

**Integrated Corridor Management
Concept Development and Foundational
Research**

Technical Memorandum

**Task 3.4 – Identify Integrated Corridor Management
Institutional Strategies and Administration**

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Task 3 involves overall foundational research to further the understanding of various aspects of Integrated Corridor Management (ICM) and to identify integration issues needed to evaluate the feasibility of the ICM initiative. The focus of Task 3.4 and the purpose of this document (TM 3.4) is "institutional integration" and the associated issues. In more specific terms, the objective of subtask 3.4 is to identify and analyze generic institutional strategies for Integrated Corridor Management; to identify the corresponding participating institutions and the stakeholders; and to address the administrative processes and requirements.					
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Integrated Corridor Management (ICM)

Tech Memo 3.4 – Final Draft

Identify Integrated Corridor Management Institutional Strategies and Administration

TASK OBJECTIVE

Task 3 involves overall foundational research to further the understanding of various aspects of Integrated Corridor Management (ICM) and to identify integration issues needed to evaluate the feasibility of the ICM initiative. The focus of Task 3.4 and the purpose of this document (TM 3.4) is “institutional integration” and the associated issues. In more specific terms, the objective of subtask 3.4 is to identify and analyze generic institutional strategies for Integrated Corridor Management; to identify the corresponding participating institutions and the stakeholders; and to address the administrative processes and requirements.

It is emphasized that the institutional focus of this Tech Memo represents only one aspect of the integration issues associated with Integrated Corridor Management. Operational and technical integration issues and needs are also important considerations, as discussed in Tech Memo 5.4. Moreover, these various integration issues (i.e., institutional, operational, and technical) are all closely related and interdependent – for example, operational integration can be more effective when technical integration has been implemented; while successful technical and operational integration typically require institutional integration (and the associated managerial support and funding¹) as a prerequisite.

BACKGROUND

The basic institutional fabric of the surface transportation network is multi-agency, multi-functional, and multi-modal. This framework has resulted in a fragmented delivery system for transportation service, resulting in an agency or individual-network² focus rather than a corridor-wide perspective. The basic premise behind the ICM initiative is that these independent, network-based, transportation management systems and their cross – network linkages can be operated in a more coordinated and integrated manner.

Institutional integration involves the coordination and collaboration between multiple agencies and jurisdictions (e.g., network owners) – transcending organizational boundaries – in support of ICM. In a pluralistic society such as ours, with its numerous levels of government and organizational hierarchies, institutional integration is where most of the difficulties lie in achieving the singular vision of a “seamless” transportation corridor. In essence, without institutional integration, the vision of integrated corridor management can never become reality. A number of documents have amplified how critical institutional integration, and the associated cooperation and collaboration, is. For example:

¹ ICM Funding is addressed in TM 3.5.

² Per the definition of a “corridor,” the term “network” is used to denote a specific combination of facility and mode.

- ? **FHWA Rule 940** – The “Background” section of Rule 940 in the Federal Register states: “Successful ITS integration and interoperability require addressing two different and yet fundamental issues; that of technical and institutional integration. *Institutional integration* involves coordination between various agencies and jurisdictions to achieve seamless operations and/or interoperability. In order to achieve effective institutional integration of systems, agencies and jurisdictions must agree on the benefits and the value of being part of an integrated system. They must agree on roles, responsibilities, and shared operational strategies. Finally, they must agree on standards and, in some cases, technologies and operating procedures to ensure interoperability. This coordination effort is a considerable task that will happen over time, not all at once. Transportation organizations, such as transit properties, State and local transportation agencies, and metropolitan planning organizations must be fully committed to achieving institutional integration in order for integration to be successful. The transportation agencies must also coordinate with agencies for which transportation is a key, but not a primary part of their business, such as, emergency management and law enforcement agencies.”
- ? Integrated Transportation Management System (ITMS) Conference – During the 4th ITMS Conference (summer, 2001), separate breakout groups addressed technical and institutional integration. They all reached the same basic conclusions – the groups focusing on institutional integration agreed “that the institutional issues associated with ITMS are frequently more difficult to address than the technical issues”; while the groups focusing on technical integration “identified the link between institutional and technical issues, noting that institutional concerns frequently influence the technical elements of a project.” In fact, most of the common themes that emerged from the ITMS conference (as documented in the Proceedings) focused on institutional issues, including the summary statement: “Institutional issues are frequently more of a stumbling block than technical issues. Interagency coordination and cooperation is key to ITMS. Developing multi-agency partnerships, bridging institutional gaps, and establishing new institutional arrangements are all needed to maximize ITMS.”
- ? *Planning for Operations Primer* – The introduction to this document³ includes the following statement: “More than ever, the safe, reliable, and secure operation of our Nation’s transportation systems depends on collaboration and coordination across traditional jurisdictional and organizational boundaries. Nowhere is this more apparent than in our metropolitan regions where numerous jurisdictions, agencies, and service providers are responsible for safely and efficiently operating various aspects of the transportation system. Many of these operations activities must cross agency and jurisdictional boundaries to be successful. These operations activities depend on collaboration, coordination, and integration to be effective and truly benefit those that use or depend upon the regional transportation system.”

