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INTEGRATED CORRIDOR MANAGEMENT AND FREIGHT OPPORTUNITIES

NOTICE

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16. Abstract

The vision of integrated corridor management (ICM) is that transportation networks will realize significant improvements in the efficient movement of people and goods through integrated, proactive management of existing infrastructure along major corridors. Through an ICM approach, transportation professionals manage the corridor as a multimodal system and make operational decisions for the benefit of the corridor as a whole. This primer examines how freight can be incorporated into an ICM approach, as well as the benefits of ICM in addressing the freight challenge. It explores opportunities to effectively integrate freight institutionally, operationally, and technically, both by leveraging existing platforms and considering new options for coordination between traditional ICM and freight stakeholders. Lastly, although integrating freight stakeholders and ICM holds great promise for more efficient operations on both ends, it is not without challenges. This document will explore what these challenges are and how they can be overcome.

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ACRONYMS

ATRI	American Transportation Research Institute
C-TIP	Cross-Town Improvement Project
DFW	Dallas-Fort Worth
DMA	Dynamic Mobility Application
DOT	department of transportation
DRG	dynamic route guidance
DSS	decision support system
FHWA	Federal Highway Administration
FPM	Freight Performance Measures
FRATIS	Freight Advanced Traveler Information System
GHG	greenhouse gas
GPS	global positioning system
HOS	hours-of-service
ICM	integrated corridor management
IMEX	intermodal move exchange
ITS	intelligent transportation systems
LTL	less-than-truckload
MPO	metropolitan planning organization
OSAP	Open Source Architecture Package
ROI	return on investment
RTTM	real-time traffic monitoring
SRI	Smart Roadside Initiative
STA	State trucking association
TL	truckload
USDOT	U.S. Department of Transportation
WDU	wireless drayage updating

INTRODUCTION

In today's urban transportation corridors, each transportation agency within the corridor typically handles operations independently. While the operators may collaborate or interact to some extent to deal with incidents or pre-planned events, each agency conducts most day-to-day operations individually. As congestion and the number of incidents have increased, this method of operations has become less effective in meeting the transportation needs of the businesses and people that rely upon the corridor.

The vision of integrated corridor management (ICM) is that transportation networks will realize significant improvements in the efficient movement of people and goods through the integrated, proactive management of existing infrastructure along major corridors. Through an ICM approach, transportation professionals manage the corridor as a multimodal system and make operational decisions for the benefit of the corridor as a whole.

Most ICM strategies to date have focused on improving passenger travel, and ICM stakeholders have included public transportation agencies, such as State and local departments of transportation (DOT), metropolitan planning organizations (MPO), and transit agencies. Yet our Nation's busiest freight corridors run through urban areas that carry millions of commuters, leisure travelers, and goods on increasingly crowded roadways and transit systems. Freight also plays a critical role in our Nation's economy. Adding definition to the relationship between ICM and freight will improve the integration of freight stakeholders, issues, and solutions into the ICM process.

This primer will examine how freight can be integrated into an ICM approach, as well as the benefits of ICM in addressing the freight challenge. It will explore opportunities to effectively integrate freight considerations into corridor management institutionally, operationally, and technically, both by leveraging existing platforms and considering new options for coordination between traditional ICM and freight stakeholders. Lastly, although integrating freight stakeholders and ICM holds great promise for more efficient operations on both ends, it is not without challenges. This document will explore these challenges and determine how they can be overcome.

Who should read this primer?

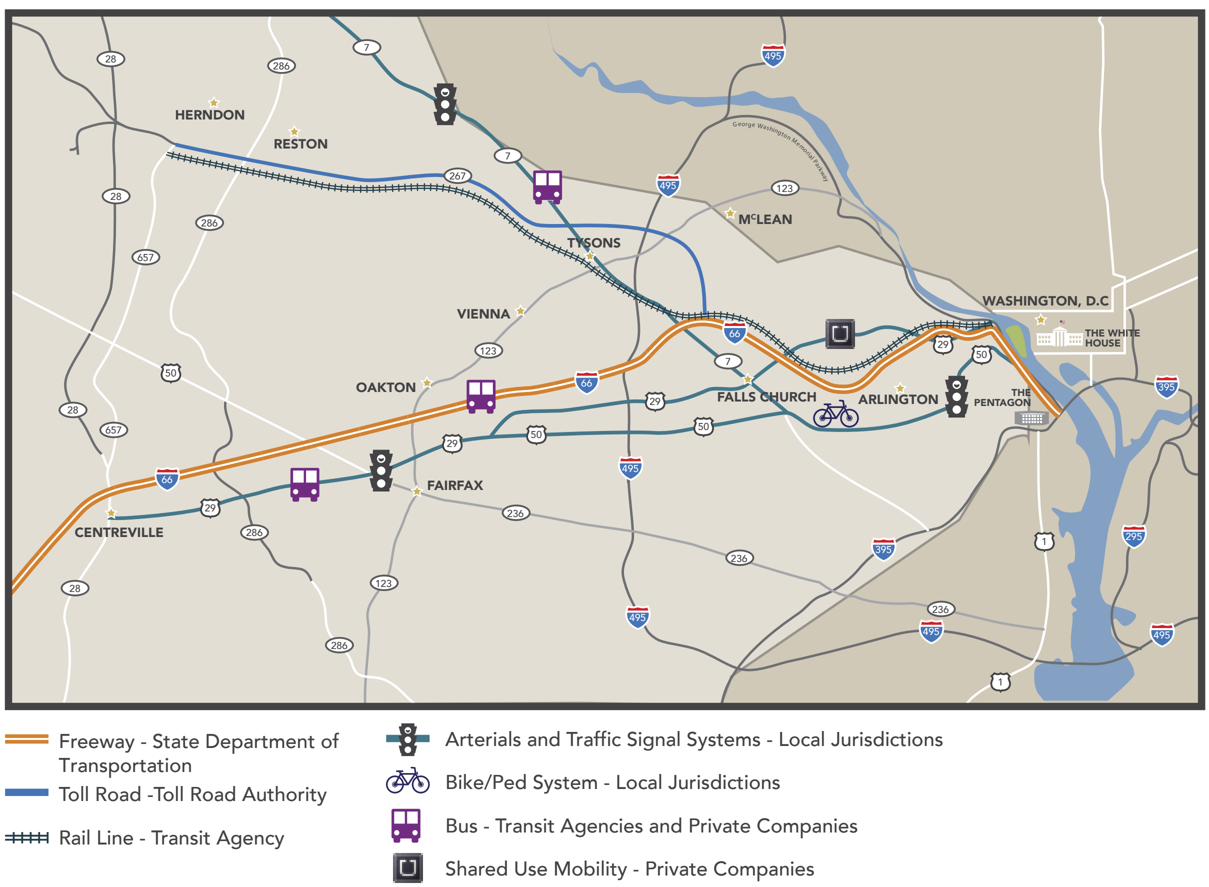
The intended audience for this primer includes stakeholders from State and local department of transportations, metropolitan planning organizations, transit agencies, and other agencies that may be involved in an integrated corridor management effort. Additionally, this primer is intended to inform freight stakeholders in major urban centers and along freight corridors of the benefits they can expect to achieve from greater integration with integrated corridor management (ICM). This includes freight interests in trucking, rail, maritime and air cargo, as well as freight distribution facilities and businesses that rely heavily on freight transportation.

THE FUNDAMENTALS OF INTEGRATED CORRIDOR MANAGEMENT

The ICM approach is based on several fundamental concepts: a corridor-level focus on operations; agency integration institutionally, operationally, and technical; and active management of corridor assets and facilities. In addition, ICM requires multi-agency, multi-modal collaboration among a diverse group of stakeholders. Each of these concepts is described in more detail in the following sections.

Corridor-Level Focus

One of the fundamental elements of ICM is that it is focused at the corridor level. From the perspective of the U.S. Department of Transportation's (USDOT) ICM Initiative, a corridor is a travel shed defined by existing and forecasted travel patterns of people and goods. A corridor serves a particular travel market or markets that are affected by similar transportation needs and mobility issues. It includes a combination of various "networks," which denote a specific combination of facility type and mode. These networks provide similar or complementary transportation functions and may include freeways, limited access facilities, surface arterials, public transit, and bicycle and pedestrian facilities, among others. Additionally, a corridor includes cross-network connections that permit travelers to easily transfer between networks.



Source: Federal Highway Administration

Figure 1. Map. Example of different agencies and transportation networks on a corridor.

Integration

Integration serves a bridging function between the various networks that make up a corridor; it involves processes and activities that facilitate more seamless operations. In order to implement ICM, the transportation networks within a corridor, and their respective intelligent transportation systems (ITS) and management systems, need to be integrated institutionally, operationally, and technically.

These three dimensions of integration are closely related and interdependent. For example, technical integration can facilitate more effective operational integration, and the integration of ongoing operations and maintenance is important to the long-term technical success of an ICM project. Successful technical and operational integration are typically based on a foundation of strong institutional integration, including associated managerial support and funding.

INSTITUTIONAL INTEGRATION	Involves coordination and collaboration between various agencies and jurisdictions (network owners) in support of ICM. Includes distributing specific operational responsibilities and sharing control functions in a manner that transcends institutional boundaries.
OPERATIONAL INTEGRATION	Involves implementing multi-agency transportation management strategies, often in real-time, that promote information sharing and cross-network coordination and operations among the various transportation networks in the corridor. Facilitates managing capacity and demand on the corridor.
TECHNICAL INTEGRATION	Provides the means (e.g., communication links between agencies, system interfaces, and the associated standards) by which information and system operations and control functions can be effectively shared and distributed among networks and their respective transportation management systems. It is also the means by which the impacts of operational decisions can be immediately viewed and evaluated by the affected agencies.

Management

ICM requires active management of the individual facilities within a corridor in order to optimize corridor performance. Management implies more than monitoring; it means taking action(s) to improve the performance of the system. Such management may take the form of dynamic traffic controls, priorities for transit vehicles, improved response to incidents, and more comprehensive and actionable traveler information. Agencies may need to enhance these types of capabilities on their networks in order to realize the full benefits of ICM.

Source: U.S. Department of Transportation

Figure 2. Illustration. The active management process.

