly, highway management involves data, communications, and technologies that help system managers optimize traffic flow and respond to situations as they arise. This increasing reliance on data and communications is expected to facilitate a more modern, performance-driven operations environment for the highway system, which will enhance overall regional mobility. The availability of automatically-collected digital data also provides system operators with the ability to share valuable information with private providers of real time traffic information, and presents an incentive for private providers to reciprocate with information they collect.

Highway management and operations include traffic incident detection and response, providing information for travelers, roadway weather detection and response, managed lanes, traffic signal coordination, work zone management, and transportation demand management. Many operations strategies are in place now, including visible efforts like open road tolling, radio traffic reports, Illinois Department of Transportation (IDOT) Minutemen and Illinois Tollway Highway Emergency Lane Patrol (HELP) trucks, and reversible lanes on the Kennedy Expressway, as well as "back-end" efforts like optimizing traffic signal timing or better managing construction zones. However, given new data, technologies, and communications, there is an opportunity to expand and intensify the use of these strategies.

Ultimately, the application of improved highway management and operations techniques to address the non-recurring sources of congestion will result in a system that operates more efficiently, reliably, and safely, while also costing less cost than capacity expansion. Underlying all operational decisions is the necessity to balance the mobility and accessibility needs of all highway users including pedestrians, bicyclists, transit vehicles, drivers passing through the community, and drivers using the facility to access local destinations. These choices impact how highways integrate with the communities they serve. A well-managed highway system works better for all users and reduces congestion, fuel use, and travel time for passenger and

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[1] Long-range plans are required to include "operational and management strategies to improve the performance of existing transportation facilities to relieve vehicular congestion and maximize the safety and mobility of people and goods." (23 USC § 134(i)(2)(F)).

freight vehicles. In fact, management and operations strategies can contribute greatly to achieving policy goals for northeastern Illinois' transportation system, helping establish a system that is safe, accessible, easy to navigate, affordable, and coordinated with nearby land uses.

The MPO Role in Planning for Operations

The role of operations and management strategies in improving highway performance has a long history in Chicago-area regional planning. In 1988, IDOT developed an eight-point plan called "Operation Green Light: a transportation plan for Northeastern Illinois[2]" in cooperation with the Regional Transportation Authority, the Illinois Tollway, the Chicago Area Transportation Study, and the Northeastern Illinois Planning Commission. Two of the eight points were focused on highway operations. The plan recommended improving freeway traffic management by expanding surveillance, dynamic message signs, highway advisory radio, ramp metering, implementing electronic toll collection, and expanding the emergency traffic patrol service and improving arterial traffic management by developing a region-wide incident detection network and an arterial congestion monitoring system. Operation Green Light promoted a five-year, $1 billion funding program to improve roadway operations.[3]

Nationwide, Metropolitan Planning Organizations (MPOs) have incorporated operations into their normal planning activities in a variety of ways, as shown in Table 1. Although CMAP has focused on hosting operations committees -- the Regional Transportation Operations Coalition (RTOC) and the Advanced Technology Task Force (ATTF) -- CMAP has awarded Unified Work Program (UWP) funding for operations-oriented planning projects, and has committed a significant amount of funding to operations projects through the Congestion Mitigation and Air Quality (CMAQ) Program. CMAQ funds supported projects such as traffic management centers, traffic signal modernization, traffic signal interconnects, intersection improvements, ramp metering, and transit signal priority systems. Additionally, Surface Transportation Funds (STP) have also been used to implement highway operations projects.

[2] Operation Greenlight a Transportation Plan for Northeastern Illinois, *Illinois Department of Transportation*, 1988, https://archive.org/details/operationgreenli00illi.

[3] Cure for Gridlock, Chicago Tribune Blair Kamin and David Ibata, February 1990. http://articles.chicagotribune.com/1990-02-23/news/9001160178_1_traffic-congestion-air-pollution/2.

Table 1: Examples of MPO Planning for Operations				
Agency Primary City (Population in Millions)	**Operations Committee**	**Regional Transportation Operations Plan**	**M&O Plan Chapter or Section**	**M&O Funding Set-Aside**
Chicago Metropolitan Agency for Planning, Chicago, IL (8.3)	Yes	No	No	No
North Central Texas Council of Governments Dallas-Ft Worth, TX (6.4)	No	Yes	Yes	Yes
Delaware Valley RPC Philadelphia, PA (5.6)	Yes	Yes	Yes	Yes
Maricopa Association of Governments Phoenix, AZ (3.8)	Yes	Yes	Yes	Yes
Puget Sound Regional Council Seattle, WA (3.7)	Yes	Yes	Yes	No
San Diego Association of Governments San Diego, CA (3.1)	No	Yes	Yes	Yes
Denver Regional Council of Governments Denver, CO (2.8)	Yes	Yes	Yes	Yes
Portland Metro Portland, OR (1.9)	No	Yes	Yes	Yes
MetroPlan Orlando Orlando, FL (1.8)	Yes	No	Yes	Yes

Note: M&O stands for Management and Operations
Source: Programming for Operations: MPO Examples of Prioritizing and Funding Transportation System Management & Operations Strategies (FHWA, 2013), agency websites.

Potential Framework for ON TO 2050

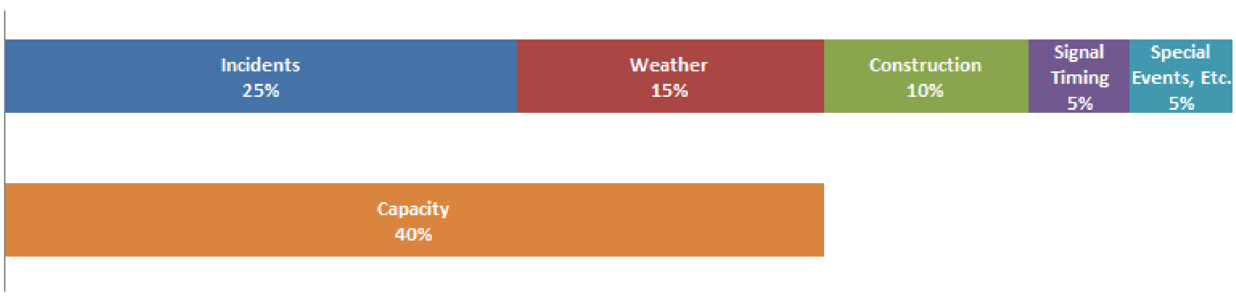
The Regional Vision for GO TO 2040 describes a future multimodal transportation system that is "safe, accessible, easy to navigate, affordable, and coordinated with nearby land use," reduces congestion and improves regional mobility, and supports "reinvestment in our existing communities…leading to environmentally sensitive and fiscally efficient outcomes." To achieve this, GO TO 2040 recommends investing in existing infrastructure to gain operational efficiencies, and prioritizing modernization projects when making investment decisions. The 2040 goals lead directly to the need for an increased commitment to improving highway operations by the region's system operators and emergency responders.

ON TO 2050 presents an opportunity to build on the recommendations of GO TO 2040 with more specific strategies to improve highway operations, which is the subject of this strategy paper. To develop such a framework, CMAP staff researched best practices and new ideas from other areas of the country as well as interviewed operations personnel from the highway agencies. Overall strategy paper development was guided by the Regional Transportation Operations Coalition and the Advanced Technology Task Force. While many of the strategies outlined below can be supported by CMAP through its planning processes, funding programs, outreach, and technical assistance, most will necessitate the leadership of transportation implementers and other entities to come to full fruition.

Consider Operations Improvements before Capacity Additions

Making operations improvements should be the first option in considering how to improve mobility in the region. Highway congestion caused by crashes, weather, or other incidents cannot be alleviated through capacity improvements. In these cases, any reductions in delay must come from the way the highways are managed and operated. In fact, 60 percent of congestion nationwide is caused by non-recurring sources -- like incidents, construction, and weather -- that are best addressed by operational changes rather than adding capacity.

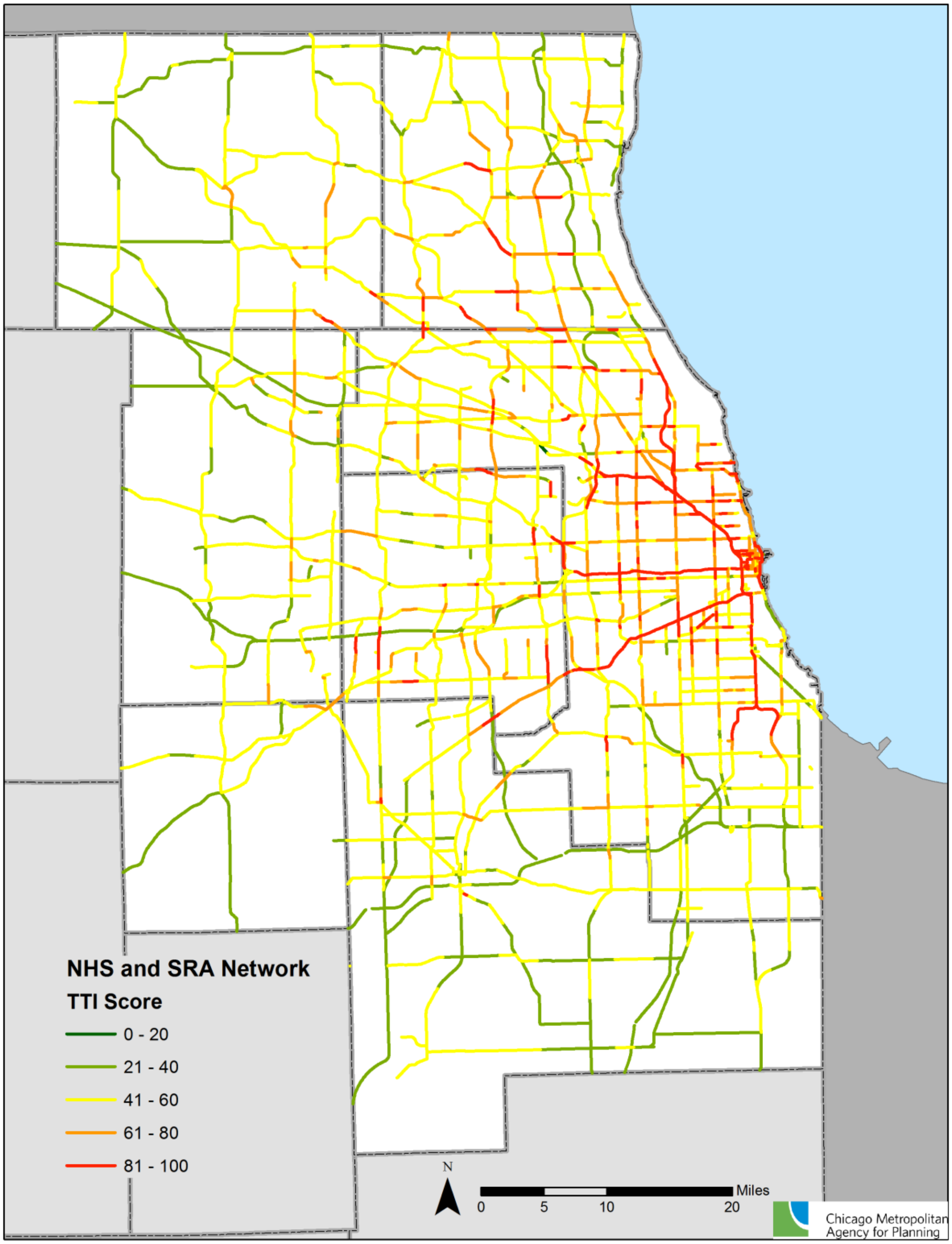
Figure 1: Sources of congestion



Source: FHWA Office of Operations
http://www.ops.fhwa.dot.gov/congestion_report/executive_summary.htm#overview

Even when insufficient capacity is the cause of congestion and delay, capacity expansion is not practical in some locations. Improving system operations offers another avenue to improve roadway travel conditions. As Figure 2 shows, the most congested locations tend to occur in the more densely developed areas of the region, where system operators may not own sufficient right of way for expansion, and obtaining additional right of way is costly and disruptive to communities.

Figure 2: Congested Locations Measured by Travel Time Index



Source: HERE 2012 Probe Data

Many management strategies can stretch tight agency budgets by extending the benefits of a new capital expenditure over a longer period of time or increasing vehicle throughput and delaying the need for capacity additions. In addition, traffic management can be part of a phased approach to highway improvements.

Numerous strategies considered in this paper have benefits many times their cost, while typical highway capacity additions have much lower benefit to cost ratios. Implementing highway management strategies can often optimize flow to reduce the impact of congestion without additional capacity. Even if congestion cannot be eliminated, the daily onset of congestion may be delayed by smoothing traffic flow and managing incidents. Moreover, in recurring oversaturated traffic conditions, effective highway management can shift from optimizing existing traffic flow to managing demand through mechanisms such as congestion pricing and various trip reduction programs. In cases where demand management is not feasible, the cost-effectiveness and feasibility of capacity additions can be reviewed.