Diverse Stakeholder Group

Another important element of ICM is that it requires collaboration among a broad group of corridor stakeholders. Stakeholders are entities that interact with a system (i.e., those that make and are affected by operational decisions that impact the performance of the system).

When considering stakeholders to include in an ICM project, implementers should cast a wide net and ask themselves who is missing from the group of stakeholders they typically engage with for operations projects. For example, for an ICM system, major stakeholders could include:

- **Travelers and Transportation Network Users** – Individuals who use the transportation networks within a corridor to go from one location (origin) to another (destination), whether for personal use or business transportation, such as freight deliveries. Their trips within the corridor may involve traversing the entire corridor or going to one or more locations within the corridor.

- **Commercial and Government Entities** – Individuals and organizations that are employers, service providers, or vendors of goods within the corridor. While these stakeholders may not travel within the corridor, they are interested in the ability of their employees and customers to do so. They will have major concerns if employees and customers are delayed or prevented from traveling.

- **Transportation Network Operators** – Individuals who are responsible for managing the specific modal networks within the corridor, such as State and local DOTs, transit agencies, MPOs, toll road authorities, etc. This group may include the individuals or organizations entrusted with overall management of the ICM system.

- **Public Safety Personnel –** Includes police, fire, safety patrol, and emergency services operators and staff that use the corridor to provide safety-related services.

The ICM concept can take many forms. Implementers at each site that adopts ICM will likely have slightly different priorities and stakeholders they want to incorporate into their approach based on corridor travel patterns and needs.

THE INTEGRATED CORRIDOR MANAGEMENT RESEARCH INITIATIVE

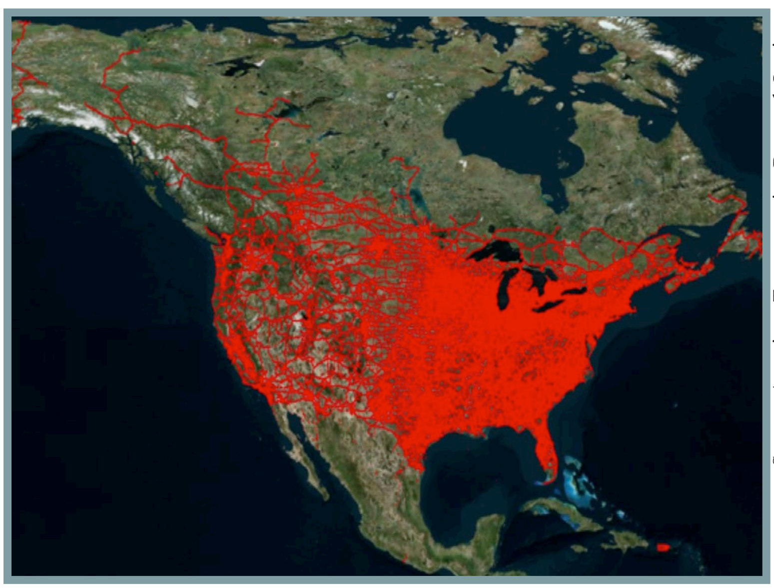
The USDOT started the ICM Research Initiative in 2006 to explore and develop ICM concepts and approaches and to advance the deployment of ICM systems throughout the country. Initially, eight pioneer sites were selected to develop concepts of operations and system requirements for ICM on a congested corridor in their region. Three of these sites went on to conduct analysis, modeling, and simulation of potential ICM response strategies on their corridor. In the final stage, two sites —the US-75 Corridor in Dallas, Texas, and the Interstate 15 (I-15) corridor in San Diego, California—were selected to design, deploy, and demonstrate their ICM systems.

The Dallas and San Diego demonstrations “went live” in the spring of 2013. Each demonstration has two phases: design and deployment, and operations and maintenance. Both sites chose to develop a decision support system (DSS) as a technical tool to facilitate the application of institutional agreements and operational approaches that corridor stakeholders agreed to over a rigorous planning and design process.

Although the DSS approach at each site differs slightly, the basic process is similar. The DSS gathers traffic data from an array of ITS in the network and uses this information to forecast future conditions on the corridor. If an event (recurring or non-recurring) occurs that is predicted to meet pre-established congestion thresholds, the DSS generates response plans. These plans contain combinations of multimodal strategies to address specific congestion scenarios. Response plans are based on detailed business rules that establish the conditions under which assets can be used, which may vary based on the magnitude of the event, time of day, congestion levels on the network, etc., as well as by policy constraints. The DSS recommends and ranks response plans by running a simulation to determine which plan will most effectively address the congestion. Operating agencies are alerted to either accept or reject the plans; if accepted, the plan will be implemented.

What could an integrated corridor management (ICM) response plan look like?

A major incident has occurred on the freeway in an ICM corridor. Travelers are advised via dynamic message sign and other traveler information sources (e.g., 511) to take a parallel route or shift to transit, where there is spare capacity. Signal timing on the parallel route is changed to better manage the flow of the detoured traffic, and transit operators prepare for the increased volumes by adding more buses along the impacted route.



Source: American Transportation Research Institute

Figure 3. Map. American Transportation Research Institute truck global positioning system data.

The USDOT is conducting independent “before-after” analyses to evaluate the benefits of ICM on transportation operator situational awareness, response and control, traveler information, and overall corridor performance at each site. The experiences and lessons learned from the demonstration sites are being actively shared with the transportation community so that regions interested in ICM can leverage the knowledge gained to better shape a successful deployment for their corridor(s).

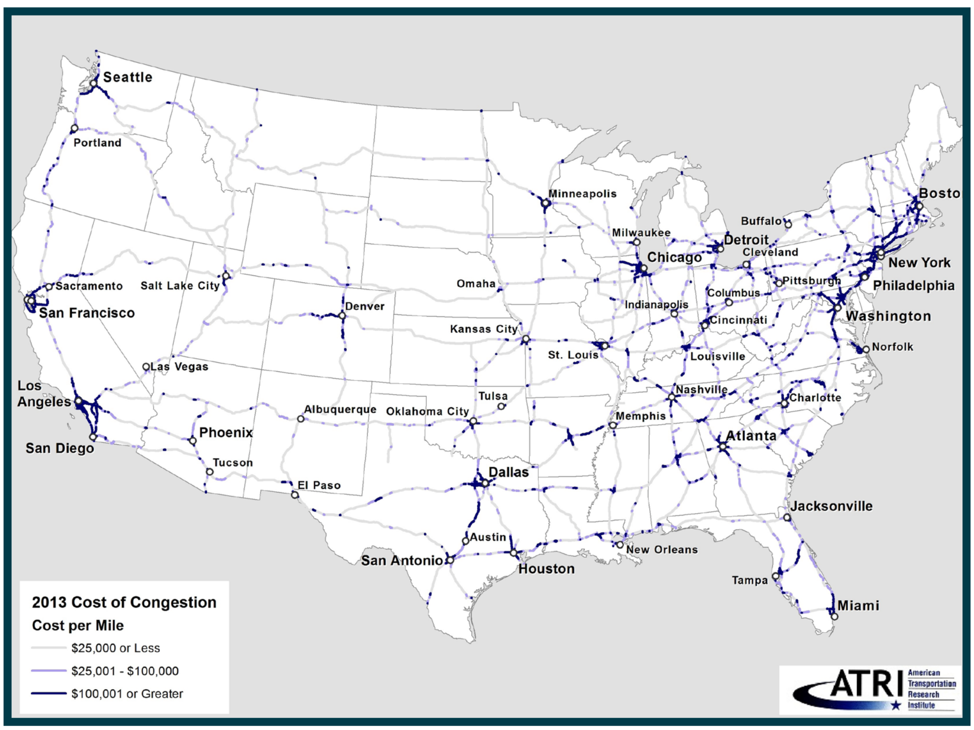
Although the demonstration sites provide valuable insights into the necessary components of building an ICM system, they do not represent the only way to implement ICM. There is no “one-size-fits-all” approach to ICM, since the circumstances of a particular corridor will vary based on traffic patterns, agency dynamics, available assets, and a host of other factors.

THE FREIGHT CHALLENGE

Freight is big business in the United States, moving tons of general and bulk commodities by truck, rail, air, water and pipeline. In 2013, a total of 14.01 billion tons of goods were transported in the United States by one of the modes.[1] The majority of freight moves by truck, making the trucking industry a key component of the U.S. economy. With $687.1 billion in gross revenues in 2013, trucking represented 81.2 percent of the U.S. freight bill in 2013[2] and just over 4 percent of the Nation's gross domestic product. In terms of tonnage, trucks transported 9.7 billion tons of freight in 2013, representing 69.1 percent of total domestic tonnage.[3]

To offer perspective on the size and scope of the trucking industry, Figure 4 (below) shows truck position reads (pings) from trucks tracked by the American Transportation Research Institute (ATRI) as part of its Freight Performance Measures[4] program. The image shows only one day of data from June 2013.

The forecast for the future indicates that trucking's share of freight movement will increase. According to the American Trucking Associations, total tonnage moved will increase to 17.3 billion tons in 2025, with 71.4 percent of that tonnage moved by truck.[5]



Source: American Transportation Research Institute

Figure 4. Map. Cost of congestion on a per-mile basis.

1 American Trucking Associations. (2014) U.S. Freight Transportation Forecast to 2025. Arlington, VA.

2 American Trucking Associations. (2014) American Trucking Trends 2014. Arlington, VA.

3 Ibid.

4 For more on the Freight Performance Measures Program, visit www.atri-online.org.

5 American Trucking Associations. (2014) U.S. Freight Transportation Forecast to 2025. Arlington, VA.

There are more than 1.3 million interstate motor carriers in the United States, of which 34.6 percent are for-hire motor carriers.[6] For-hire carriers provide freight transportation services to the general public. An additional 53.2 percent of motor carriers are private fleets,[7] carriers whose primary business is not hauling freight but transporting goods in support of their primary business, such as retail (Wal-Mart) or food and beverage (Frito-Lay).

Among for-hire carriers, there are three key sectors; truckload (TL), less-than-truckload (LTL) and specialized. TL fleets typically haul a dedicated load of freight for one customer (shipper) to a specific destination (receiver or consignee). LTL carriers pick up smaller shipments and return to a terminal where the packages are unloaded, sorted, and consolidated with other shipments going to similar locations. Specialized carriers operate equipment designed for hauling specific commodities such as flatbed trailers, tank trucks, and specially permitted oversize and overweight loads.

One commonality among all motor carriers – for-hire, private, TL, LTL or specialized – is their operating environment. Trucks use the roadways as their workplace, and in 2012 trucks logged 421.3 billion miles on those roadways.[8] This operating environment continues to become more challenging each year as congestion, both recurring and non-recurring, clogs the system.

On average, it costs $67.00 per hour to operate a truck, and 64 percent of that cost is attributed to fuel costs and driver wages.[9] Both cost centers are negatively impacted by congestion. Fuel is burned (and emissions generated) when trucks sit stuck in traffic. Driver time is expended on non-revenue generating activities and available driver hours-of-service are wasted. In 2013, weekday congestion on the Interstate system alone was estimated to cost the trucking industry $9.2 billion.[10] Total delay was 141 million hours, equating to over 51,000 truck drivers sitting idle for an entire working year.[11] Nearly 90 percent of the industry's congestion costs were concentrated on just 12 percent of the Interstate mileage in 2013 (Figure 4.).[12]

Congestion impacts on the trucking industry are costly, and with projections for increased freight demand and truck transportation, the problem will only worsen unless new solutions and approaches for dealing with congestion are identified. In an annual survey of trucking industry stakeholders, congestion has ranked as a top 10 trucking industry concern for the past 10 years.[13]

6 American Trucking Associations. (2014) American Trucking Trends 2014. Arlington, VA.

7 Ibid.

8 Ibid.

9 Torrey, W.F. (2014) An Analysis of the Operational Costs of Trucking: A 2014 Update. American Transportation Research Institute. Arlington, VA.

10 Pierce., D. & Murray, D. (2014) Cost of Congestion to the Trucking Industry. American Transportation Research Institute. Arlington, VA.

11 Ibid.

12 Ibid.

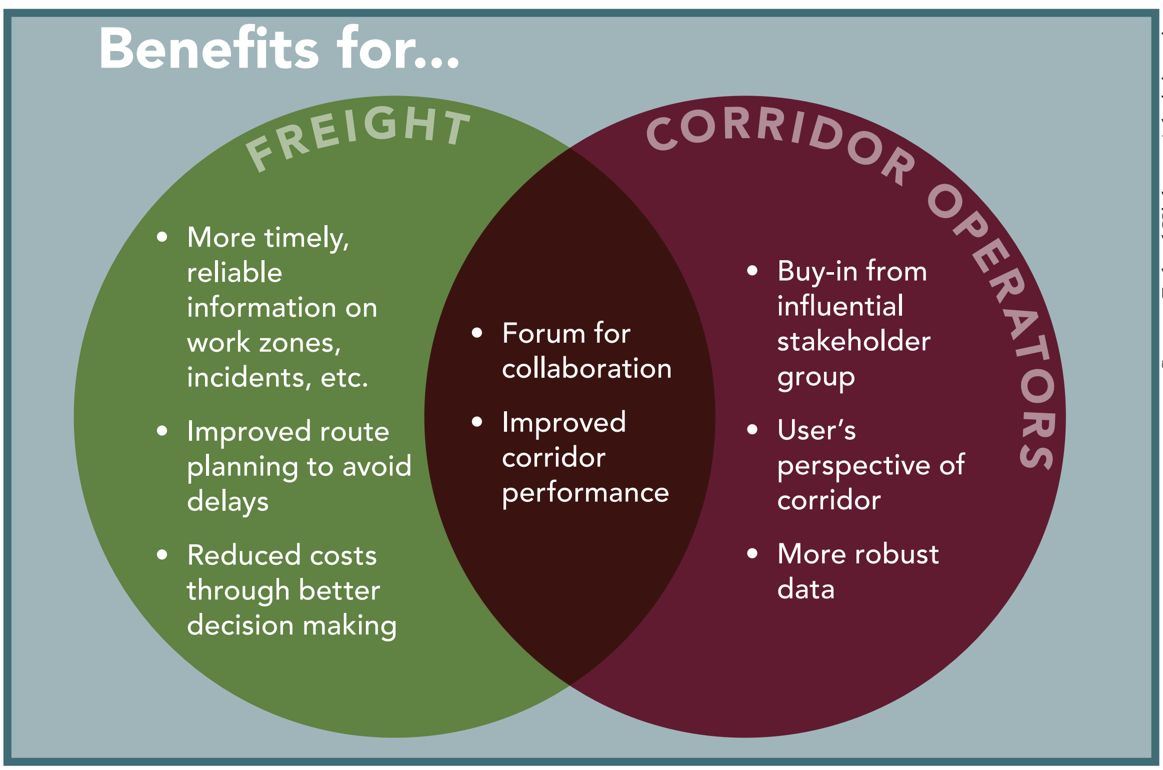
13 American Transportation Research Institute. (2014) Critical Issues in the Trucking Industry 2014. Arlington, VA.

BENEFITS OF INTEGRATION

Tons of freight move through the Nation's major urban areas, as evidenced by the 12 percent of miles where the bulk of the trucking industry's congestion costs are generated. Many of these urban areas' freight corridors are also candidate integrated corridor management (ICM) corridors. Therefore, freight providers constitute an important ICM end-user that should not be overlooked in the conceptualization and design of an ICM system.

Implementing ICM could result in many benefits for freight operators if they are effectively integrated into the ICM approach. The most significant benefit of ICM to freight stakeholders is improved situational awareness of conditions on the corridor. While unreliable road conditions affect us all, few are more affected than freight transportation providers, and specifically motor carriers. The costs that they experience from congestion are felt throughout the supply chain and eventually are paid by consumers in the form of higher prices on all the goods and products we rely on daily.

In addition, motor carriers today have little insight into specific planned work zones or congestion management strategies being deployed by the various operating agencies along a specific corridor. Where they do have access to the information, these operations are generally not planned, executed, or communicated in an integrated fashion. Often, motor carriers and their drivers rely on information passed along through the media or from drivers to their dispatchers and operations personnel.



Source: Federal Highway Administration

Figure 5. Illustration. Benefits of integrating freight and integrated corridor management.

In an ICM corridor, freight stakeholders can receive regular, validated information updates from managing agencies across the length of the corridor. This could include not only travel times but also information on incidents, work zones, road closures, and suggested alternate routes. Armed with this information, motor carriers and drivers can select alternate routes, notify shippers and receivers of pick-up and delivery times, and make informed choices about scheduling off-duty and rest periods to remain compliant with hours-of-service (HOS) rules. By becoming involved in the ICM planning process, freight stakeholders could also help shape additional information that they would like to receive through the ICM platform, such as information on truck parking availability and truck restrictions on proposed alternate routes.

Just as ICM partners seek to optimize the use of existing infrastructure assets and unused capacity along the Nation's urban corridors, freight stakeholders also focus on equipment optimization and identifying available capacity. Equipped with better information, freight providers could be more proactive in their selection of routes, timing of deliveries, or management of truck driver HOS and available equipment. Avoiding congested routes could also help providers cut down on operational costs through fuel, driver, and equipment savings.

The benefits of integrating ICM and freight apply not just to freight operators but to the stakeholders who are leading an ICM project in a region. Gaining buy-in from freight stakeholders can help project leaders make a case for ICM in a region. In addition, gathering the perspective of freight operators who regularly travel the corridor will provide a more robust picture of travel from the user's perspective, such as particular problem areas. Additionally, adding freight data into the ICM mix provides a more robust picture of traffic conditions within a corridor or region.

Another advantage that ICM offers to both operating agencies and stakeholders is that it provides freight stakeholders with a forum for collaboration. In some regions, public agencies may not be fully aware of some of the challenges that freight providers face. Bringing freight stakeholders to the table gives them an opportunity to explain these challenges and help to design a system that could better meet their needs. This dialogue could extend to discussions about potential operational strategies that could improve freight performance. The ICM analysis, modeling, and simulation methodology may provide a robust framework for applying freight domain supply chain software and modeling to identify potential benefits of freight operational strategies such as off-hour freight deliveries, which reduce the impact of truck traffic during peak congestion times. Through collaboration, both public sector and freight stakeholders could gain insight into strategies that they may not have otherwise considered.

OPPORTUNITIES FOR INTEGRATION

There are numerous opportunities for integrating freight into an integrated corridor management (ICM) process. ICM project teams can leverage existing platforms and initiatives to engage freight stakeholders and incorporate freight strategies into an ICM concept. However, as outlined in the table below, there are also significant challenges associated with connecting ICM and freight. The following sections will explore these institutional, operational, and technical challenges in more detail.

Table 1. Opportunities and challenges associated with integrated corridor management and freight.

OPPORTUNITIES	CHALLENGES
Urban freight corridors are bogged down by congestion due to twice-daily rush hour, special events, work zones, and incidents. ICM strategies that mitigate the effects of these benefit freight transportation providers along the corridor.	Securing agreements among institutional partners on data sharing and new ways of operating is perhaps the greatest challenge for both freight and ICM stakeholders.
ICM mobility and environmental benefits to corridors and corridor users are of interest to freight corridor stakeholders. Collaboration can help achieve these benefits.	Freight initiatives and ICM both seek to integrate available, and sometimes spotty, data for a more complete, real-time, shared picture of roadway conditions and available capacity.
ICM analysis, modeling, and simulation methodology provides a robust framework for applying freight domain supply chain software/ modeling to identify potential benefits of off-hour delivery strategies, a key freight strategy of increased interest in urban areas.	Both freight and ICM seek to deliver more comprehensive information on available capacity and road conditions to road users in an actionable and instantly usable fashion.
Enhanced traveler information strategies developed for freight transportation providers and commuters may offer synergies.	Currently, most ICM approaches in practice are oriented toward passenger travel. Additional research on freight routes, data opportunities and gaps, and stakeholders may be required.