Reducing congestion through improved operations is one part of a performance-based approach to system improvement. The approach includes monitoring performance, implementing operational improvements, managing demand and expanding capacity where appropriate.

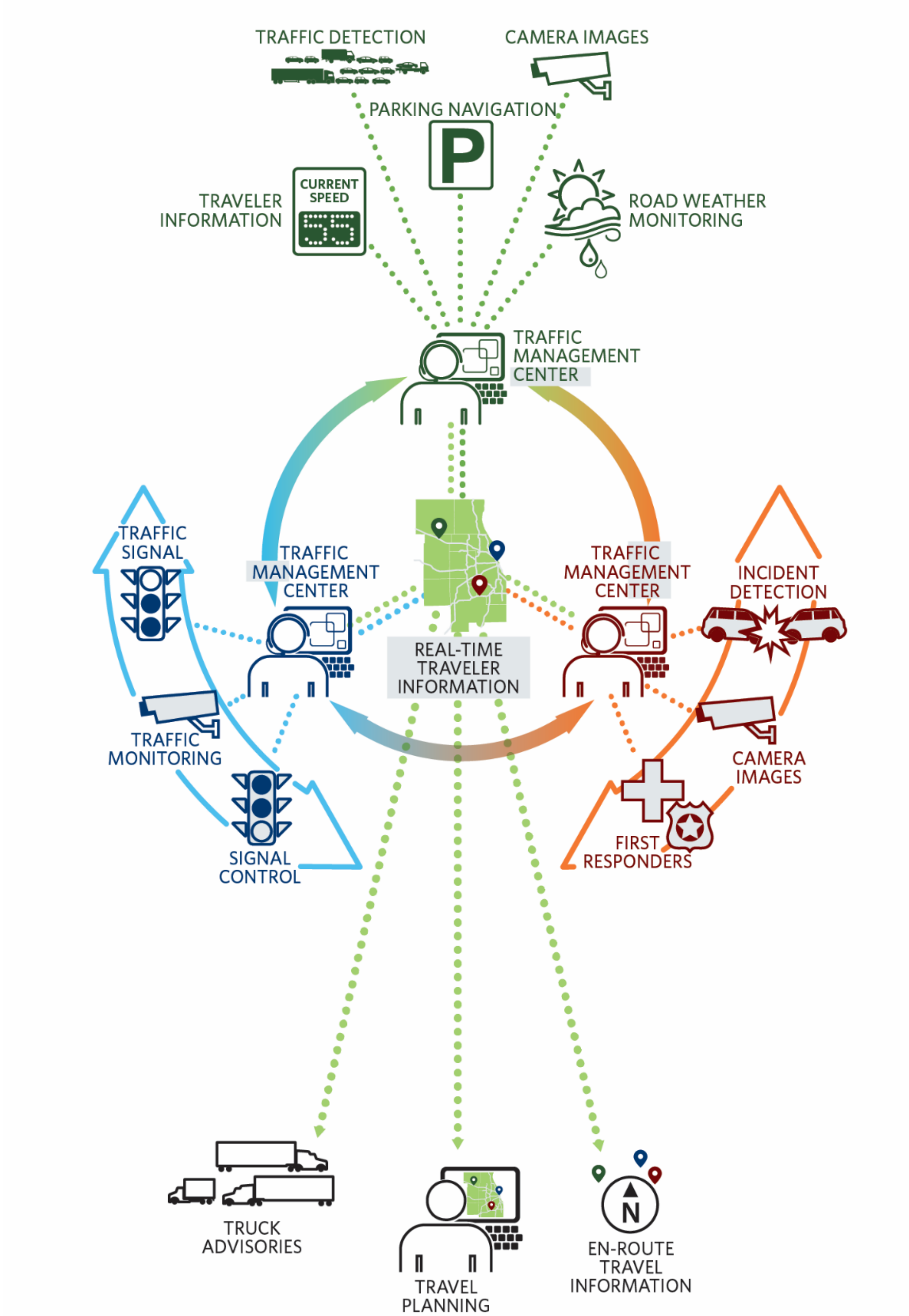
Lastly, many management and operations strategies presuppose an infrastructure investment. Understanding future operations system requirements will result in better preparatory capital investment decisions now.

Enhance Communication and Coordination to Improve Highway Operations

Increasingly, highway management involves data, communications, and technologies that help system managers optimize traffic flow and respond to situations as they arise. On a regional scale, the highway system is most effectively managed when communication extends coordination beyond an individual operating agency by establishing communication between highway agencies, emergency management services, transit operators, and real time traveler information services. The long-term goal for the region's highway operators is a connected management system operating as presented in Figure 3, where individual agencies can monitor and manage their own equipment in the field such as cameras, message signs, and traffic signals. Highway and emergency response agencies exchange information and share camera images. Highway agencies actively adjust traffic control equipment, and inform the public of road conditions. Information is passed to other highway and transit agencies who can also respond by making changes in their own systems. The continuous and automatic flow of data and communications facilitates a more modern, performance-driven operations environment for the highway system. This requires coordination between agencies and agreements on how to share data and what to do in response to shared information. In interviews, operations staff often suggested that agency policies are more difficult to overcome than technological constraints. The rest of this section describes investments and activities the region can pursue that bring us closer to the goal, and includes:

- Developing traffic management centers, which house the staff, hardware, and decision-support software and act as communications hubs for all higher-level highway operations capabilities.
- Developing a regional communications network, which provides the linkage between modern equipment in the field and the decision support in the management center, and allows communication to flow between different agencies and the public.
- Improving incident response, which includes training, communications, and policies that speed up clearance and reduce secondary crashes.
- Improving weather response by improving traveler information and targeting response to locations known to be especially susceptible to weather impacts.
- Modernizing and retiming traffic signals, and developing expanded capabilities of controlling them from a traffic management center.
- Reducing work zone duration to reduce delay and safety impacts.
- Implementing interstate and arterial active traffic management by blanketing critical corridors with a combination of equipment, communications and policies to improve operations.
- Implementing integrated corridor management so a system of roadways and transit can be operated as a unit, improving travel conditions by balancing demand among them.
- Taking advantage of private sector real-time travel information distribution and collection opportunities.

Figure 3: Regional Highway Operations System

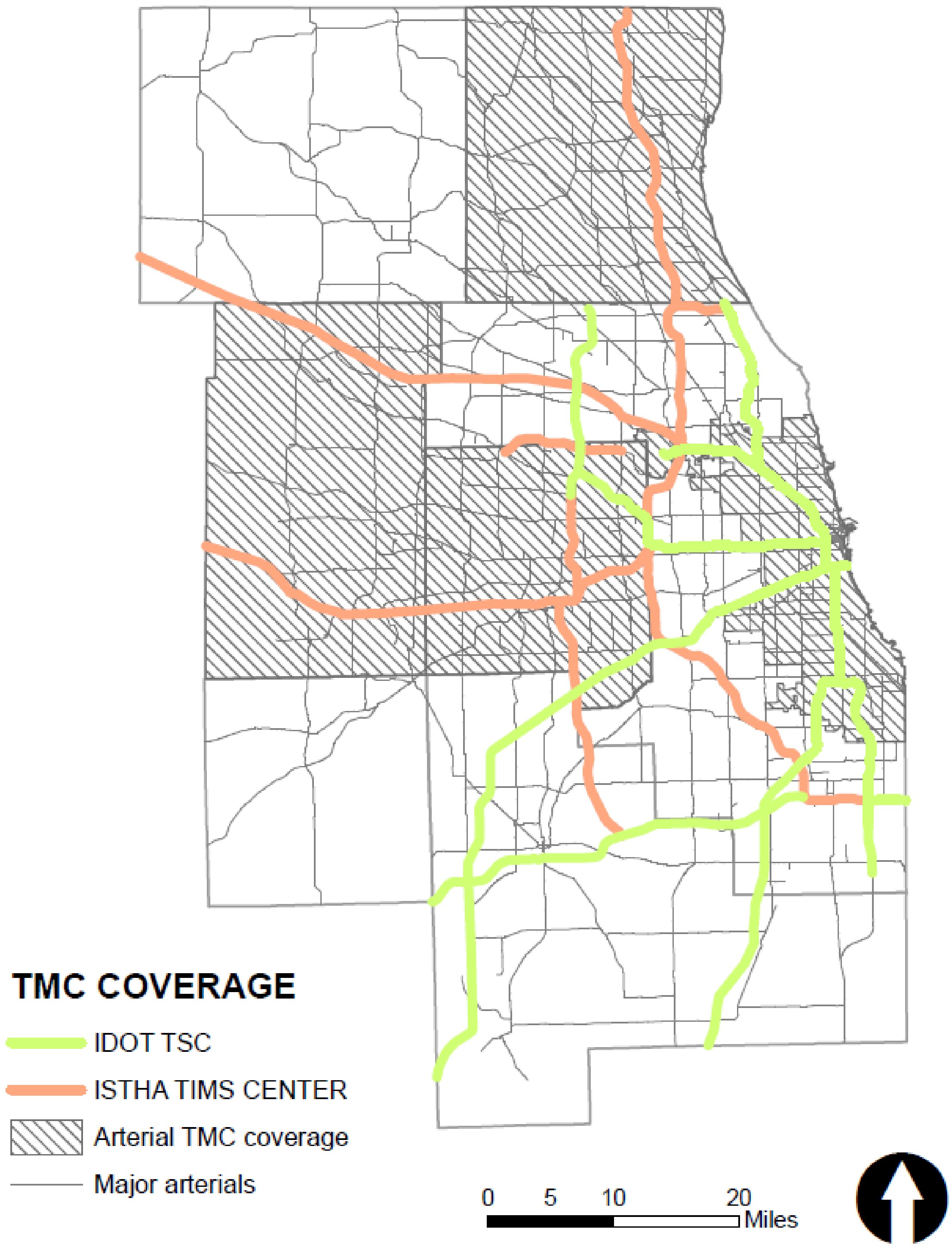


Source: Chicago Metropolitan Agency for Planning

Expand and Potentially Regionalize Traffic Management Centers

The hub for all the data-dependent activities and systems used in highway management is the traffic management center (TMC). Providing all urban areas of the region with TMC coverage is critical. TMCs host the hardware, software and staff that monitor and operate all the region's highway systems. Typical traffic management center functions include providing traffic incident detection and surveillance, providing coordination among various agencies, monitoring traffic signal equipment, and dispatching resources to fix malfunctioning equipment.

Figure 4. Existing and Programmed Traffic Management Centers



Source: Chicago Metropolitan Agency for Planning

The largest TMCs are the Tollway's Traffic and Incident Management System and IDOT's ComCenter, the latter of which acts as the 24-hour incident management and operations center for IDOT District 1 interstates (Figure 4). IDOT also has its Transportation System Center (TSC), which is responsible for monitoring the vehicle detection system on IDOT's District 1 expressway system. IDOT does not maintain an arterial traffic management center.

Cook County does not maintain a traffic management center and continues to advocate for development of an arterial traffic management center to be shared with IDOT. Especially in northwest Cook County, there are many congested IDOT and Cook County jurisdiction arterials that would benefit from coordinated management. Maintaining a joint center would facilitate that coordination. The Chicago Department of Transportation operates a "mini-TMC" out of its Traffic Control Room, which will be expanded as needed until a more permanent facility is built with the Chicago Office of Emergency Management and Communications hosting the hardware (servers and communications). It is expected that the Chicago TMC and the 911 Center will integrate operations and communications to some degree.

In DuPage's Virtual TMC, monitoring and management are assigned to a workstation in the DuPage County complex. DuPage County DOT, the City of Naperville and the City of Aurora are use-testing the same traffic management software which will likely form the software foundation of the virtual center. In Lake County, the Lake County PASSAGE Traffic Management Center (TMC) operates the County roadways and provides motorists real time traffic congestion, crash and construction information. Kane County constructed a TMC in 2015, following a 2007 feasibility study. The center is now operational. McHenry, Kendall, and Will Counties have no current plans to develop TMCs.

Lastly, some consideration should be given to how to integrate communications between traffic management centers. In the current CMAP ITS Architecture[4] this is envisioned to happen using the IDOT Gateway Traveler Information System[5] (GTIS) as a communications hub, eliminating the need for agencies to connect with multiple centers. However, in agency interviews some operations staff expressed concern about whether the GTIS will be robust enough to support this. In addition, developing and staffing multiple traffic management centers is costly, which has been the main impediment to developing them. A regional center would eliminate the need for integrating multiple TMCs, and share the staffing, hardware and software costs. This could be a virtual TMC or traditional brick and mortar location. CMAP should undertake a study of the costs and benefits of implementing a regional, multi-jurisdictional traffic management center, either virtual or traditional.