ICM= integrated corridor management

INSTITUTIONAL INTEGRATION

Institutional integration involves coordination and collaboration between various agencies and stakeholder groups in support of ICM, including the distribution of specific operational responsibilities and the sharing of control functions in a manner that transcends institutional boundaries. Understanding who the freight stakeholders are is the first step in identifying the right individuals to engage in ICM. In addition to trucking stakeholders, potential ICM participants on the freight side include railroads, air cargo providers, port and cargo facilities, and manufacturing businesses that rely on just-in-time freight deliveries.

Trucking

Each state has a state trucking association (STA) whose mission is to represent the interest of its members (typically motor carriers and industry suppliers) in the state. Contacting the STA is a logical first step in identifying the motor carriers operating in a specific ICM corridor. Through the STA, ICM partners are able to connect with both for-hire and private fleet operators. The Appendix contains a list of STA websites.

In addition to motor carriers/fleet operators, commercial truck drivers also represent an important trucking stakeholder. In 2012 there were 3.2 million truck drivers.[14] Truck drivers can be company drivers (who work for a motor carrier/fleet operator) or owner-operators who may be independent contractors; i.e., individuals who operate under their own authority and contract their services out to trucking fleets, shippers, and receivers.

Who are freight stakeholders?

- **Trucking:**
  - » Motor carriers.
  - » Fleet owner/operators.
  - » Commercial truck drivers.
- **Cargo Facilities:**
  - » Railroads.
  - » Air cargo.
  - » Ports/maritime cargo facilities.
  - » Intermodal yards.
- **Customers:**
  - » Businesses that rely on on-time deliveries (end customers).
  - » Individual recipients (residential or single business delivery).

Cargo Facilities and Customers

There are other modes that haul freight (e.g., rail, air cargo, and water) and they all connect with trucks at intermodal yards, airports, and maritime and cargo facilities, making these interests potential stakeholders in ICM. In addition, manufacturing businesses that rely on just-in-time deliveries to keep production lines moving share similar transportation management objectives with ICM, as do retailers and other businesses that utilize just-in-time deliveries of goods to minimize inventory costs while continually meeting consumer demand.

14 American Trucking Associations. (2014) American Trucking Trends 2014. Arlington, VA.

Opportunities for Institutional Integration

Make a Compelling Case for Integrated Corridor Management

When freight stakeholders operate along an ICM corridor, their goals and objectives often intersect with ICM. In order to gain buy-in and support from freight stakeholders, ICM project leaders should be prepared to effectively articulate how ICM could help achieve freight-specific goals and objectives.

Table 2. Freight stakeholder goals and objectives.

FREIGHT STAKEHOLDER GOALS AND OBJECTIVES	WHY IT MATTERS
On-Time Pick-Ups and Deliveries	• Contracts for freight services often include very specific time windows for pick-ups and deliveries, and penalties for missing those windows can be costly. • Commercial drivers are regulated by Federal hours-of-service rules, which limit the hours each day that drivers can be on-duty and driving, and any delays in a driver's schedule can impact their availability to work later in the day and week.
Improved Travel Reliability	• Reliable travel times allow freight transportation providers to accurately manage loads and equipment, schedule pick-up and delivery times, and plan for mandated driver rest breaks.
Reduced Fuel Consumption	• Fuel represents the single highest individual cost center for most motor carriers – in 2013, fuel costs represented 38 percent of the total average cost per mile to operate a truck.[1] • Idling trucks can consume anywhere from ½ to 1 gallon per hour.[2] • Medium- and heavy-duty trucks account for 22 percent of transportation-related greenhouse gas (GHG) emissions, which equates to roughly 6 percent of total U.S. GHG emissions.[3]

1 Torrey, W.F. (2014) An Analysis of the Operational Costs of Trucking: A 2014 Update. American Transportation Research Institute. Arlington, VA.

2 American Transportation Research Institute. Sustainable Freight Practices for the Trucking Industry. Available online: http://atri-online.org/sustainable-driving-practices/#Idling

3 U.S. EPA. Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2012. (April 2014) Available online: http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

Table 2. Freight stakeholder goals and objectives. (cont'd.)

FREIGHT STAKEHOLDER GOALS AND OBJECTIVES	WHY IT MATTERS
Reduced Labor and Vehicle Maintenance Costs	• The trucking industry faces a significant driver shortage. American Transportation Research Institute estimates that the industry will need nearly 100,000 new drivers each year for the next 10 years to meet demand and replace those drivers who are leaving the industry due to retirement or other careers.[4] The driver shortage is pushing driver wages higher, making the non-revenue-generating labor hours that drivers spend stuck in traffic more costly. • The highest industry costs per mile for vehicle repair and maintenance are experienced by less-than-truckload carriers whose operations are often focused on pick-up and delivery in congested urban areas.[5]
Reduced Crash Involvement	• According to the Federal Motor Carrier Safety Administration (FMCSA), the estimated cost of all large truck and bus (10,000 lbs. and higher) crashes in 2011 was $87 billion.[6] • Research that compared crash involvement rates for medium-duty (10,001 - 26,000 lbs.) and heavy-duty (26,001 lbs. and greater) trucks found the highest crash rate index for medium-duty trucks in the central counties of metropolitan areas with populations over 1 million.[7]

4 American Trucking Associations. (2012) ATA Benchmarking Guide for Driver Recruitment and Retention. Arlington, VA.

5 Torrey, W.F. (2014) An Analysis of the Operational Costs of Trucking: A 2014 Update. American Transportation Research Institute. Arlington, VA.

6 Federal Motor Carrier Safety Administration. (2013) Commercial Motor Vehicle Facts – March 2013. Available online at: http://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/Commercial_Motor_Vechicle_Facts_March_2013.pdf

7 Pierce, D. & Park, L. (2013) Large Truck Safety Trends. American Transportation Research Institute. Arlington, VA.

Leverage Existing Forums for Collaboration

In addition to reaching out to the STA to identify motor carriers operating in the corridor, another avenue for engaging the freight community in ICM is through existing freight stakeholder groups that may have been organized by the State department of transportation (DOT) or metropolitan planning organization (MPO) (see callout box on next page). These groups typically have a strong network of contacts within the diverse freight community. In some cases, they may already be exploring potential improvement projects and have engaged the relevant contacts.

MAP-21 brought a renewed focus on the significance of freight, and as part of the highway authorization, the U.S. Department of Transportation (USDOT) is encouraging States to create freight advisory committees to include a representative cross section of public- and private-sector freight stakeholders.[15] The charge for these committees is typically to develop a comprehensive freight plan mapping out near- and long-term freight investments for the State, so it is a logical venue for engaging the freight community on ICM and its benefits to freight movement.

15 Federal Highway Administration. "MAP-21 – Moving Ahead for Progress in the 21st Century" web page. Fact Sheet – Significant Freight Provisions. Available online at: https://www.fhwa.dot.gov/map21/factsheets/freight.cfm

Delaware Valley Goods Movement Task Force

The Delaware Valley Goods Movement Task Force is an example of an existing institutional body that could be used to engage regional freight stakeholders in integrated corridor management. The Task Force is a freight advisory committee co-chaired by the Delaware Valley Regional Planning Commission and Pennsylvania Department of Transportation.

The objectives of the Task Force are to:

- Ensure the participation of the freight industry in the planning process.
- Identify improvements to facilitate the safe and efficient movement of freight.
- Implement regional congestion and intermodal management programs.
- Improve communications and data and technology sharing.

Membership is open to all members of the freight community, and the group meets on a quarterly basis.

Source: Delaware Valley Good Movement Task Force Website, Delaware Valley Regional Planning Commission, Accessed 26 Jan 2015. http://www.dvrpc.org/Freight/DVGMTF.htm

In addition, the GROW AMERICA Act, the surface transportation reauthorization legislation proposed early in 2015, would fund efforts in which States and multimodal stakeholders collaborate to improve freight mobility.[16] These initiatives will encourage the formation of freight planning groups where they do not already exist and may provide a platform for public sector ICM and freight partners to come together.

Challenges to Institutional Integration

While benefits accrue to both ICM and freight stakeholders from institutional integration, the process is not without its challenges. First, the private sector is generally reluctant to actively engage in public sector-led activities without a well-defined return on investment (ROI). It may be difficult to convince the private sector of their role in a public sector project or how they are impacted. Quantifying ROI may be hindered by the very different time horizons under which public and private sector entities operate. Public sector initiatives often evaluate project success on a continuum spanning 5-10 years, while a long-term outlook for private sector freight stakeholders to experience a positive ROI may be 6-18 months.

Freight stakeholders can also be challenging to engage in a public sector-driven initiative because their planning windows are often much shorter and more elastic than those of the public sector; because decisions are made often at corporate levels, which may not be in an area of impact; and because there are numerous stakeholders in the private sector (many shippers, carriers and customers). If engaged, it can be even harder to sustain their commitment throughout a project's lifecycle due to their focus on business operations. A particular struggle with the private sector is the amount of time individuals have available to participate in research-oriented efforts, where uncertainty is expected in terms of schedule and the level of benefits that can be achieved.

16 U.S. Department of Transportation, "Investing in our Freight System to Grow the American Economy," GROW AMERICA: Expanding our ability to move freight, http://www.dot.gov/grow-america/fact-sheets/freight.

Another challenge to including freight groups in an ICM project is securing institutional agreements on data sharing and operations – especially among private sector freight stakeholders whose data are highly sensitive and proprietary. Closely related, it may also be difficult to bring freight stakeholders together in some regions due to both competing priorities—these organizations are running businesses—as well as inter-organizational competition among themselves.

OPERATIONAL INTEGRATION

Operational integration involves implementing multi-agency transportation management strategies, often in real-time, that both promote information sharing and coordinated operations across the various transportation networks in the corridor as well as facilitate management of the total capacity and demand of the corridor. Designing an operational response requires taking multiple factors into account:[17]

- **Assets** – All of the potential networks, routes, systems, and capabilities along the corridor that could potentially be used as part of a response.
- **Availability** – The status of the assets and whether they are currently available for use as part of a response. Availability can be limited based on time of day and other factors; for example, it may be impermissible to re-route traffic along a certain arterial during school zone hours.
- **Scale of Response** – A response may be conservative, medium, or aggressive based on the predicted impact of an event, which is defined by an integrated performance metric (e.g., person-miles traveled). The assets that will be used may vary based on the scale of the response. For example, at the Dallas demonstration site, travelers are advised to take transit only if a major incident of a certain magnitude occurs on the freeway.