[4] [4] CMAP ITS Architecture v3.0, http://data.cmap.illinois.gov/its_arch_v30/index.htm.

[5] CMAP ITS Architecture v3.0 Gateway Traveler Information System GTIS, http://data.cmap.illinois.gov/its_arch_v30/html/inv/el56.htm.

Invest in the Communications Backbone

Real-time monitoring of the system and communication with field equipment requires a robust and redundant communication system. Active traffic management requires the ability to monitor and communicate with all field equipment, including traffic signals, cameras, dynamic message signs, other operations centers, and in the future perhaps even vehicles on the roadway. In agency interviews, staff stated that often the most difficult part of implementing intelligent transportation system projects was establishing the communication infrastructure to support them. Most of the agencies use a combination of wireless and fiber communication, but the volume of data transmission, especially camera images, requires the high capacity linkages most often provided by fiber optic cables.

In addition to supporting current traffic management activities, the existence of a system wide communication system must be in place to take advantage of future Vehicle-to-Infrastructure (V2I) capabilities. Communication between the receiving and transmitting field devices and the traffic management center will be required, potentially meaning a large investment is needed depending on whether existing fiber is available.[6]

For a number of reasons, including the recurring cost of using publicly available communication systems and security concerns, transportation agencies in our region have been building private communication networks to support traffic management activities. The Illinois Tollway has complete coverage of its 286-mile system and has written agreements to share fiber communication capacity with the GTIS and the Lake County Division of Transportation. IDOT has an extensive fiber optic network, but there is a need to inventory and review location and condition of the system.[7]

In the near future, Lake County DOT will share just over 100 miles of fiber with other agencies (Illinois Tollway, IDOT and Cook County), plus it will have 38 miles of county-owned fiber. DuPage and Kane Counties are installing fiber links as needed as they develop their central traffic signal control capabilities (discussed more later). The Chicago Department of Transportation has an inventory of the location of its extensive fiber communication system. There are also 902 miles of traffic signal interconnect on the regional arterial system, which can be counted as segments of communication infrastructure serving individual systems in the field. These systems form the beginning of communication coverage on the arterial system. Old signal interconnects may communicate with copper wires, but new ones are all installed

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[6] "According to AASHTO, some sites may only require an upgrade to their current backhaul system to support expected bandwidth requirements for connected vehicle communications. However, 40 percent of all traffic signals have either no backhaul or will require new systems, according to AASHTO. The difference in cost between tying into an existing fiber-optic backhaul and installing a new fiber-optic backhaul for the sites is significant, according to DOT. The average national cost to upgrade backhaul to a DSRC roadside site is estimated to vary from $3,000, if a site has sufficient backhaul and will only need an upgrade, to $40,000, if the V2I site requires a completely new backhaul system, according to AASHTO estimates." Intelligent Transportation Systems Vehicle-to-Infrastructure Technologies Expected to Offer Benefits, but Deployment Challenges Exist, United States GAO, September 2015.

[7] IDOT was in the process of procuring that inventory as of late 2015.

with fiber communications. When the systems become part of a central signal system, communication to the traffic management center is added.

A region-wide inventory of transportation-related fiber-optic cable does not currently exist, which makes planning for expansion opportunities more difficult. If agencies agree on the future communication layout, they may be able to incorporate features during normal roadwork that make expansion to build the system easier and cheaper. Retrofitting roadways with fiber optic communication is costly.[8] Even requiring the installation of empty conduit when projects are constructed would decrease the cost of adding communications in the future. Extra capacity can be provided by including extra fiber in an installation, or using larger conduit so more cable can be added later. It might not be sensible to require this for every construction project, but could be practical on roadways that were included in a communications system master plan.

A number of agencies in the region have at some point experienced lost communication with all field equipment because of damage to a critical system link. As the communication system of each of the agencies expands, opportunities for links between agencies and resulting redundant paths will become available. Expanding the system and creating the necessary redundancy may proceed in a smoother and more predictable way if the region has an understanding of how the system should or will be developed. In interviews and through committee meetings, the region's highway agencies have expressed a desire to work together to develop a communications master plan. The plan would require assembling information about the communications infrastructure owned by individual agencies and including it in a single database where it can be viewed at a regional scale. If agencies have developed expansion plans, those linkages could also be included. Note that agencies have expressed concerns about the vulnerability of the communication system if this data were public, and most believe it would be necessary to keep it private. CMAP is an appropriate coordinator of this activity.

Focus More Resources on Incident Management

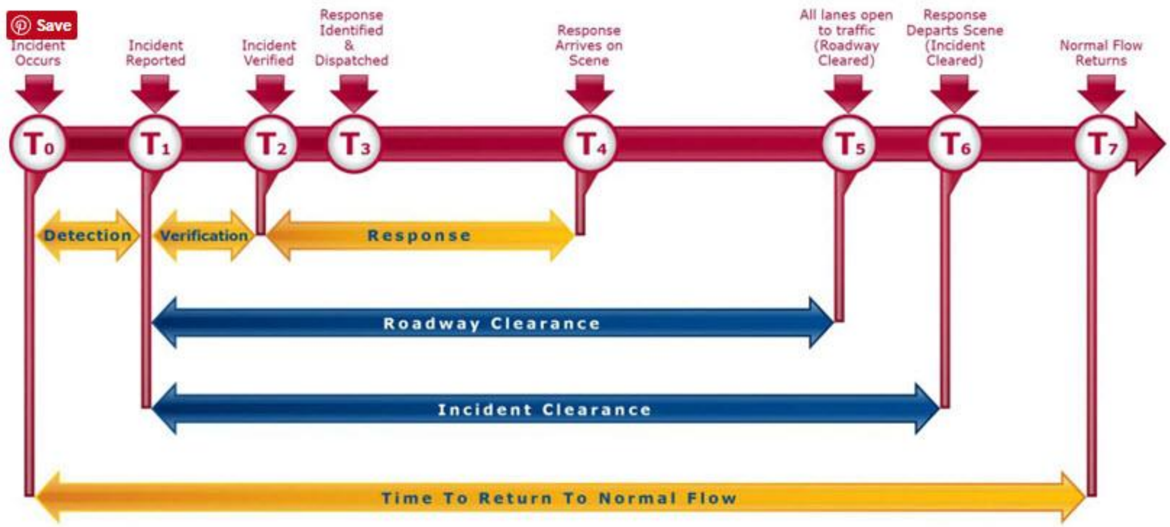
Since incidents like crashes, broken down or abandoned vehicles, and debris on roadways cause so much of the non-recurring delay in the region, improving incident management is a priority. Each incident presents an opportunity to reduce congestion through earlier detection and verification, faster response, and adherence to quick clearance principles. Reducing incident duration also reduces the potential for additional incidents ("secondary incidents") caused by

[8] According to USDOT Intelligent Transportation Systems Joint Program Office, the cost of in-ground fiber optic cable installation might range $21,000 to $55,000 per mile but "in ground installation would cost significantly less if implemented in conjunction with a construction project." According to a Chicago Department of Transportation staff member, locations with very complex underground utility systems like the City of Chicago can incur costs of $0.5 – 1.0 million per mile for design and construction of fiber optic communication.

congestion resulting from the first incident. Nationwide, approximately 20 percent of all incidents are secondary incidents.[9]

Incident management includes a number of steps, each with the potential for reducing the total amount of time needed to return traffic to normal flows (Figure 5). However, unlike other highway operations activities, incident management is largely managed by a public safety agency, with the transportation agency playing a supporting role. Therefore, much of the work to improve performance falls upon the public safety agencies.

Figure 5: Timeline of Incident Management Process



Source: Federal Highway Administration Office of Operations "Traffic Incident Management Gap Analysis Primer," http://www.ops.fhwa.dot.gov/publications/fhwahop15007/chapter1.htm

Better Incident Detection

Automated detection methods can be more effective for early detection than relying on human observation. Analyzing vehicle detection system or probe data, (GPS traces indicating traffic speed) can detect potential incidents and generate automated notifications to traffic management center operators. Traffic cameras with automated incident detection capabilities have been tested on expressways in the region and have been found to accurately identify the occurrence of most traffic incidents. At the time they were tested, they were expensive compared to the existing closed-circuit television camera systems, but they can return benefits

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[9] "Traffic Incident Management," *Federal Highway Administration's Office of Operations*, April 2004, http://ops.fhwa.dot.gov/aboutus/one_pagers/tim.htm.

12 times their cost.[10] IDOT and the Illinois Tollway should explore the use of automated incident detection equipment on the interstates.

While some counties also use video imaging traffic detection to provide data for the traffic signals, using camera technology to detect incidents is unlikely to become widespread on the arterial system, as there are too many miles of coverage needed and the stop and go flows make detection by camera difficult. On arterials, it may be possible instead to use real-time probe data to alert operators to changes in expected flows that can indicate an incident. Cameras would be needed to manually verify the existence and characteristics of an incident. At critical arterial locations, more CCTV cameras should be installed to aid incident detection.

Integrate Public Safety Answering Points (PSAP)

A Public Safety Answering Point (PSAP) is the call center receiving 911 calls and dispatching appropriate emergency responders. Since CCTV and other sensing devices do not fully cover the entire region, communications with public safety agencies, including PSAPs, is necessary. PSAPs have the most accurate real time information about highway incidents, so transportation agencies are seeking direct automated electronic communications with computer-aided dispatch (CAD) systems operated by PSAPs. Often, the PSAP has a policy for staff to notify departments of transportation about incidents rather than implementing such an automated process. During major highway incidents when public safety resources are being deployed, transportation communications may be a lower priority, resulting in significantly delayed responses to incidents.

Information exchange can improve incident response by allowing transportation agencies to change traffic signal timing, alter ramp meter timing, provide real time traveler information, and take other steps to manage the transportation network during major incidents. Field operations staff can also more quickly remove spills and debris and repair damaged equipment. In addition, the support provided by the DOT can increase safety for emergency responders. Sharing access to CCTV video, including camera control, is common in these arrangements and provides important information to responders who are en-route to the scene.

In 2002, the Illinois Tollway and Illinois State Police District 15 collaborated to deploy a two-way data exchange between their traffic management centers and dispatch service. This innovative approach built upon the unique agency dispatch operation that already handled State Police and Tollway maintenance and operations from a single CAD system. The deployment became recognized in the transportation industry as the first of its kind. Since that time, Lake County Division of Transportation (LCDOT) has also established connections to many PSAP operators within the county. Some of these agreements have included LCDOT

[10] Mashrur Chowdhurt et al., "Benefit Cost Analysis of Accelerated Incident Clearance Final Report," *Clemson University Transportation Systems Research and Education Prepared for South Carolina Department of Transportation,* April 14, 2007, http://www.clemson.edu/t3s/scdot/pdf/projects/spr659.pdf.

camera images in return for PSAP highway incident dispatch data. While not all of the Lake County integration efforts include a two-way component, the benefits remain.

The region's transportation operators are certain that additional integration efforts will further enhance the safety and mobility of the region. However, progress on collecting this required[11] information has been difficult. PSAP-to-transportation operator information exchanges typically require development of formal operational policies and agreements. Before those can occur, participants must understand the information to be shared, when it will be shared, and with whom it will be shared. In addition, information exchanged between these systems is sensitive, and there are legitimate concerns about maintaining appropriate levels of privacy and software system security. For example, IDOT District 1 has been working for 10 years to implement an agreement for integrated communications with the Illinois State Police and the Cook County Sheriff. The Illinois Tollway and Lake County Department of Transportation experiences offer potential solutions to protect privacy and maintain secure exchanges of information between computer systems.

In January 2016, Public Act 099-0006 required counties to reduce the number of 911 centers by half, and created The Office of the Statewide 9-1-1 Administrator[12] within the Illinois State Police to develop, implement and oversee a uniform 911 system, excluding municipalities with more than 500,000 residents (i.e., City of Chicago). This process provides an opportunity to advance the goal of PSAP integration as part of the standardization of the statewide system, and to reduce the number of PSAP communications connections that must be developed to exchange the desired information.