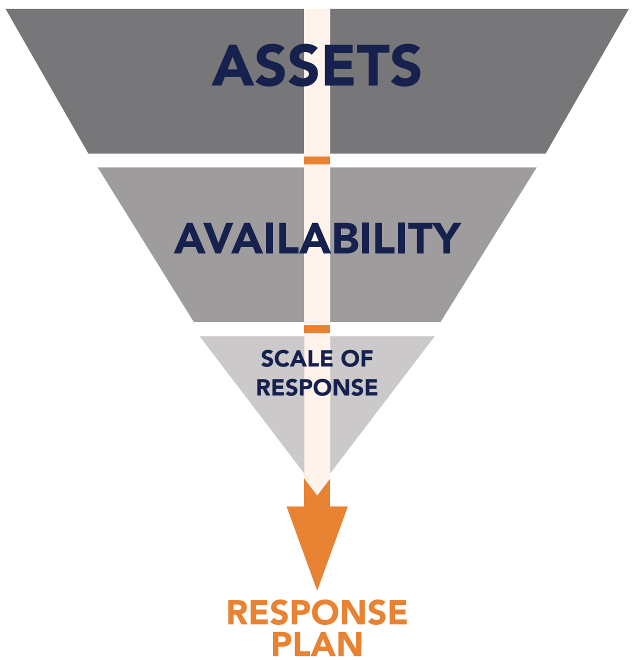


Figure 6. Diagram. Dynamic response plan selection process.[18]
(adapted from San Diego Association of Governments diagram)

17 Adapted from San Diego Association of Governments presentation, A. Estrella, "I-15 San Diego Integrated Corridor Management Project," ITS America Annual Meeting 2013, Nashville, TN, 22 April 2013.

18 Figure adapted from a San Diego Association of Governments presentation by A. Estrella, "I-15 San Diego Integrated Corridor Management Project," ITS America Annual Meeting 2013, Nashville, TN, 22 April 2013.

Opportunities for Operational Integration

Operational integration for ICM within a freight context would involve designing response plans that consider freight operators as users of the system. This may simply involve providing freight operators with visibility into conditions on the system, or it may involve response plans that include freight-related strategies. Several opportunities for incorporating freight into operational responses are described below.

When regional transportation authorities decide to pursue ICM, they should start by considering the full range of potential freight-related strategies that could improve operations along the corridor. However, a detailed analysis needs to be conducted to ensure that the best alternatives are identified. What may work for one region may not work for another.

Freight-Specific Travel Information

As described above, one major challenge in freight operations is a lack of advance planning and real-time information. This can negatively impact:[19]

- Efficient movement of freight transportation.
- Congestion on roads and long lines at terminal gates.
- Planning of freight daily work activities.
- Logistics management systems.
- Environment of neighboring communities.
- Energy consumption.
- Safety of the traveling public.

ICM provides a more holistic view of conditions on a corridor by combining multimodal information. This information can be pushed to the public through a 511 system or by private sector companies who re-purpose the data for smart phone applications. Freight operators can benefit from this information since it allows them to better plan their routes to avoid congestion. However, freight operators may require additional information beyond what would be relevant to the traveling public.

To address this need, the USDOT has led several intelligent transportation system (ITS) projects that combine data from multiple sources in order to provide real-time, freight-specific information to stakeholders so that they can plan routes and dynamically manage their operations more efficiently. These initiatives – described in more detail below – could provide tools to integrate freight information into an ICM approach.

19 M. Mollaghasemi, “Freight Advanced Traveler Information Systems (FRATIS) – Overview and Results,” presented at ITS America workshop on DSS for ICM Stakeholders, 6 August 2014.

Cross-Town Improvement Project

The Cross-Town Improvement Project (C-TIP) was developed to improve efficiency for freight operators by providing timely and useful information on loads. The first iteration of the project consisted only of a high-level concept that incorporated an "intermodal move database" for coordinating cross-town traffic to reduce empty moves between terminals. It loosely defined ideas for tracking intermodal assets and distributing information to truckers wirelessly. The second iteration created specific applications geared toward providing data to wireless devices, including work order, traffic, and routing information.

Numerous private sector entities had a stake in the C-TIP design and test results, including Class I railroads, dray operators/terminal operators, and third party technology providers, developers, and subcontractors. The Class I railroads were key data providers, while the dray carriers and terminal operators were critical end users of the C-TIP applications, especially the components that were deployed via mobile device.

As C-TIP evolved due to changing freight flows and private sector participation, the program, which was field-tested in Kansas City in 2011, ultimately consisted of:

- Simulated testing of an intermodal move exchange (IMEX) application's ability to reduce bobtail moves (i.e., trips in which a truck is not carrying a chassis, trailer, or container) and match loads in other locations given the significant reduction in cross-town moves in Kansas City.

- A collaborative dispatch model allowing freight railroads and dray carriers to easily identify load matching opportunities.

- An in-cab, real-time traffic monitoring (RTTM) smart phone application that provided real-time traffic and routing information from the Kansas City traffic management center, KC Scout, to dray truck drivers. The final real-time traffic monitoring application included dynamic route guidance (DRG).

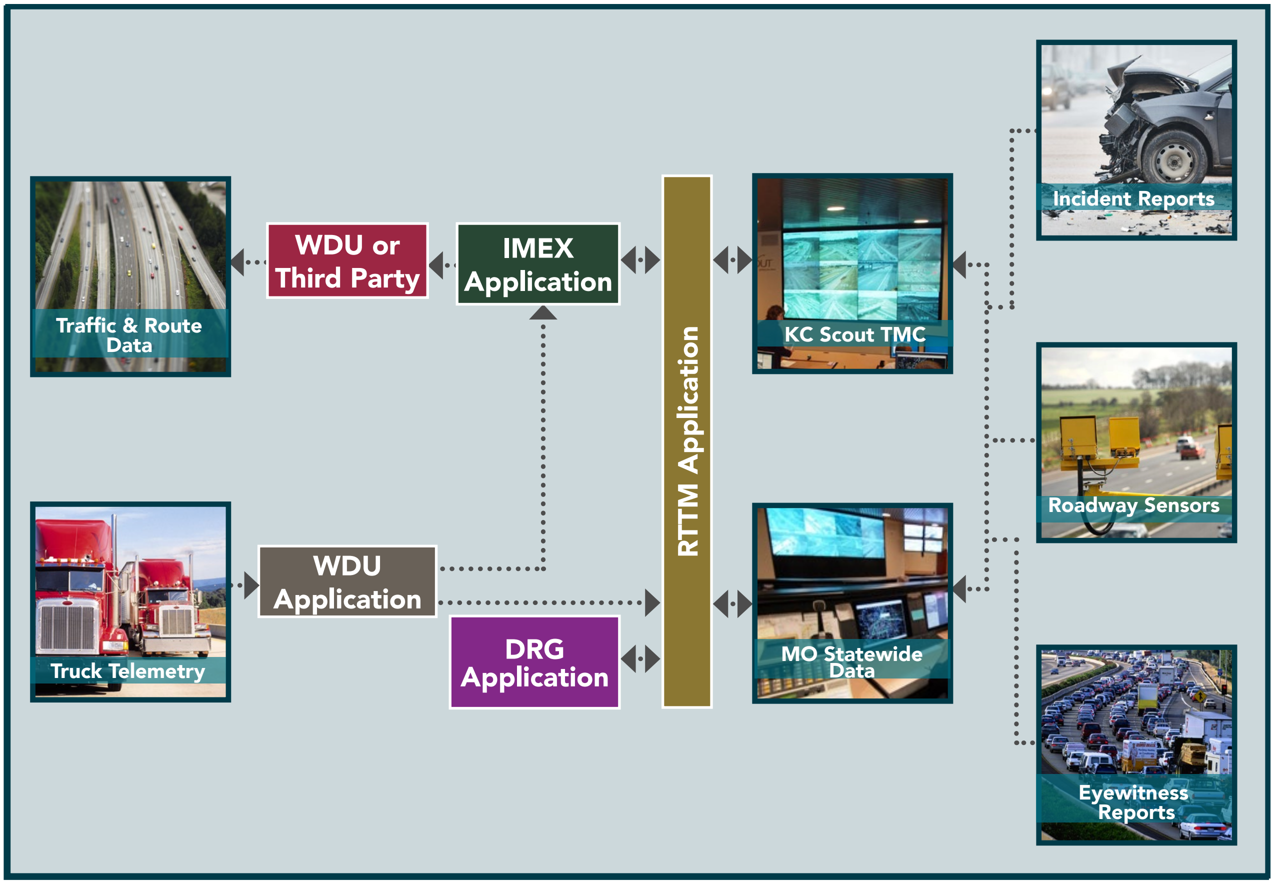
- An Open Source Architecture Package (OSAP) that provided dray dispatchers with real-time driver location data and a wireless communications platform for delivering work orders to drivers, allowing for easy identification of load matching opportunities and thereby reducing unproductive bobtails. The final package was turned into a wireless drayage updating (WDU) application.

Each application within C-TIP required specific data elements to be collected, analyzed, and disseminated. The IMEX application facilitated the exchange of load data and availability information between railroads, terminal operators, and trucking companies. All participating railroads had to provide load information, yet each had a different process. A common application (IMEX) and architecture (Electronic Freight Management) was used to overcome this challenge. Chassis pool operators provided equipment information.

The RTTM provided a means for up-to-the minute information regarding roadway conditions, travel speeds, and predicted travel times to be captured and passed along to the trucking community. A separate database system was used to collect and distribute the information, but was integrated with IMEX. The DRG feature leveraged the real-time information to identify alternate routing information for the truck drivers.

The goal of WDU was to distribute information inexpensively to drivers regarding planned, current, and pending load assignment; pickup and delivery instructions and verification; and traffic congestion information. Key pieces of information about each order were provided back to the dray companies to execute the moves, including work order, driver itinerary, and load status.

The figure below summarizes the components of C-TIP in Kansas City, including the external data sources integrated into the applications.