Expand Full Function Service Patrols

To keep roadways clear of debris and disabled vehicles, both the Illinois Department of Transportation and the Illinois Tollway employ emergency traffic patrols on the region's expressways and tollways. Northeastern Illinois developed the first continuous service freeway service patrol in the nation in 1960.[13] The goal of the service patrol is to detect and remove incidents quickly. Patrols perform minor vehicle repairs, provide fuel, change tires, remove

[11] Recent federal regulations require departments of transportation to provide timely and accurate dissemination of traffic incident data to the traveling public, giving the state strong reason to encourage PSAP integration as a way to obtain that information. (Real-Time System Management Information Program [1201]) "The timeliness for the availability of information related to roadway or lane blocking traffic incident will be (…) 10 minutes or less from the time that the incident is verified for roadways within Metropolitan areas. (…) Establishment of the real-time information program for traffic and travel conditions on the Interstate system highways shall be completed no later than November 8, 2014. Establishment of the real-time information program for traffic and travel conditions reporting along the State-designated metropolitan area routes of significance shall be completed no later than November 8, 2016."

[12] The Office of The Statewide 9-1-1 Administrator, Illinois State Police, http://www.isp.state.il.us/statewide911/statewide911.cfm.

[13] Nancy Houston et al., "Service Patrol Handbook," *Federal Highway Administration*, November 2008, http://www.ops.fhwa.dot.gov/publications/fhwahop08031/ffsp_handbook.pdf.

debris, and assist emergency responders at crash scenes. These patrols are integrated within the agency incident management system, and may be dispatched to a location from the traffic management center. IDOT's patrols[14], called "Minutemen," cover the core Cook County IDOT expressway system twenty-four hours a day, every day of the year. The IDOT service patrol provides over 115,000 assists annually – or over 315 per day. This service is also important for keeping the shoulder clear for Pace bus-on-shoulder service on I-55 as well as the planned service on 1-94. The Illinois Tollway service patrols[15], called Highway Emergency Lane Patrol or H.E.L.P, patrol the entire tollway system between 5 a.m. and 8 p.m. on weekdays. In 2015, H.E.L.P patrol staff assisted 30,000 drivers.

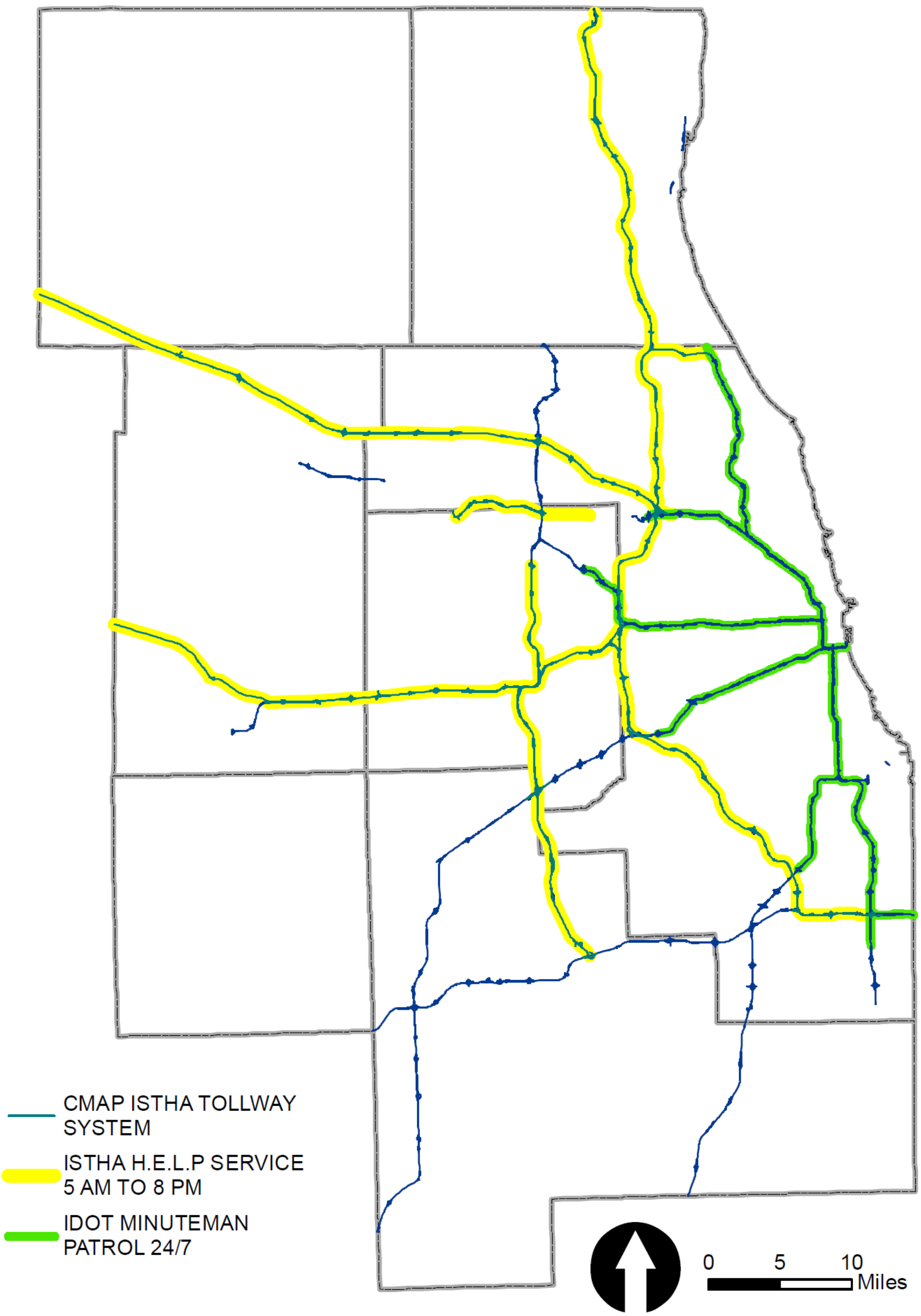
Important attributes of service patrols include coverage area, frequency of patrol, hours of operation, and type of patrol vehicles (Figure 6). Agency operations staff has expressed a desire to extend service patrol coverage, frequency, and hours of service. In a study completed in 2009, the Missouri Department of Transportation estimated that the Motorist Assist (MA) program provides an annual benefit-cost ratio of 38:1.[16] This high ratio is based in part on the relatively low operational cost of service patrols, and the fact that the researchers included the costs of secondary incidents, which have not always been reflected in analyses of these programs. The researchers estimated that the service patrols reduced secondary crashes by more than 1,000 per year. Emergency patrol services should be expanded to cover all the region's expressways on a 24/7 basis.

[14] Emergency Traffic Patrol, Illinois Department of Transportation, http://www.idot.illinois.gov/travel-information/roadway-information/driver-information/emergency-traffic-patrol/index.

[15] H.E.L.P. on the Illinois Tollway, Illinois Tollway https://www.illinoistollway.com/travel-information?inheritRedirect=true#H.E.L.P.%20on%20the%20Illinois%20Tollway.

[16] Carlos Sun et al., "Evaluation of Freeway Motorist Assist Program Final Report," *University of Missouri, HDR Engineering and Missouri Department of Transportation,* September 30, 2009, http://ntl.bts.gov/lib/33000/33000/33049/or10018.pdf.

Figure 6: Coverage Area of IDOT Minutemen and Tollway HELP Patrol



Source: Chicago Metropolitan Agency for Planning

Shorten Investigations of Major Crashes

A crash requiring an investigation may close a roadway for hours. Although the region does not currently track performance in the area of crash clearance, a CMAP analysis of detailed crash activity records (2008-11) provided by IDOT provides a view into clearance time. When a crash results in a fatality, the duration of an incident can be especially lengthy. As Table 2 shows, the median clearance time of fatal accidents is more than four hours.

Table 2: Categorized Clear Times Percentiles in Hours for 1,256 IDOT Incidents on IDOT Arterials and Controlled Access Expressways With a Range of 0.2 Hours - 48.0 hours (2008-11)

Response Clear Times Categories	25th Percentile	Median	75th Percentile
Fire Department	**1.00**	**2.22**	**7.57**
Injury/Ambulance/Hospital	**1.39**	**3.50**	**7.08**
Fatal	**2.50**	**4.47**	**7.22**

Source: IDOT (data) Chicago Metropolitan Agency for Planning (analysis)

In a survey conducted of jurisdictions in 21 states, 73 percent require medical examiners or coroners to respond to the crash site before the deceased can be removed.[17] Illinois is a state with this requirement, and waiting for a coroner to arrive on scene can contribute to extended highway closure times. A number of states have instituted policies such as allowing responding emergency medical staff to certify the death, allowing on-scene responders to electronically transmit vital signs to a remotely located coroner for verification, allowing on-scene responders to move the body to a safer location to protect public safety (Pennsylvania Turnpike Commission), or move the body with the permission of the coroner by telephone or other communication mode (Rhode Island DOT).

As a way to ensure that reducing the duration of incidents is a priority for all agencies involved, a number of states have enacted Open Roads Policies (for example Florida[18], Georgia[19], Minnesota[20], Maryland, Tennessee, and Washington). Open Roads Policies define agency responsibilities for incident response.[21] For example, law enforcement agencies commit to performing investigations as quickly as possible and may require non-critical portions of the investigation to occur when lighter traffic conditions prevail. Under such a policy, agencies

[17] "National Cooperative Highway Research Program Synthesis 318, Safe and Quick Clearance of Traffic Incidents, A Synthesis of Highway Practice," *Transportation Research Board, 2003,* http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_318.pdf.

[18] State of Florida Open Roads Policy Agreement (Revised January 2014), http://www.fdot.gov/traffic/Traf_Incident/pdf/Open_Roads_Policy_FDOT_FHP.pdf.

[19] State of Georgia Open Roads Policy Version 6.0 (June 2011), http://www.timetaskforce.com/documents/FINAL%20GA%20Open%20Roads%20Policy_fully%20signed%20governor%20endorsed.pdf.

[20] State of Minnesota Open Roads Policy, (July 2010), http://www.dot.state.mn.us/environment/regulatedmaterials/pdf/mndotopenroadspolicy.pdf.

[21] Traffic Control Concepts for Incident Clearance, FHWA, 2009.

agree to close only the travel lanes necessary to deal with the incident, and they work with transportation agencies to set up appropriate traffic control, establish alternate routes, and expedite traffic movement at the incident scene.

Kansas City Scout[22], the bi-state (Kansas, Missouri) traffic management system, implemented a traffic incident management program in 2007. Prior to that time, investigators did not consider the implications of a highway shutdown and it was not uncommon for it to take four to six hours to clear the roadway. The Kansas City Police department typically would not call a Medical Examiner until the police work was finished and would not call for tow trucks until the investigation was complete. Following a 2007 Traffic Incident Management Summit, vehicle crash squads were established, and a target of 90-minutes maximum closure time was adopted. As a result, secondary incidents were reduced by 47 percent, and the average time to clear incidents was reduced from 39 minutes to 22 minutes. For "Level 3" incidents (greater than 90 minutes) average incident duration was reduced by 111 minutes.[23]

The region, working with system operators and municipal, county, and state police, should establish a goal to reduce the amount of time roads are closed due to crash investigations and develop strategies to address them. The upcoming development of state and regional safety performance measures to meet federal requirements offers one potential implementation avenue. CMAP will explore this topic further in the Safety Strategy Paper.

Enhance Driver Removal and Authority Removal Laws

A key component of incident clearance programs is the enactment of removal laws. Removal laws require that disabled vehicles and spilled cargo be moved out of driving lanes as quickly as possible if this can be safely achieved. While Illinois has enacted a driver removal law, anecdotally it seems that drivers involved in crashes often do not remove their vehicles from the traffic lanes. Removal laws are not useful if drivers or law enforcement are unaware of their existence.

Authority Removal laws allow an authority, generally including police, fire, or department of transportation staff to order a driver to remove a vehicle from the roadway if it constitutes a hazard or obstructs traffic. Under state law, police or a highway authority may move any vehicle obstructing a roadway[24], and the City of Chicago is authorized to designate any city department to remove vehicles from the roadway.[25] State law also authorizes towing of a vehicle on or adjacent to the roadway when ordered by a law enforcement official.[26] In addition

[22] Kansas City SCOUT, Missouri DOY and Kansas DOT, http://www.kcscout.net/Default.aspx.

[23] KC Scout, "Major Crash Investigation and Traffic Incident Management Presentation," http://www.kcscout.com/downloads/ITSSymposium/TIM Patrol Bureau.ppt.

[24] 625 ILCS 5/11-404 (C).

[25] 625 ILCS 5/4-212.1.

[26] 625 ILCS 5/4-203.

to personal vehicles, authority removal laws include authority to remove commercial vehicles and their spilled freight. The Illinois vehicle removal laws do not address relocation of spilled cargo off the roadway.