Source: Federal Highway Administration

DRG = dynamic route guidance
IMEX = intermodal move exchange
KC = Kansas City
MO = Missouri
RTTM = real-time traffic monitoring
TMC = transportation management center
WDU = wireless drayage updating

Figure 7. Diagram. Overview of Kansas City Cross-Town Improvement Project components and data sources.

The initial Kansas City deployment test of the RTTM and DRG proved that the applications could provide public and private sector benefits, such as congestion mitigation, emissions reductions, and truck travel time savings. During the 4-month test period, measured benefits included:

- Greenhouse gas emissions reductions of about 163,000 grams of carbon dioxide (CO^{2}) equivalents.
- Through initial route recommendations at trip outset, RTTM saved drivers on one Kansas City intermodal lane an average of 6 minutes per trip.
- Out of 95 total trips on 5 intermodal lanes, DRG redirected trucks 30 times on 3 lanes, with travel time savings ranging from 5 to 7 minutes per trip.

In addition to the deployment test, the Federal Highway Administration (FHWA) conducted a simulation of the C-TIP applications in both Kansas City and Chicago. The results showed that in Kansas City, IMEX could have eliminated 135 bobtail trips over a 4-month period, thereby eliminating over 1,000 empty truck miles and saving 180 gallons of diesel fuel. This would have reduced greenhouse gases by about 2.6 million grams and criteria pollutants by almost 19,000 grams, if C-TIP were fully utilized by all stakeholders.

In Chicago, C-TIP could have matched between 415 and 2,000 loads during a 4 month period, depending on the size of the cross-town delivery window. This would save between 1,700 and 8,000 gallons of diesel fuel, with concomitant reductions in greenhouse gas and criteria pollutant emissions.

Dallas-Fort Worth Freight Advanced Traveler Information System Demonstration Stakeholders

- Associated Carriers (Dray Carrier).
- Southwest Freight (Dray Carrier).
- Intermodal Cartage Group (Container Yard).
- BNSF Railway.

As part of a separate drayage optimization test, the C-TIP team used the OSAP to develop an automated dispatch system for Pride Logistics. The system allowed dispatchers to better allocate resources throughout the day, eliminating most of the manual effort involved in the dispatch operation and better identifying load matching opportunities. The number of bobtail trips and the percentage of miles in bobtail miles fell by approximately half during the test, while the number of total loads grew. Similarly, a C-TIP OSAP deployment by IXT in Kansas City contributed to a 13 percent reduction in bobtail records even as revenue loads remained stable.

Freight Advanced Traveler Information System

The purpose of the Freight Advanced Traveler Information System (FRATIS) is to provide real-time information to freight companies to support dynamic planning and efficient decision making. The FRATIS effort is a part of the USDOT Dynamic Mobility Applications (DMA) program, which seeks to develop and promote innovative applications and concepts that leverage the increasing volume and quality of data generated due to connected vehicles. FRATIS also builds off of complementary FHWA efforts designed to improve freight efficiency, including C-TIP.

Two applications comprise FRATIS:

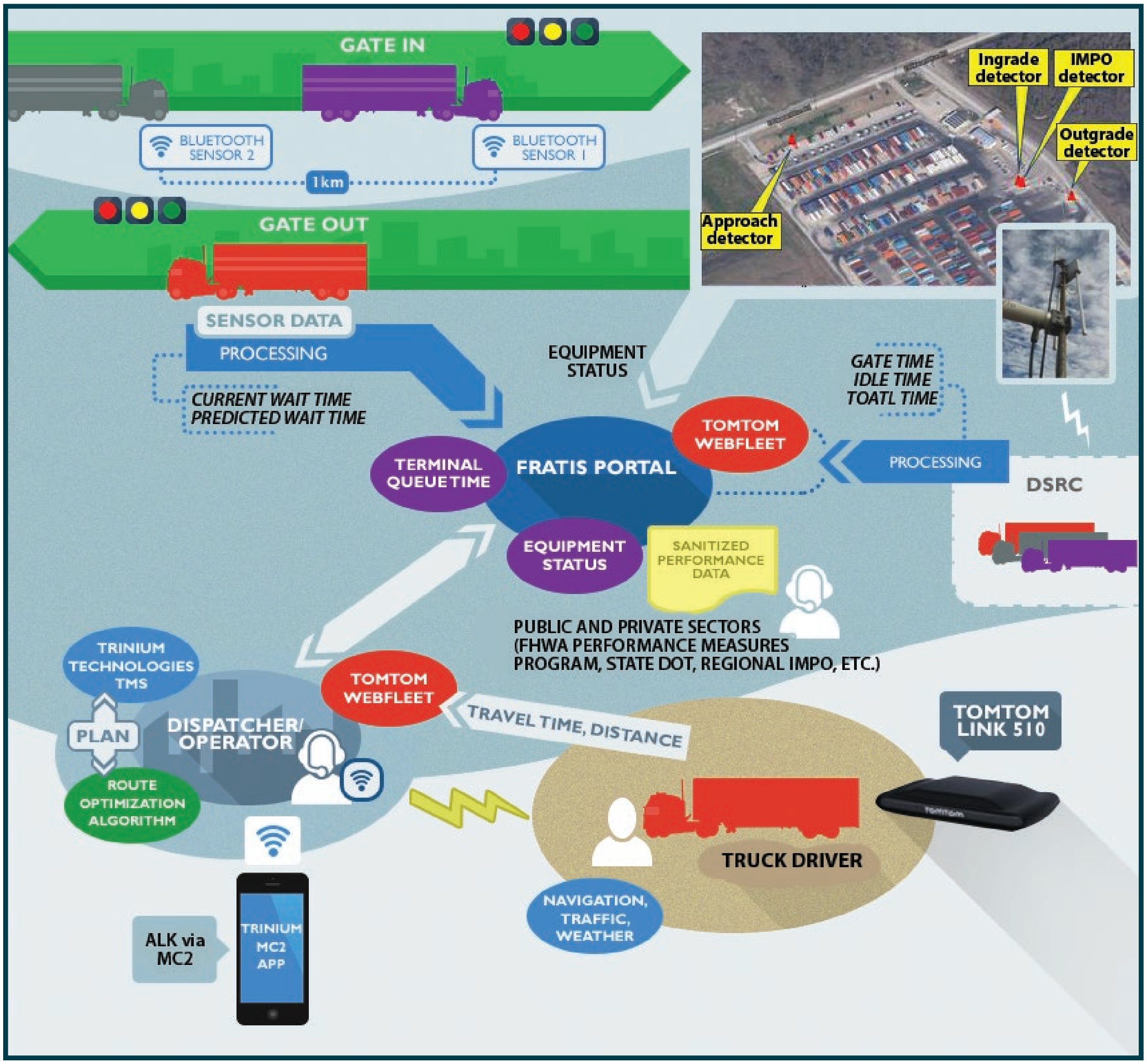
- **Freight-Specific Dynamic Travel Planning and Performance** – This application enhances existing traveler information systems – both public and private sector – to address freight-specific needs. It integrates data on wait times at intermodal facilities, traffic conditions (including speeds and volumes), incidents, road closures and work zones, route restrictions (e.g., hazardous materials, oversize/overweight), and truck parking availability. The application also provides adaptive communication between drayage companies, drivers, and intermodal facilities, along with real-time information and dynamic routing for drivers.

- **Drayage Optimization –** This application seeks to optimize truck/load movements between freight facilities. Using travel information and port terminal conditions, it assigns individual trucks with "best time" windows for pick-up or drop-off so that each can optimize operations. This application requires extensive communication from a wide range of freight entities, including rail carriers, MPOs, traffic management centers, customers, and carriers.

Both applications have two levels – a basic application, developed from open-source data and services and available in the public realm; and a "value-added" commercial application targeted at existing subscriber user groups.[20]

FRATIS prototype applications are being developed and demonstrated at three sites: Dallas-Fort Worth (DFW), the Los Angeles-Gateway Region, and South Florida. The DFW prototype incorporates size and weight permitting and a Bluetooth wait time system in a terminal that calculates real-time, historic, and predicted wait time. This information is provided to drivers, dispatchers, and terminal staff via the FRATIS server to web and mobile applications.

20 USDOT, Office of the Assistant Secretary for Research and Technology, Intelligent Transportation Systems Joint Program Office, "Dynamic Mobility Applications" web page. Available at: http://its.dot.gov/dma/index.htm



Source: Federal Highway Administration

FHWA = Federal Highway Administration
DOT = department of transportation
MPO = metropolitan planning organization
FRATIS = Freight Advanced Traveler Information System
DSRC = dedicated short range communications
App = application

Figure 8. Diagram. Architecture of the Dallas-Fort Worth Freight Advanced Traveler Information System prototype.

For drayage optimization, the DFW FRATIS prototype relies on significant amounts of data from the dray company's operating system software, including order number, type, origin and destination, and appointment time/window. Information from the dray company's software is also used to generate emails to participating terminal operators (a rail facility and a container yard) regarding the number and type of orders from the participating dray carriers that day.

21 USDOT, Office of the Assistant Secretary for Research and Technology, Intelligent Transportation Systems Joint Program Office, "Dynamic Mobility Applications" web page. Available at: http://its.dot.gov/dma/index.htm

For the wait time system, Wi-Fi and Bluetooth readers are installed at the participating container yard. The readers record when a mobile device inside a vehicle passes a point on the road into the terminal and when that same device passes through the gate to enter and exit the yard. This information is passed to a server for analysis and display of the actual, current wait time at the yard. In addition, the data are stored and used to calculate predicted wait time by time of day and day of week.

Expected benefits of the FRATIS prototype demonstrations include reductions in:

- Number of bobtails.
- Travel time (i.e., origin to destination).
- Fuel consumption.
- Emissions.
- Terminal queue time (i.e., the amount of time a truck spends waiting to get into the intermodal terminal).

Freight Signal Priority

As part of the Dynamic Mobility Applications program, the USDOT is exploring the possibilities for smarter traffic signal timing using vehicle-to-infrastructure communications. The Multi-Modal Intelligent Traffic Signal Systems is a bundle of applications that allows traffic signals to be monitored and adjusted in real-time to maximize traffic flows or to accommodate specific user groups, such as freight, transit, emergency vehicles, and pedestrians. The Freight Signal Priority application provides signal priority to trucks near freight facilities based on current and projected freight movements. The goal of this application is "to reduce delays and increase travel time reliability for freight traffic while enhancing safety at key intersections."[21]

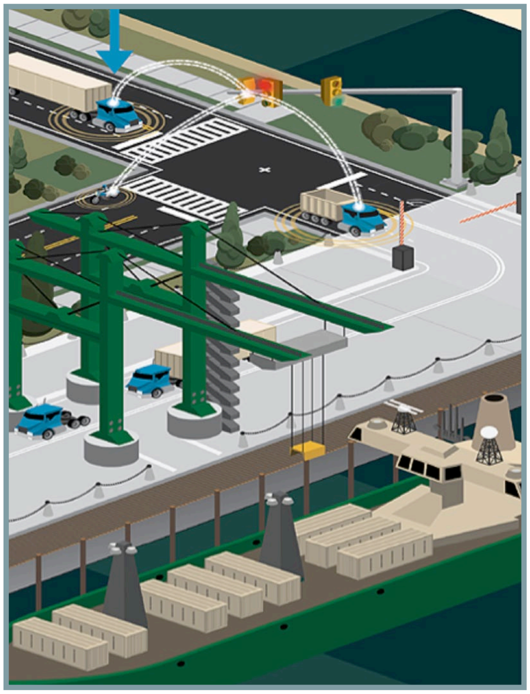

Source: U.S. Department of Transportation

Figure 9. Illustration. An eco-freight signal priority application.

A similar application is being explored under the USDOT ITS Joint Program Office's Applications for the Environment: Real-time Information Synthesis program. The Eco-Freight Signal Priority application gives signal priority to freight vehicles approaching a signalized intersection, taking into consideration the vehicle's location, speed, type, and weight. Priority decisions are based on real-time traffic and emissions data to produce the least amount of emissions at signalized intersections. Preliminary modeling results showed that Eco-Freight Signal

22 USDOT, Office of the Assistant Secretary for Research and Technology, Combined Modeling of Eco-Signal Operations Applications, Applications for the Environment: Real Time information Synthesis (AERIS) Program Summer Webinar Series, 25 June 2015. Available at http://www.its.dot.gov/aeris/pdf/Eco-Signal_Operations_Combined_Modeling_webinar_final_062414.pdf.

Priority provides up to 4 percent fuel reduction benefits for freight vehicles, which equates to up to $649,000 annual savings for a fleet of 1,000 city delivery vehicles driving 30,000 miles on arterials each year. For a large fleet of 80,000 vehicles, this would result in annual savings of $51 million.[22]

Although these applications of freight signal priority may not be immediately implementable since it will take time for roadside infrastructure and freight vehicles to be equipped with connected vehicle technology, it is an innovative strategy that regions implementing ICM could consider in their long-term version, particularly if their corridor experiences heavy freight traffic. Freight signal priority also offers an incentive for freight stakeholders to participate in an ICM initiative as the application could create a smoother travel experience for drivers on arterials. With less delay at intersections, drivers would be better equipped to make on-time deliveries, and fuel consumption and emissions due to idling at intersections could be reduced.

Truck Parking Guidance

Truck drivers must follow Federal hours-of-service (HOS) rules that require them to take anywhere from a 30-minute to an 8-hour or longer break before continuing to operate legally. In order to take these breaks, drivers need to be able to find legal and safe parking spaces to pull over. Several efforts are underway to explore how to gather truck parking availability information and disseminate it to trucking companies and drivers, potentially facilitating spot reservations.

At present, very few operational systems exist for commercial drivers to access information on truck parking availability. Although some private parking facilities offer parking availability information through mobile phone applications, these systems rely on cumbersome manual data collection and are not widely deployed. In addition, the National Association of Truck Stop Operators maintains a directory of truck stop locations and has an outreach campaign to enable truck stop operators to promote their facilities. However, these services do not provide real-time information on truck parking availability.

Commercial drivers typically rely on information provided by a dispatcher or "word of mouth" from other drivers to identify available spaces. They also make frequent use of public rest stop parking facilities rather than venture off their routes to see if a private facility has available spaces. ITS-based truck parking systems are in various stages of development in California, Michigan, and Minnesota (see callout box), as well as along the I-95 corridor from Connecticut to North Carolina. These projects are supported through the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, Section 1305, Truck Parking Facilities Program.

What is needed with respect to future truck parking projects and systems is for space availability information to be provided directly to the driver. ICM may provide a forum for truck parking information to become more dynamic, first by providing this information directly to the driver, perhaps automatically in response to an incident or congestion ahead on the drivers' route, and second by allowing the driver to interact with the truck parking application to reserve a space at the facility. Directly providing this information to the driver before they need it may reduce instances where the

23 Federal Motor Carrier Safety Administration, Smart Roadside Initiative. Available at: http://www.fmcsa.dot.gov/research-and-analysis/technology/smart-roadside-initiative (Accessed 4 February, 2015).

driver violates HOS requirements. It may also contribute to improved efficiency since drivers could travel directly to the parking facility where spaces are available (and perhaps even reserved) without having to venture off their routes.

Currently, truck parking is bundled with the USDOT Smart Roadside Initiative (SRI).[23] For the SRI prototype, the following use case is outlined for truck parking:

- The truck is operating on a roadway that possesses public and private truck stop parking facilities with an installed Real-Time Parking Information System. The truck's on-board unit is equipped with an application that monitors the driver's duty status and records driver HOS.

- The truck enters a geo-fenced region that automatically exchanges information with the truck's on-board unit, notifying the driver that the remaining HOS have reached a pre-defined threshold and that there is available parking at upcoming facilities, designated by exit ramp numbers.

- The truck also maintains a GPS-based geo-fenced perimeter. At pre-designated distance points, the system automatically and wirelessly queries the truck parking server for local parking availability.

- When a truck approaches a facility, the system provides a final notification regarding availability so that the driver can avoid entering and searching the facility if all spaces have been filled. When a truck enters a space, the system reduces the available count by one. When a truck exits a space, the system increases the space-available count by one. In each case, the central server appropriately modifies the space-available calculation.

Minnesota Truck Parking Information System

With Section 1305 funding through the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, the American Transportation Research Institute and the Minnesota Department of Transportation jointly developed and tested a new system for truck parking management. The SmartPark system employs an automated network of cameras that uses software and vision algorithms to identify available parking spaces. Using pixel-level information, the system determines the presence or absence of a vehicle. Multiple camera views are used to identify an available space and create a dynamic count of truck parking availability. The space availability is then communicated through a series of distribution systems, including roadside variable message signs (VMS), a direct, in-cab data feed and the SmartPark4Trucks website. The SmartPark system was tested at three public rest stops along the I-94 corridor in Minnesota.

Source: Minnesota Department of Transportation

Figure 10. Photo. Variable message sign information display from Minnesota SmartPark system.

Challenges to Operational Integration

Although initiatives like C-TIP and FRATIS provide useful platforms for integrating freight data and providing relevant information to freight operators, such systems are not widespread. In addition, the challenges experienced while building these systems would also apply within an ICM context. These projects require accessing information from trucking companies and potentially sharing data among multiple companies. Getting these companies to agree to sharing the data necessary to make something like C-TIP or FRATIS work could be difficult. Furthermore, moving beyond a pilot or prototype stage would likely require the private sector to take on the responsibility for system operations and maintenance, which can be a hurdle to overcome given competing priorities with respect to operating budgets within these companies.

Another operational challenge is the ability of drivers to actually re-route based on the information they are given. For example, an ICM system may recommend re-routing drivers onto a parallel arterial to avoid congestion on the freeway. There could be size/weight or cargo restrictions on that alternate route, which would add an additional layer of information that needs to be incorporated into an ICM system. There could also be "unofficial" hazards to re-routing, such as low-hanging tree limbs that could scratch a driver's vehicle, potentially burdening drivers with repair costs. Better understanding what these hazards are would require bringing regular drivers of the ICM corridor into early planning discussions.

Source: E-Squared Engineering

Figure 11. Photo. Low-hanging tree limbs create "unofficial" hazard on an alternate route.

Source: E-Squared Engineering

Figure 12. Photo. Overpass with height restrictions can impact alternate route availability.

The FRATIS program is evaluating freight-specific dynamic routing to overcome some of these hurdles. Work in the private sector by firms such as TomTom®, HERE, and ALK® may also be leveraged within ICM, as these companies have put a truck-specific spin on real-time navigation, including dynamic routing for trucks where constraints such as size, weight, and bridge height clearance are accounted for in alternate route recommendation. The cost for these data could potentially be split between public sector agencies and private sector freight companies, and the ability to purchase the data at a discounted rate could be a significant draw for freight stakeholders to collaborate with ICM partners.

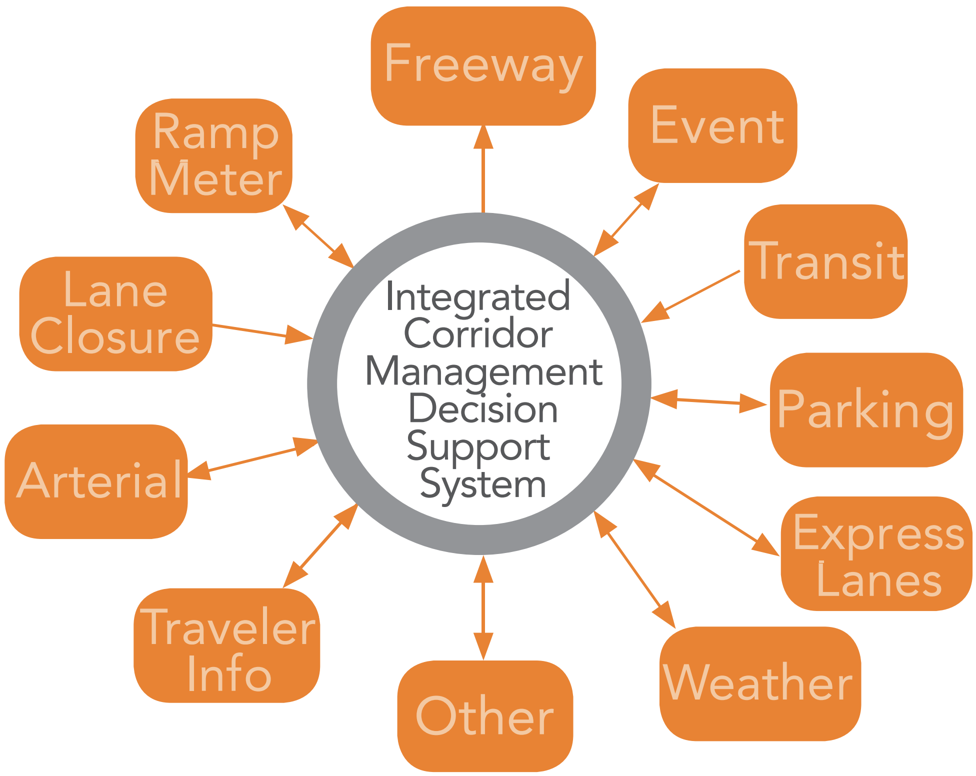
In addition to re-routing constraints on the freight side, arterial operating agencies may be resistant to re-routing trucks along their roads due to the added congestion and emissions. These agencies would need to feel comfortable with the circumstances in which trucks would be guided to re-route. It may be helpful to note that if truck drivers along the corridor know of an incident, they would re-route anyway; ICM just provides a way for arterial operators to better anticipate and manage the added truck traffic when it occurs.