Highway operators expressed concern with potential damage claims resulting from clearing driving lanes of disabled vehicles and debris. Some States have enacted laws to protect responders from being responsible for damages to vehicles and cargo caused by responsible incident clearance procedures. National models are available, such as one from the I-95 Corridor Coalition.[27]

Provide Training for Emergency Responders

Emergency responders include police, fire, ambulance, and vehicle towing and recovery.[28] When emergency personnel are on the scene of a traffic incident, there is always the danger of a responder becoming a crash victim. Many emergency responders are harmed in the line of duty. Thus, first responders tend to focus on life safety to the exclusion of other needs. In a 1997 study of urban arterial incident management, researchers found that maintaining traffic operations was a low priority for emergency responders.[29] Agency interviews revealed this situation continues today. Effective traffic incident scene management could improve safety for responders as well as make navigating the area easier and safer for drivers. Interviews with highway system operators indicated that performance in this area was very uneven, and they expressed a desire for local agencies to work towards better performance and standard traffic incident management procedures.

IDOT recognized this need and in 2011 started working with the Illinois Center for Transportation at Southern Illinois University to develop a training program[30] intended for law enforcement, fire departments, emergency medical personnel, tow and recovery operators, highway department staff, and 911 center operators. At this point, many of those needing training have not yet been trained (Figure 7). The training includes incident command system

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[27] The critical element of this policy is that "governmental agencies responding to incidents, including but not limited to law enforcement, firefighting, emergency medical services, hazardous materials, transportation agencies and other emergency governmental responders are authorized to exercise the incident clearance functions enumerated in this section. If such functions are exercised with reasonable care and at the direction of the incident commander, those governmental agencies and their personnel and other designated representatives are insulated from liability resulting from such actions taken pursuant to incident clearance (…)" Incident Responders' Safety Model Law, I-95 Corridor Coalition.

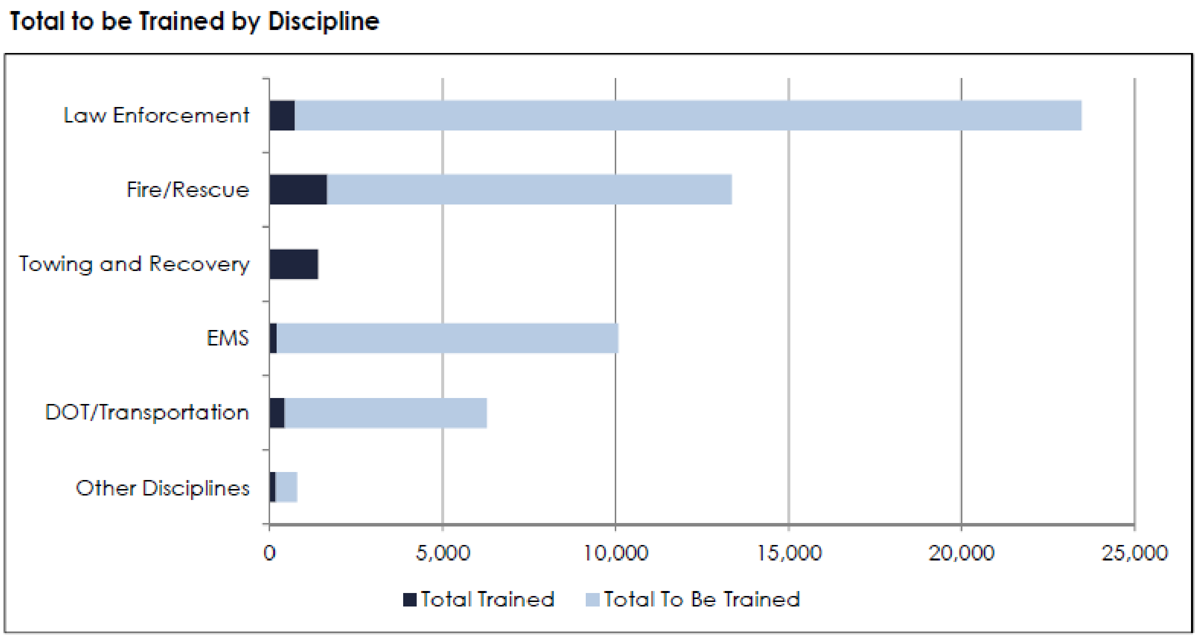
[28] The region's tollway system is patrolled by the Illinois State Police (ISP) District 15. The dispatch for ISP District 15 is housed within the Illinois Tollway Building. ISP District 2 serves the non-tollway interstates in DuPage Kane, Lake and McHenry Counties. ISP District 5 serves non-tollway interstates in Kendall and Will Counties. ISP Chicago District serves Cook County non-tollway interstates. The arterial system is patrolled by county and municipal police departments. Incident response for the entire system of interstates and arterials relies on local fire, rescue and towing/recovery staff.

[29] Raub, Richard A., and Joseph L. Shofer, "Managing Incidents on Urban Arterial Roadways," *Transportation Research Record Volume* 1603 (1997): 12-9, http://ntl.bts.gov/lib/jpodocs/rept_mis/10667.pdf.

[30] Traffic Incident Management, Illinois Department of Transportation, http://www.idot.illinois.gov/transportation-system/safety/roadway/traffic-incident-management.

training, response vehicle parking guidelines, the use of high visibility apparel, on-scene emergency lighting procedures, and the use of temporary traffic management devices including queue warnings. State law now requires this training for tow truck operators; however, the law does not require local public safety agency personnel to receive such training.

Figure 7: Illinois Highway Incident Management Training Recipients as of November 2015



Source: Illinois Training Report, Illinois Department of Transportation (November 2015)

Improved Vehicle Technology

More than 90 percent of crashes nationwide are attributable to human error. [31] Technological innovations have the potential to greatly reduce crashes and crash severity. Automated vehicles include systems to perform functions that have historically been controlled by the driver. The Insurance Institute for Highway Safety reports that vehicles with automatic braking systems, which function as front crash avoidance systems, reduced rear-end collisions by 40 percent.[32] The Institute also found that electronic stability control, standard on 2012 and later models "lowered the risk of a fatal single-vehicle crash by about half, and the risk of a fatal rollover by as much as 80 percent."

[31] Traffic Safety Facts," *National Highway Traffic Safety Administration,* February 2015, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115.

[32] "Status Report Volume 51 Number 1," *Insurance Institute for Highway Safety Highway Loss Data Institute,* January 2016, http://www.iihs.org/iihs/sr/statusreport/article/51/1/1.

The new systems are proving to be effective and are becoming more widely available. Higher cost auto models offer crash avoidance automation features such as front crash protection, lane departure warning, blind spot detection, adaptive headlights, and parking assist. A number of these technologies are also available for commercial vehicles. As the technology proves its value and the cost of including it on vehicles is reduced, these options will become either standard or required and will permeate the vehicle fleet. These technologies only require automakers to install them, with no special investment needed from the road operators.

Connected/automated vehicles go a step farther. While automated vehicles are equipped with on-board sensors to detect conditions immediately surrounding the vehicle and response systems to react to detected conditions, connected vehicles can receive information beyond both the immediate vicinity and the types of information that detectors can sense. This technology requires that vehicle devices (vehicle to vehicle, V2V) or roadside devices (vehicle to infrastructure, V2I) transmit information to detect. A vehicle in the front of the platoon may broadcast deployment of its brakes, allowing the following vehicles to reduce speed without directly detecting the slowing vehicle. Additionally, roadside equipment may listen for vehicle information and transmit it back to a traffic management center for use – such as detecting the deployment of antilock braking systems that may indicate roadway icing. The region is already deploying V2I in the form of transit signal priority (TSP), a partnership project between IDOT, county DOTs, the City of Chicago, RTA, Pace and the Chicago Transit Authority, using a radio on the bus to communicate specific messages to a radio at the traffic signal. Any transmission of dynamic information from the traffic management center to a field radio will require supporting communication infrastructure, as will any collection of intelligence from vehicles for use in managing the system. In addition, traffic management center hardware, software and staffing will be needed to support the system. The advance of this technology will likely require roadside devices to exchange information with vehicles and transmit information between the device and a center – another reason for operating agencies in the region to implement traffic management centers.

This does not mean that significant investment in incident management is unnecessary. Our future includes a fleet of vehicles with crash avoidance technology, but the rate of market penetration into the general fleet may be slow. For example, in 1985 antilock braking systems became available. Twenty-five years later, by 2010, 88 percent of registered vehicles had antilock braking systems.[33] As the new features are incorporated into the region's fleet, the number and severity of crashes should decline. However, the region's fleet will continue to include a large number of vehicles without accident avoidance systems for the near future.

At some point in the future, fully automated vehicles will provide new technologies that contribute to crash reduction. It is possible that automated vehicles will require some infrastructure investment, yet unknown. It is also possible that automated vehicles will

[33] "Predicted Availability of Safety Features on Registered Vehicles—An Update," *Highway Loss Data Institute, Bulletin, Volume 31,* no. *15* (2014), http://bit.ly/2ibkXa7.

eliminate the necessity of other infrastructure investments such as traffic lights and message signs. Traffic may become more self-organizing, changing the requirements of the traffic management center. At this time, impacts are unknown. CMAP is exploring the subject in more depth as part of the "Alternative Futures" scenario development.

Consider Ways to Improve Weather Response

Inclement weather is estimated to cause 15 percent of congestion, increasing the number of crashes and delays and reducing road capacity. About half the days in a typical year have weather conditions that impact driving, contributing to road closures, traffic slowdowns, crashes, and damage to electronic devices such as traffic lights, message signs, and cameras. Existing regional strategies to mitigate impacts include traveler information and alerts, weather advisories, vehicle restrictions such as banning trucks during high winds, road closures for flooding or drifting snow, anti-icing/deicing road surface treatments, plowing, and pumping water from flooded locations.

Some deficiencies currently exist in the availability of real-time "road weather" (pavement) information. While IDOT and the Tollway report their weather information to TravelMidwest, as does Lake County, the other counties currently do not. Real time road weather information should be available system-wide across the region, although this will depend on implementation of traffic management centers in the other counties.

Weather responsive traffic management is not widely used today, except for closing roads to traffic under severe conditions. The expansion of ITS devices and traffic management capabilities will support a variety of weather responsive traffic management strategies such as variable speed limit systems to reduce speeds during inclement weather, coordinated traffic signal timing that reflects the slower speed of travel in corridors during bad weather, alternative signal plans to support detours, and increasing the coverage of emergency vehicle patrols to remove disabled vehicles more quickly. In addition, as the region's maintenance fleets become equipped with GPS-based fleet management technology and center-based management software, opportunities are opened for better coordination of snow and ice removal between different jurisdictions. This will reduce costs and improve the efficiency of these activities.

Climate change is already causing more frequent road flooding and heat- and cold-related pavement failures. Freezing and thawing can cause damage to underground communication infrastructure. Operating agencies should perform an analysis of road performance under severe weather conditions to highlight critical locations for management and operations changes and to plan for detours and traffic management needed to support them. It will be important to collect and analyze information about how facilities perform under various weather scenarios so agencies can develop planned responses to weather events. For example, focusing incident management resources on locations that are known to be especially impacted by rain or snow can reduce congestion and secondary incidents.

Pavement flooding information has not been collected on a regional basis, and there is no standard pavement flooding reporting system. It is unknown today what the impact of flooding has been on our roadway operations. CMAP should develop a regional pavement flooding reporting system to help plan for flood events.

Finally, power outages are often connected to extreme weather. Under normal conditions, a power failure is a time consuming inconvenience. In an emergency, the same power failure can cripple our ability to respond to emergencies, warn travelers of danger ahead, or move people to safer locations. As our reliance on technology to operate the roadways increases, it will be important for agencies to include provision of backup power for system components.

Modernize and Retime Traffic Signals

Intersections account for the vast majority of delay occurring on arterials. Some of this is unavoidable, but poorly timed traffic signals make the situation worse. According to the Institute of Transportation Engineers, about three-quarters of the nation’s traffic signals can be improved by retiming or updating equipment. Comprehensive signal retiming programs can reduce overall travel time 7 percent to 13 percent, delay 15 percent to 37 percent, and fuel use by 6 percent to 9 percent.[34] Northeastern Illinois has approximately 8,000 signalized locations, making signal maintenance and retiming potentially an area of significant savings in the region in aggregate.

Traffic signals that are not timed to reflect traffic patterns increase travel delay, crashes, fuel consumption and pollution. Signal retiming and maintenance is often ad-hoc. Regular agency monitoring may reveal problems, but poorly functioning signals are too often addressed when the public submits complaints to the operating agency. For instance, according to a Chicago Department of Transportation official, “We are largely in a firefighting mode, relying on calls from the public to 311 (the city's nonemergency hotline) and from aldermen.”[35] Unfortunately, traffic signals that provide basic functions are often considered to be performing well enough, and maintenance may be delayed or canceled even though the signal operation could be improved. Agencies should establish standards for signal timing field review and timing practices, and commit the resources needed to achieve them.

The Institute of Transportation Engineers recommends field reviews of signal operations be performed annually for all intersections, and that intersections be systematically retimed every three to five years. [36] Traffic signal retiming is a cost effective way to improve highway

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[34] “Traffic Signal Timing,” *Institute of Transportation Engineers*, http://www.ite.org/signal/index.asp.

[35] Hilkevitch, Jon, “Chicago Looks for Green Light from Indiana Signal System,” *Chicago Tribune*, July 16, 2012, http://trib.in/2hqv1wS.

[36] “Traffic Signal Audit Guide,” *Institute of Transportation Engineers*, 2007, http://bit.ly/2iBlwca.

operations, with a cost / benefit ratio of 40:1 or more.[37] Retiming a single intersection costs about $6,000, but the cost is reduced to about $4,000 per intersection if multiple intersections are being retimed[38] including traffic counts, modeling, and field observation. At $4,000 per intersection, it would cost $32 million to retime the region's 8,000 signalized intersections. If each signal were retimed every five years, the cost would be $6.4 million annually.

Transportation agencies appreciate the value of traffic signal timing. IDOT's coordinated signal systems were each the subject of a before and after study for conditions and performance. They are re-evaluated every five to seven years. Lake County DOT retimes traffic signals in coordinated corridors every five years, following the IDOT standard. Implementation of the region's bus transit improvement program, Bus Rapid Transit (BRT) and Transit Signal Priority (TSP), requires traffic signals to be optimized in the bus corridors. For example, as part of the Loop Link BRT project, traffic signals were retimed at about 100 locations. During 2005 and 2006, the City of Naperville re-optimized three traffic signal systems, reducing peak directional travel time 32 percent.

Expand the Use of Central Signal Systems

Central signal systems provide the ability to actively monitor traffic signals and highway operations in real time, and communicate desired changes to the traffic signals from a central office. For example, if a road were blocked by an incident, traffic management staff in a central office could observe traffic patterns at traffic lights in the vicinity using cameras and transmit new instructions to a group of signals to accommodate the new traffic pattern. The results could then be observed from the central office to confirm that the changes had the desired effect, and further adjustments could be made as needed. The inclusion of an adequate number of cameras also creates a significant resource for improving incident response, allowing sharing of images with emergency responders. A complete central signal system requires significant investment in communications, hardware, software, and cameras to observe system performance, and trained operators to manage the system.

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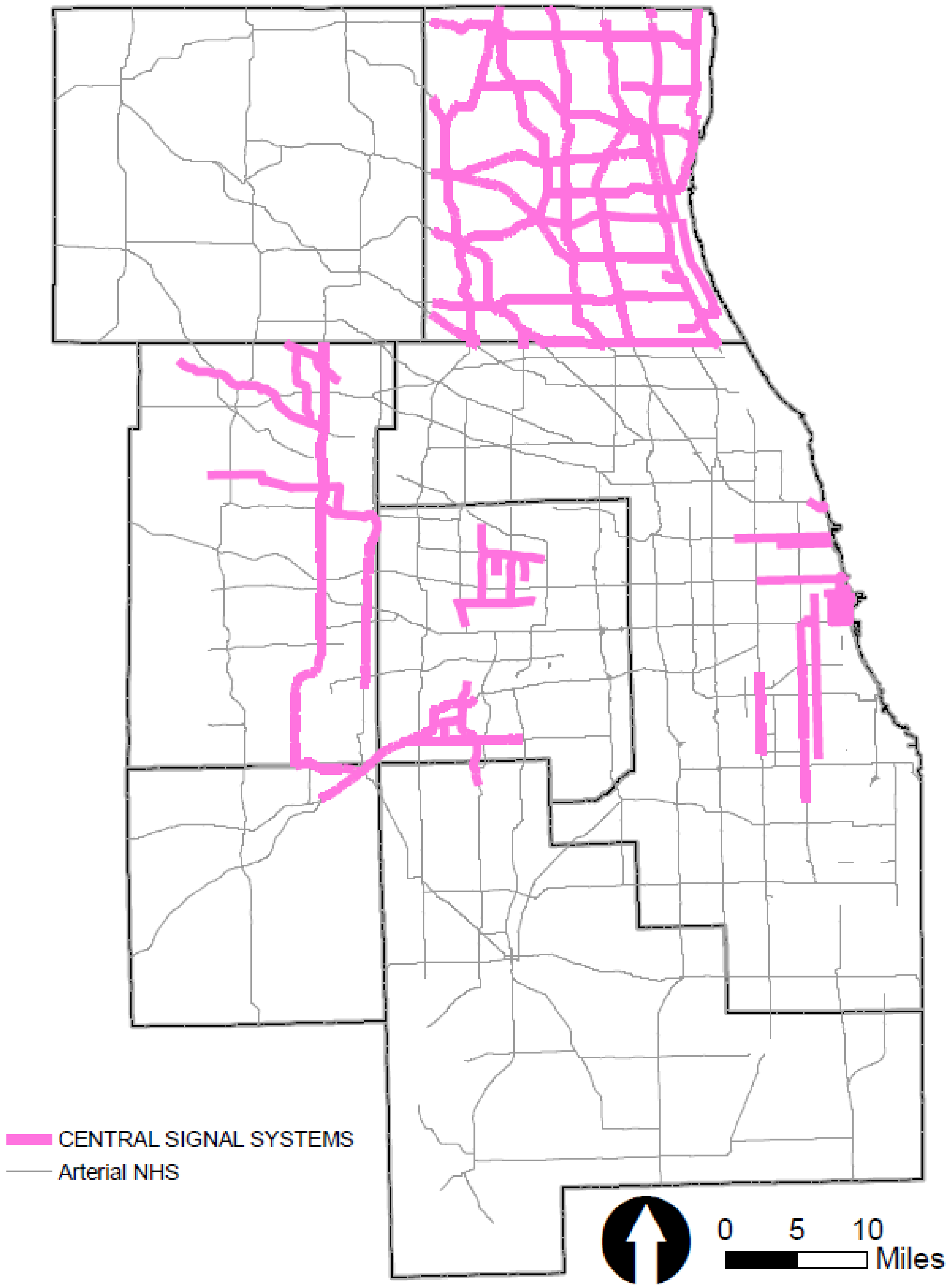
[37] "National Traffic Signal Report Card Executive Summary 2007," *National Transportation Operations Coalition,* 2007, http://library.ite.org/pub/e265c148-2354-d714-515a-eb251643bd2a.

[38] Lake County DOT estimate, April 2016.

Figure 8. Existing and Programmed Central Signal Systems in the Region



Source: Chicago Metropolitan Agency for Planning

Interviews with system operators suggest that the operators' ultimate goal is to monitor and manage traffic signals using central signal systems. A number of central signal systems are in place or are in the process of implementation, but much of the region remains unconnected (Figure 8). DuPage County is developing a central traffic signal system. Phase 1 construction was completed in June 2016. Kane County is also developing a central signal system. IDOT owns the largest number of traffic signals in the region and has not implemented any central traffic signal control technology. Instead, IDOT has entered into agreements that allow other entities to include IDOT signals within their central systems.

There are a variety of existing signal system coordination agreements between agencies. As central systems become more developed, the potential for coordinating signal operations between jurisdictions will be improved. Center-to-center integration has been considered the route by which this will happen, although other approaches are possible.[39]

Reduce Work Zone Duration

Work zones are estimated to cause 10 percent of congestion. A review of expressway construction reports from TravelMidwest.com on December 31, 2015 shows over 100 construction locations on the expressway system in the CMAP region. There were 4,287 work zone crashes in Illinois in 2014, with 30 fatalities. [40] Of the fatalities, 90 percent were road users, not construction workers. Work zone management strategies are used to minimize delay, minimize congestion, and ensure driver and worker safety. Each road construction project includes a transportation management plan that addresses operational strategies, temporary traffic control devices, and public information. There are many specific strategies available to planners, engineers, and contractors to meet the goals, and they are selected based on an evaluation of the tradeoffs between traffic flow and construction efficiency.

Both the Illinois Tollway and IDOT use technology to manage work zones. Cameras and speed monitoring equipment allow operators to track traffic around the zone. Portable queue detection systems that sense when traffic is backed up and relay the information to a sign before the construction zone, warning drivers of stopped traffic ahead, can be used if needed. Camera speed enforcement may be used. Speed feedback signs, which measure vehicle speeds and display a warning if the vehicle is traveling over the posted speed, have been effective. These systems are most widely used for interstate construction, but are also useful for large arterial projects. Arterial projects also include attention to signal plans that accommodate rerouted traffic. Note that rerouted traffic may not travel the routes project planners envisioned. A

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[39] In DuPage County, testing of a different strategy is being planned. In this instance, DuPage County plans to host the hardware and software for a "virtual" traffic management center. The City of Naperville and the City of Aurora will be the first members of the virtual center, and use the hardware and software to manage their own signals. This should reduce the cost of procuring hardware, software, maintenance and upgrades of the signal management system.

[40] "2014 Illinois Crash Facts and Statistics," *Illinois Department of Transportation*, 2015, http://bit.ly/2ier0Np.

central signal system and cameras for observation would make responding to this eventuality much easier to do.

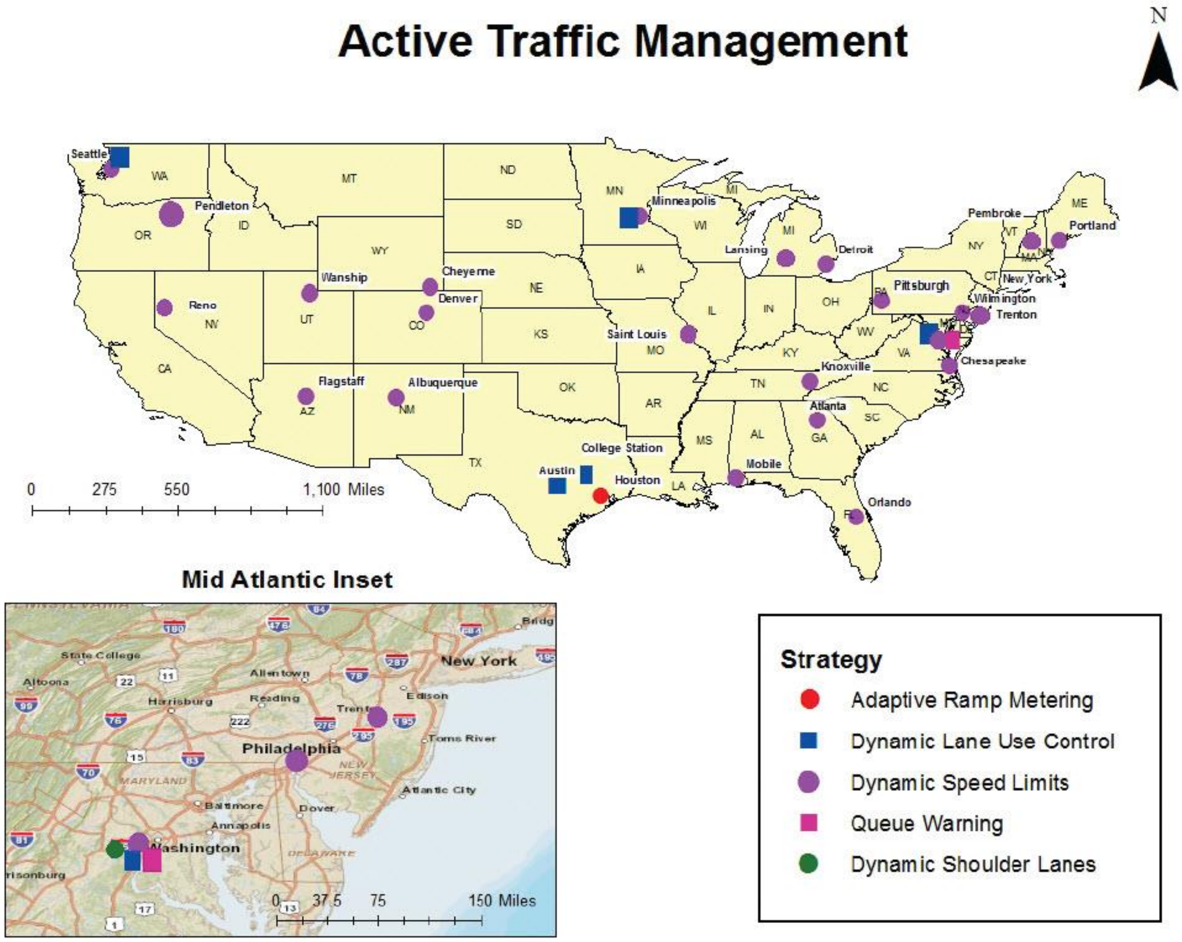
Reducing the amount of time a location is under construction reduces the disruption it causes. Bonuses or penalties can be included in contracts to encourage timely work completion. Working during times of day with low traffic volumes, and controlling lane closures by time of day can also reduce construction impacts on highway users. Agencies in our region have successfully employed these strategies. Many exciting new construction techniques and materials are also becoming available that will reduce project completion time or extend the time between maintenance and rehabilitation treatments. Increasing the value placed on operational impacts and mobility may increase the speed of adoption.