Lastly, sites may be limited in the freight-specific strategies they are able to apply due to resource limitations. ICM agencies must prioritize the most important freight elements to incorporate into an approach. Keep in mind that ICM can evolve in a region, and strategies that agencies cannot afford to implement immediately may be feasible in the future. Inversely, strategies that were initially appropriate may no longer be relevant as conditions change along the corridor.

TECHNICAL INTEGRATION

Once stakeholders are committed and operational integration opportunities are identified and prioritized, the final step is technical integration. This provides the means (e.g., communication links between agencies, system interfaces, and the associated standards) by which information, system operations, and control functions can be effectively shared and distributed among network transportation management systems, and by which the impacts of operational decisions can be immediately viewed and evaluated by the affected agencies.

Technical integration involves building a system that facilitates the application of the agreements made between the ICM partners. At the Dallas and San Diego demonstration sites, this system takes the form of a near real-time decision support system (DSS) that uses multimodal information on corridor conditions to analyze and recommend response plans. Building a DSS requires integrating information from a range of independently operated, existing systems along the corridor.



Source: Federal Highway Administration

Figure 13. Diagram. Potential integrated corridor management system components.

Challenges to Technical Integration

Even if a site does not develop a DSS of the scale and complexity of those developed by Dallas and San Diego, any technical ICM system requires a significant amount of data sharing between parties. The entities that have been involved in most ICM implementations to date have been public sector agencies – State and local DOTs, MPOs, and transit agencies – each of which typically operates one or more management systems. By contrast, freight stakeholders are not represented by one single agency, and there may be numerous freight providers and management systems operating along an ICM corridor of focus. In addition, while public agencies in a region may have a history of working together and sharing information from their systems, ICM may be the first time freight companies and transportation agencies have worked together.

Freight providers may also vary in the amount and quality of data they collect, and they may use different methods for collecting, storing, and formatting that data. Streamlining this information for ICM could prove challenging. In addition, as noted above, some providers may be unwilling to share their data if they feel it will give their competitors an advantage. If only a few of the freight providers along an ICM corridor are willing to share their data, the overall impact of the full dataset will be diminished. For example, taking out origin and destination data makes it challenging to assess freight flows/routes across a region.

Opportunities for Technical Integration

In addition to the private sector data sources noted above, another solution to the potentially spotty nature of freight data along a corridor is the American Transportation Research Institute (ATRI) Freight Performance Measures (FPM) Database. The FPM program, developed with partial sponsorship from FHWA, uses ATRI-pioneered methods for analyzing real-time and archived truck GPS data activity on the Nation's roadways. Federal, State and local jurisdictions use FPM data and analysis for a range of freight planning and operations purposes. Working closely with numerous industry partners, ATRI produces measurements and analyses of travel speeds, travel times, reliability measures, truck routing and freight flows, and origin/destination analyses on road networks through North America. The research is conducted primarily through the application of sophisticated and customized geographic information system (GIS) software and a unique and substantial truck position database containing travel data from more than 500,000 commercial trucks throughout North America.

Among the FPM applications and tools that could play a role in ICM are:

- **Weather/Incident Delay Impacts –** Real-time weather information and truck impacts can be monitored, and the driver can be contacted in advance of the impact with likely delay times and truck parking or alternative route options.

- **Truck Parking Analyses –** FPM data can be used to identify where trucks are stopped for an extended period of time and identify whether the area is a truck parking facility, or if not, determine which sites in the area are in need of a truck parking facility.

- **Freight Origin/Destination Analyses –** Using the unique truck identifiers contained in the FPM data, it becomes possible to analyze macro freight flows as well as where truck trips originate and where the final trip/freight destination is anywhere in North America.

- **Intermodal/Port Connector Assessments –** Similar to the freight origin/destination analyses, intermodal and port-to-port freight movements can be assessed using the same unique truck identifiers in the FPM data.

- **Identification of Truck Congestion Points and Bottlenecks –** Every year, ATRI uses FPM data to perform a nationwide analysis of 250 freight-specific bottlenecks that are the result of heavy congestion delays.

CONCLUSION

Integrated corridor managment (ICM) is the next logical step in transportation operations. As congestion continues to grow, and agencies' ability to expand the roadway network is limited by both space and resources, ICM provides operators with a tool to maximize the capacity of existing roadway infrastructure through multi-modal, active management of all assets along a corridor.

ICM is about moving transportation system users along a corridor as efficiently as possible, and the freight industry constitutes an important user group. Freight transportation is a critical component of our Nation's economy, and ICM has the potential to improve freight mobility throughout our major urban corridors. This can be achieved through advanced, freight-specific traveler information that allows freight companies to avoid congestion and make better planning and routing decisions. In addition, ICM offers a platform for public sector and freight stakeholders to explore potential operational strategies to improve freight travel along a corridor, such as freight signal priority and parking guidance.

There are ample opportunities to integrate freight into an ICM approach. ICM project teams can take advantage of existing groups for collaboration with freight stakeholders. In addition, ITS efforts like Cross-Town Improvement Project and Freight Advanced Traveler Information System provide useful models for integrating freight data and providing useful freight-specific traveler information. However, while these opportunities show promise, there are many barriers to overcome in order to successfully include freight in an ICM approach. The freight industry includes multiple stakeholders with competing business interests. In addition, ICM requires a significant amount of data, and freight data may be limited in many regions. Where those data are available, it could be difficult to collect due to privacy concerns.

Despite these hurdles, the benefits of integrating ICM and freight can yield a payoff that minimizes the impact of the challenges. As more regions begin to explore an ICM concept for their region, they should think of how to engage this critical stakeholder group. In turn, freight stakeholders should consider how they could benefit from involvement in an ICM project. Ultimately, integration can help further the shared vision of both public sector agencies and the freight industry for an efficient and reliable travel experience.

APPENDIX. STATE TRUCKING ASSOCIATION WEBSITES

ASSOCIATION	WEB ADDRESS
Alabama Trucking Association, Inc.	alabamatrucking.org
Alaska Trucking Association, Inc.	aktrucks.org
Arizona Trucking Association	arizonatrucking.com
Arkansas Trucking Association	arkansastrucking.com
California Trucking Association	caltrux.org
Colorado Motor Carriers Association	cmca.com
Delaware Motor Transport Association, Inc.	N/A
Florida Trucking Association, Inc.	fltrucking.org
Georgia Motor Trucking Association, Inc.	gmta.org
Hawaii Transportation Association	htahawaii.org
Idaho Trucking Association	idtrucking.org
Illinois Trucking Association, Inc.	iltrucking.com
Indiana Motor Truck Association, Inc.	intrucking.org
Iowa Motor Truck Association, Inc.	iowamotortruck.com
Kansas Motor Carriers Association	kmca.org
Kentucky Motor Transport Assoc., Inc.	kmta.net
Louisiana Motor Transport Association, Inc.	louisianatrucking.com
Maine Motor Transport Association, Inc.	mmta.com
Maryland Motor Truck Association, Inc.	mmtanet.com
Massachusetts Motor Transp. Association, Inc.	mass-trucking.org
Michigan Trucking Association, Inc.	mitrucking.org
Minnesota Trucking Association	mntruck.org
Mississippi Trucking Association	mstrucking.org
Missouri Trucking Association	motrucking.org
Motor Carriers of Montana	mttrucking.org

ASSOCIATION	WEB ADDRESS
Motor Transport Association of CT, Inc.	mtac.us
Nebraska Trucking Association	nebtrucking.com
Nevada Trucking Association, Inc.	nevadatrucking.com
New Hampshire Motor Transport Association	nhmta.org
New Jersey Motor Truck Association	njmta.org
New Mexico Trucking Association	nmtrucking.org
New York State Motor Truck Association	nytrucks.org
North Carolina Trucking Association, Inc.	nctrucking.com
North Dakota Motor Carriers Association, Inc.	ndmca.org
Ohio Trucking Association	ohiotrucking.org
Oklahoma Trucking Association	oktrucking.org
Oregon Trucking Associations, Inc.	ortrucking.org
Pennsylvania Motor Truck Association	pmta.org
Rhode Island Trucking Association, Inc.	ritrucking.org
South Carolina Trucking Association, Inc.	sctrucking.org
South Dakota Trucking Association	southdakotatrucking.com
Tennessee Trucking Association	tntrucking.org
Texas Trucking Association	texastrucking.com
Utah Trucking Association	utahtrucking.com
Vermont Truck and Bus Association, Inc.	vtba.org
Virginia Trucking Association	vatrucking.org
Washington Trucking Associations	wtatrucking.com
West Virginia Trucking Association, Inc.	wvtrucking.com
Wisconsin Motor Carriers Association	witruck.org
Wyoming Trucking Association, Inc.	wytruck.org

U.S.Department of Transportation
Federal Highway Administration

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