Implement Active Traffic Management

The future of congestion management is the application of selected real-time strategies in a coordinated fashion on individual roadways, which is often called *active traffic management* (ATM). Active traffic management is the ability to dynamically manage traffic based on current and expected traffic conditions. While northeastern Illinois implemented reversible lanes and ramp metering decades ago, other active traffic management strategies have not been used in the region. However, they have been widely used across the United States (see Figure 9). Nationwide, active traffic management applications are more widely found on expressways than on arterials. Further, several countries in Europe have used ATM for years, increasing overall capacity by up to 22 percent, throughput by up to 7 percent, a decline in crashes and secondary incidents by up to 30 percent and 50 percent, respectively. ATM has helped delay the onset of traffic congestion and made travel times more reliable.[41]

[41] "Active Traffic Management Fact Sheet," *Texas A&M Transportation Institute*, http://bit.ly/2ibkmoP.

Figure 9: Active Traffic Management Locations



Source: Active Transportation Demand Management Program Brief: Active Traffic Management, http://www.ops.fhwa.dot.gov/publications/fhwahop13003/fhwahop13003.pdf. FHWA Office of Operations, October 2012

Active Expressway Management

Active expressway management is most effective when multiple strategies are used in combination. Implementing these capabilities requires development or expansion of field equipment deployment, communication infrastructure, backup power systems, and traffic management center hardware and software to operate. The prioritization section below discusses places where active traffic management strategies might be most appropriate. Some potential expressway management strategies include the following:

- **Dynamic lane management**, which opens and closes travel lanes based on travel conditions such as downstream incidents. For instance, dynamic lane management was implemented by the California Department of Transportation (CalTrans) on northbound

SR-110, an 8.2-mile section of freeway that had an accident rate of 3.36 accidents per million vehicle miles when the expected rate was 0.73. Peak hour average vehicle delay was over 20 minutes. Restriping provided an optional dynamically managed lane and the result was delay reduced to under five minutes and a 30 percent reduction in accidents from the previous year.[42]

- **Speed harmonization,** which involves gradually lowering speeds before a heavily congested area in order to reduce stop-and-go traffic. It has the potential to smooth traffic, increase the number of vehicles that a roadway can handle, and improve safety by making it easier for drivers to change lanes when necessary.
- **Dynamic shoulder use**, which allows the road shoulder to be opened and closed to all or selected traffic based on travel conditions. This strategy provides extra capacity at critical times.
- **Dynamic speed limits,** which are modified based on traffic and weather conditions. Dynamic speed limits can reduce crashes and delay the onset of congestion. With a goal of improving safety, the Wyoming Department of Transportation implemented dynamic speed limits on four portions of I-80, which appears to have avoided an estimated 50 crashes per year on I-80.[43] The system also helped them reduce road closures due to weather.
- **Congestion pricing**, which manages demand and congestion using tolling, increasing vehicle throughput and providing drivers with reliable travel times. This strategy[44] was recommended by GO TO 2040, and the region is moving toward a new managed lane on the I-55 Stevenson Expressway, which IDOT is studying and hopes to build by 2019.

The Illinois Tollway is currently rebuilding and widening the Jane Addams Memorial Tollway (I-90) as a 21st century, state-of-the-art corridor linking Rockford to O'Hare International Airport. I-90 will be the first facility equipped to implement active traffic management and will go live in early summer 2017. The project includes reliable power and communications, and ATM system related equipment and systems (cameras, wireless traffic sensors, dynamic message signs, road weather stations) to support lane management. The technology is flexible enough to accommodate changes in future lane management such as implementing congestion pricing and the use of Vehicle-to-Infrastructure (V2I) communication.

Active Arterial Management – Smart Corridors

Managing the region's arterials is important because arterials carry 64 percent of the region's annual vehicle miles traveled on non-local roadways. Smart Arterial Corridors include

[42] Moinuddin, Sheik, "Dynamic Management an ITS Solution to Enhance Safety and Mobility," *Caltrans, Los Angeles Division of Operations,* 2012, http://bit.ly/2iANp8l.

[43] Garcia, R. Vince, "WYDOT's Variable Speed Limits," *Wyoming Department of Transportation,* http://bit.ly/2iBcSdx.

[44] Congestion Pricing, CMAP http://www.cmap.illinois.gov/mobility/roads/congestion-pricing.

technologies that monitor and respond to arterial traffic conditions in real time, such as traffic surveillance systems to monitor traffic conditions. Real-time arterial traveler information about congestion and crashes can be distributed. Real-time system performance can be used to help operate traffic signals and detect incidents. Automated speed and traffic signal enforcement can reduce the number of crashes. Cameras can provide information about incident impacts to traffic operations staff. Intelligent parking systems that monitor available parking capacity and provide real time information to drivers can reduce the number of vehicles cruising to find a parking space and improve enforcement of time of day parking restrictions.

While the technology needed to actively manage the arterial system has only recently reached maturity, Smart Corridors are not a new concept for the CMAP region. In 2001, the City of Chicago began a project to implement Smart Corridor technology on Cicero Avenue near Midway Airport.[45] More recently, the Cook-DuPage Smart Corridor Study was undertaken in the Cook-DuPage corridor, a large swath of the western suburbs. This project screened and prioritized 45 candidate corridors based on 11 criteria and selected four as pilot projects for implementation. The four selected corridors are Cermak/22nd/Butterfield (Cicero Avenue to Winfield Road), Harlem Avenue (Glenview Road to 95th Street), North Avenue (Cicero Avenue to DuPage/Kane County Line), and Roosevelt Road (Harlem Avenue to DuPage/Kane County Line). Conceptual design plans were developed for the four corridors and included recommendations for specific technologies that should be considered for each segment of the roadways. Work is underway to identify funding and begin implementing these projects. CMAP supported this project by providing planning funds for the study and should support implementation by treating applications for CMAQ funding favorably when they are submitted for individual project components.

Integrated Corridor Management

Integrated corridor management (ICM) represents the next step in cooperatively managing interstate, arterial and transit system operations. It can be defined as the operational coordination of multiple transportation networks and cross-network connections comprising a corridor and the coordination of institutions responsible for corridor mobility.[46] The goal of ICM is to improve mobility, safety, and other transportation objectives for travelers and goods.

The USDOT partnered with eight transportation agencies, or Pioneer Sites, in large urban areas to research how integrated corridor management can be implemented. Ultimately, the sites in

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[45] The project includes advanced traffic management capabilities incorporating 19 traffic signals, seven closed circuit televisions, two dynamic message signs and multiple traffic detectors. Future enhancements will include adaptive signal controls and other roadside device enhancements. The advanced traveler information system includes highway advisory radio providing information on the status of at-grade rail crossings in the corridor (gate down/gate up). Dynamic message signs will provide information on travel conditions on nearby I-55.

[46] Reiss, R., et al., "Integrated Corridor Management Phase 1 Concept, Development and Foundational Research: Task 3.1 "Develop Alternative Definitions, *"United States Department of Transportation ITS Joint Program Office,* April 11, 2006, http://ntl.bts.gov/lib/jpodocs/repts_te/14273_files/14273.pdf.

Dallas and San Diego were selected as Pioneer Demonstration Sites where integrated corridor management deployment began in spring 2013.[47] These efforts are too new to provide observed data on program impacts, but study modeling suggests a number of benefits (Table 3). Separate efforts in San Francisco on the "I-80 Integrated Corridor Mobility Project" and Virginia "I-95/I-395 Integrated Corridor Management Initiative" are also underway to apply ICM concepts to improve corridor performance.

Table 3: Expected Annual ICM Benefits of Pioneer Sites on Corridor Performance

	San Diego	Dallas	Minneapolis
Person Hours Saved	246,000	740,000	132,000
Reduction in Travel Time Variance	10.6%	3%	4.4%
Gallons of Fuel Saved	323,000	981,000	17,600
Tons of Mobile Emissions Saved	3,100	9,400	175

Source: Integrated Corridor Management Modeling Results Report: Dallas, Minneapolis, and San Diego, FHWA, February 2012

Interviews with system operators in the CMAP region revealed that they were concerned about the interaction between the interstate and arterial systems, and felt that the need for a more holistic approach to system management is clear. They highlighted the impact that deteriorating traffic conditions on one system have on other systems. Some operators were concerned about whether the arterial system could accommodate traffic "routed off" the expressway during an incident, especially in a congested corridor. However, traffic diversion to arterials already happens, and unexpected changes in traffic patterns in a corridor that includes interstates, arterials, and transit can be better accommodated if policies and systems are put in place to respond to it. Some comments suggested that the main obstacle to integrated management is agency policy and not technology.

Integrated corridor management is a flexible tool to smooth traffic in corridors, with policies and procedures agreed upon by the stakeholders in the corridor, including emergency responders. Agencies would establish locations and conditions under which integrated management would take place, agreed upon procedures for responding to potential conditions, policies to help decide which procedures should be applied, and authority for staff to implement the procedures. Establishing these agreements happens during the development of the corridor plan. Integration can be as limited as establishing responsive signal policies around certain interstate ramps, automated display of other jurisdiction system conditions on dynamic message signs, or a full application including arterials, interstates, and transit services in a corridor. In interviews with operators and in committee discussions, there was agreement that many locations in the region offered the potential for improved operations provided by integrated management. There are some existing examples of limited integration in the region where arterial traffic signals are managed to improve ramp and mainline expressway safety,

[47] "Integrated Corridor Management (ICM) Demonstration Sites," *U.S. Department of Transportation*, http://www.its.dot.gov/factsheets/pdf/icm_demosites_v7.pdf.

and where different system operators post messages about conditions on other corridor roadways.[48]

Identification of Potential ICM Combinations

A few candidates for integrated corridors readily come to mind. For example, the Kennedy Expressway currently operates two reversible lanes between the Edens Expressway and Ohio Street. In the past, traffic flow was more directional and providing extra capacity in the prevailing direction reduced congestion in that direction. As time passed and total traffic grew, traffic became heavy in both directions during the morning and evening peak, reducing the benefit of the reversible lanes. "The decision is absolutely getting harder to make," said an IDOT engineer. "There simply is not much benefit to be gained by making the switch when there is equity in the volume of inbound and outbound traffic."[49]

The CTA Blue Line train operates in this corridor with 798 parking spaces at the Rosemont station and 1,633 spaces at the Cumberland stop. Metra's Union Pacific Northwest line parallels the roadway and from Cumberland to Clybourn has 1,884 parking spaces. The Pace bus Pulse Milwaukee Line will travel on Milwaukee Avenue between Golf Road and Jefferson Park transportation station. Jefferson Park Transit Center links the Blue Line O'Hare branch, the Metra UP Northwest line and multiple bus routes. Elston Avenue and Milwaukee Avenue both parallel the Kennedy Expressway. Integrated corridor management in this location could include conversion of the reversible lanes to bi-directional express toll lanes and active traffic management on the general purpose lanes. Arterial traffic signal timing plans could support detouring traffic during interstate incidents. The system could also include real-time information about travel times and costs on the express toll lanes, general-purpose lanes, public transportation and arterials to downtown, as well as real-time parking availability information and parking reservation capabilities. En-route information could be provided allowing people to change route or mode.

CMAP should undertake a planning study to identify other locations where integrated corridor management can improve corridor operations, and should also fund planning activities that work towards implementing active expressway management, active arterial management, and integrated corridor management. Traffic signal policies around interstate interchanges can also be reviewed to identify places where changes can improve performance. The evaluation of

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[48] The Army Trail Road Queue Backup Protection system: at I-355 and Army Trail road in DuPage County traffic signal coordination and integration has been implemented. A traffic monitoring system detects significant changes in volumes of traffic on Army Trail Road and locations west of this interchange. Tollway ramp devices initiate an alarm at the DuPage County Division of Transportation (DDOT) office and activate a pre-installed timing programs designed to clear ramps of queued traffic so it doesn't back up onto the expressway. There also a number of locations in the region where arterially located dynamic message signs provide traffic information for nearby interstates, for example IL 83 at IL 64, IL 83 at I-290, US 6 at Dixie Highway, and several others. There are agreements between the Illinois interstate operators and operators of neighboring states to display requested information on DMS signs, but these are not automated and are subject to the authority of the TMC operator.

[49] Hilkevitch, Jon, "Getting Around: As Kennedy Traffic Swells, Reversible Lanes Lose Their Magic," *Chicago Tribune,* November 11, 2013, http://trib.in/2iBoJIu.

potential locations for integrated corridor management can be undertaken using performance data. A key indicator of whether roadways and transit services operate as a system is what happens to traffic on one roadway or transit service in the corridor when there is a disruption of traffic on another. Performance data showing roadway travel times on an average day compared to travel times during an incident should provide a picture of performance linkages between roadways. Transit ridership on an average day and on the disrupted day can also be analyzed.

Establish Regional Objectives for Highway Operations

GO TO 2040 established goals for transportation system performance, including congestion reduction, transit system usage, system condition, and others. The plan supported performance-based programming as a way to ensure that transportation funds are spent effectively to meet desired performance goals. These goals will be refined during ON TO 2050 and at that time operations objectives should be considered to help meet the goals. The operations objectives for ON TO 2050 goals can guide the selection of operations strategies. Operations objectives should be specific, quantifiable, and realistic, have a reasonable timeframe and be consensus based. When the selected operations strategies are implemented, it is important to track system performance (monitoring and evaluation) to identify necessary changes or new strategies.

Based on the strategies discussed in this paper, the process to develop ON TO 2050 should consider a number of operations-oriented objectives and CMAP should commit to tracking performance in those areas. These may include:

1. Reducing clearance time for traffic incidents on expressways by x percent;
2. Reducing delay associated with traffic signals by x percent; and
3. Reducing delay associated with work zones by x percent.

Operations objectives are measureable and address results, not inputs. Strategies to address these might be to add automatic incident detection and communication with emergency responders to our traffic management centers, replace outdated traffic signals with modern signals that generate high resolution data used to monitor and retime signals, and implement electronic construction management systems to reduce project delivery delays caused by slow paper communications processes.

Prioritize Investments in Highway Operations

Regional performance goals have not been set yet in the process to develop ON TO 2050. However, over the last five years CMAP has been developing databases of performance information intended to help prioritize investments by helping us understand which locations seem most in need of investment based on performance. Observed performance both shows where operational improvements could enhance system performance and establishes a baseline for system performance evaluation when improvements are made.

As an example of how the region might use performance-based selection, existing performance data was applied to the National Highway System (NHS) expressways and arterials. The NHS system "consists of roadways important to the nation's economy, defense and mobility" and includes interstates, other principal arterials, strategic highway network roads, major strategic highway network connectors, and intermodal connectors. [50]

A number of performance datasets were used to score and prioritize the system:

- **Importance to regional travel** was measured using the annual average daily traffic included in the 2014 Illinois Roadway Information System (IRIS) from the Illinois Department of Transportation (IDOT). This was used for expressways and arterials.
- **Importance to freight movement** was measured using heavy commercial vehicle volumes included in the 2014 Illinois Roadway Information System (IRIS) file from IDOT. This was used for expressways and arterials. The data included for arterials may be of poor quality but better data is not available at this time.
- **Congestion** was measured using the travel time index calculated using 2012 highway probe data. The travel time index is the ratio of average peak hour travel time to free flow travel time. A higher number shows that there is more traffic on average in the peak than during free flow times, while a number closer to one shows that there isn't much more traffic in the peak than during free flow times. This was used for expressways and arterials.
- **Reliability** was measured using the planning time index calculated using 2012 highway probe data. The planning time index is the ratio of the 95th percentile time (travel time on a particularly bad day) to free flow time. An index close to one indicates that on a bad day, the travel time is not much worse than free flow travel time, and high numbers show that a bad day is much worse than free flow travel time. These indices are larger than the travel time index.
- **Safety** was measured using the rate of fatal and serious injury crashes per vehicle mile traveled over a five-year period. The crash data was provided by IDOT's safety data mart, and the vehicle miles traveled was calculated using the 2012 IDOT IRIS file. This was used for expressways and arterials.
- **Availability of existing ITS infrastructure** was measured by the percent of the segment included in a traffic signal interconnect. This indicates that there is communication infrastructure available and came from the CMAP traffic signal interconnect inventory, updated in 2012. This was only used for arterials because expressways do not use traffic signals.

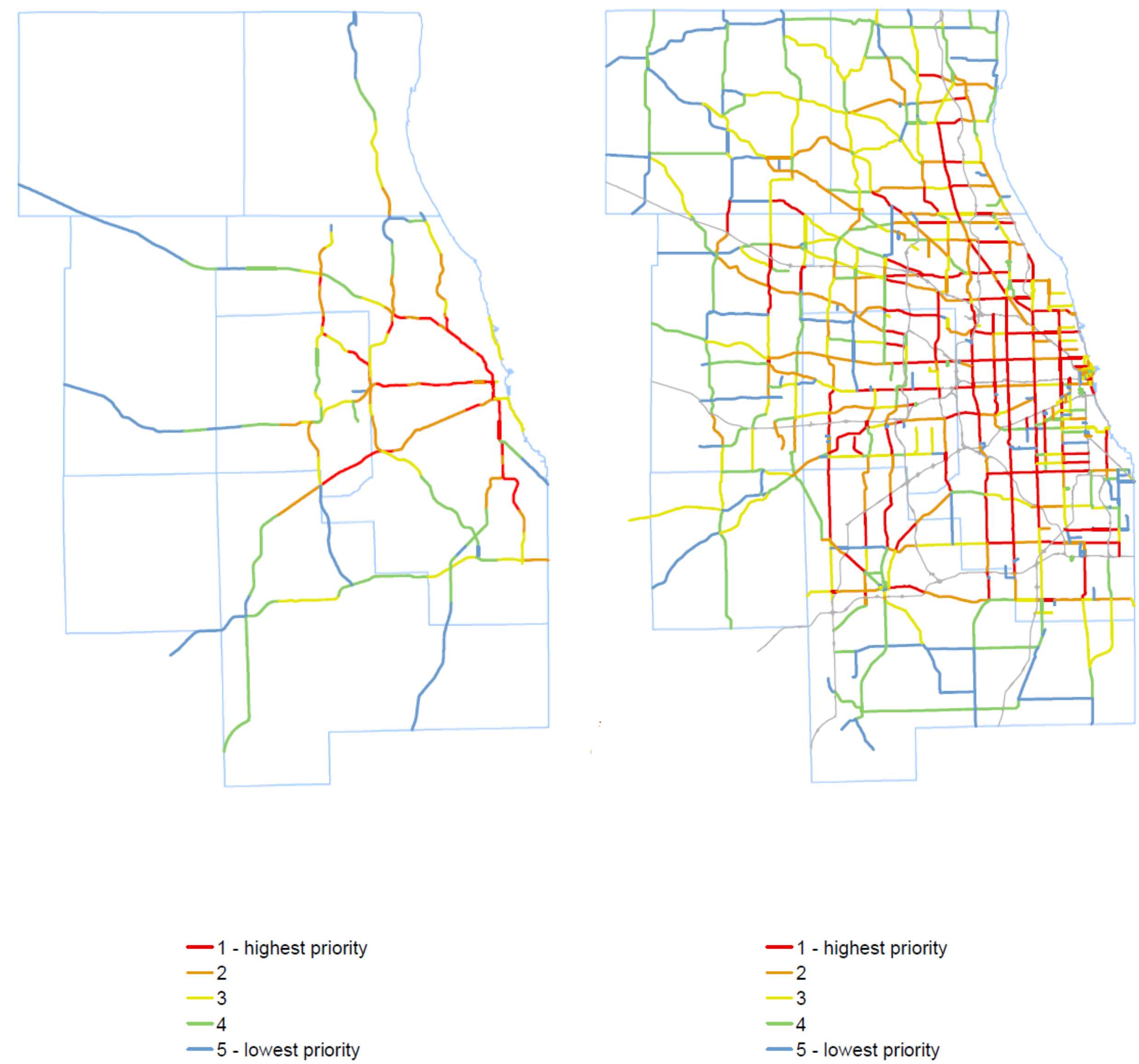
[50] "National Highway System," *Federal Highway Administration*, February 2016, http://www.fhwa.dot.gov/planning/national_highway_system.

- If an arterial **serves an expressway interchange,** it is the point of integration between the arterial system and the expressway system. This was determined through a visual inspection of the NHS system. This was only used for arterials.
- If the Regional Transportation Authority (RTA), the Chicago Transit Authority (CTA) and Pace suburban bus plan to include the road as part of the **transit signal priority** system, prioritization should reflect its increased importance. An analysis determined whether any part of road segment was a TSP route using a shapefile from the RTA. This was only used for arterials.

Because averaging would tend to wash out locations of most need, and the application of operations improvements should focus on improving performance at the worst locations, segment scoring was based on the worst measured conditions. A segment traffic volume score was assigned by the highest traffic location. The freight volume score was assigned by the highest segment freight volume. The safety score was also assigned based on the worst location. The travel time index and planning time index are directional and differ by time of day. The worst segment direction during the worst time of day was used to assign those scores. In all of these cases, the segments were sorted from worst to best and divided into five quantiles. The combination of these scores resulted in a prioritization of the network from first priority, which should be evaluated for operational improvements first, to the last priority, which would be evaluated farther in the future. (Figure 10).

On the arterials, a segment received a score of five if it served an interstate interchange, and zero if it did not. It received a five if it included any transit signal priority locations and zero if it did not. The signal interconnect score was assigned based on the percent of segment served by a signal interconnect. No signal interconnect received zero points. One percent to 20 percent received one point, 20 percent to 40 percent received two points, 40 percent to 60 percent received three points, 60 percent to 80 percent received four points and 80 percent to 100 percent received 5 points. All of the scores were added for total “need points.” The need points were again ranked highest to lowest. These were used to generate priority recommendations of one to five. Expressways and arterials were scored and prioritized separately. Based on this work, it is clear we can use existing data to support performance based planning for operations improvements. In addition, it will be necessary to consider arterials separately from the expressways system since the operations metrics available for each system differ considerably.

Figure 10: Expressway and Arterial Priority Segments



Source: Chicago Metropolitan Agency for Planning

Next Steps

While most of the activities necessary to improve highway operations can only be initiated by our partners who operate the systems, there are a number of activities CMAP, with help from regional partners, can pursue to promote improved roadway operations.

Arterial Management

- Research and report back on the state of the region's traffic signals. CMAP is currently developing a signal database that should be populated by the end of 2017.
- Launch an effort to develop a regional fiber optic communication location database. This is a longer-term effort that can begin after the completion of ON TO 2050.

Integrated Corridor Management

- Review traffic signal policies around interstate interchanges.
- Identify opportunities for integrated corridor management using observed highway operations data. This important near-term effort would help develop priorities for ON TO 2050.

Incident Management

- As part of the region's safety goal development process, as required under federal law, initiate discussions about regional incident response objectives and how to achieve them. This is a shorter-term activity.
- Sponsor educational activities focused on quick clearance principles and laws.
- Advocate for inclusion of communication between emergency call centers and traffic management centers as a standard 911-system feature. This is a shorter-term activity.

Travel Weather Management

- Develop a flooded pavement reporting system to track the impacts of heavy rain events. This is a longer-term activity that may begin after ON TO 2050.

Special Event Management

- Advance a plan to coordinate outreach to municipalities and private venues for reporting special events. This is a longer-term effort that can take place with the completion of ON TO 2050.

Work Zone Management

- Undertake a study to evaluate the region's utility relocation performance and quantify the associated cost and travel impacts. This is a longer-term effort that can take place with the completion of ON TO 2050.

MPO Processes

- Complete a congestion reduction study to quantify the benefits of operational strategies. CMAP will undertake this in 2017.

- Develop operations objectives to support ON TO 2050 Plan goals.
- Work with implementers to identify funding opportunities for projects in the region's ITS Architecture.[51] This should be a regular activity discussed with RTOC, other committees, and individual stakeholders.
- Support highway system operations by funding operations oriented projects through the Unified Planning Work Program (UWP) and Congestion Mitigation and Air Quality (CMAQ) programs.

[51] Northeastern Illinois ITS Architecture v3.0, http://data.cmap.illinois.gov/its_arch_v30/index.htm, approved January 2015.

233 South Wacker Drive, Suite 800
Chicago, Illinois 60606
312-454-0400
ONTO2050@cmap.illinois.gov

www.cmap.illinois.gov

The Chicago Metropolitan Agency for Planning (CMAP) is our region's comprehensive planning organization. The agency and its partners are developing ON TO 2050, a new comprehensive regional plan to help the seven counties and 284 communities of northeastern Illinois implement strategies that address transportation, housing, economic development, open space, the environment, and other quality-of-life issues. See www.cmap.illinois.gov for more information.

ON TO 2050 strategy papers will explore potential new topics or refinements to existing GO TO 2040 recommendations. These documents and data-driven snapshot reports will define further research needs as the plan is being developed prior to adoption in October 2018.

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