For integrated corridor management to become a reality, the numerous institutions and stakeholders responsible for, or in some manner involved with, the management and operation of the individual transportation networks must first agree on the need for integrated corridor management and where the corridor boundaries lie; and then agree

³ “Regional Transportation Operations Collaboration and Coordination, a Primer for Working Together To Improve Transportation Safety, Reliability, and Security,” FHWA, Publication FHWA-OP-03-008, 2002

on which ICM approaches and strategies are appropriate for the corridor(s), and under what operational circumstances (e.g., recurring congestion, incidents, special events) these strategies should be implemented. Subsequently, they must define and distribute responsibilities for information sharing, system control functions, and decision making to facilitate ICM operations. Other activities requiring institutional coordination collaboration include reaching concurrence as to how information will be exchanged and operational strategies activated (e.g., system interfaces and standards, ICMS software, communications); committing the necessary resources to implement, operate, and maintain the ICMS; and developing the necessary interagency agreements (and possibly legislation) documenting the various ICMS policies and procedures. This can be a daunting and often frustrating task, with a significant amount of time and effort directed towards overcoming a multitude of institutional barriers and challenges.

INSTITUTIONAL ISSUES AND NEEDS

As discussed in Tech Memo 3.3,⁴ corridor management and regional management are significantly different, particularly in terms of their physical make-up and boundaries, and the extent and focus to which transportation management and operational integration are addressed. However, several parallels and similarities exist between corridor and regional management with respect to institutional integration and needs. After all, there is a crossing of geographic, political and institutional boundaries (i.e., networks) in both cases, with the concomitant need for coordination and collaboration between the stakeholders.

The aforementioned *Planning for Operations Primer* is an introductory document that discusses a formal collaborative activity called “regional planning for operations.” The primer contains several generic concepts, institutional strategies, and administrative processes that, given the parallels and similarities between corridor management and regional management from an institutional perspective, are also applicable at a more detailed level to integrated corridor management.⁵ The relative difference in the application of collaborative concepts at the integrated corridor level is due to the added complexity of integrating operations among corridor networks.

The *Planning for Operations Primer* includes a figure, reproduced here as Figure 1, showing the overall framework by which “managers with day-to-day responsibilities for providing transportation and public safety services can build sustained relationships and create strategies to improve transportation system performance.” The intent of the framework is to help institutionalize working together (i.e., institutional integration) as a way of doing business among transportation agencies and network owners, public safety officials, and other public and private sector interests. This Technical Memorandum uses the “Planning for Operations Primer” framework to analyze the institutional barriers associated with integrated corridor management and provide insight concerning overcoming these barriers to enable integrated corridor operations.

This overall framework creates *structures* through which *processes* occur that result in *products*. It implies a commitment of *resources* needed to initiate and sustain corridor collaboration and coordination and for implementing agreed upon solutions and

⁴ Relationship Between Corridor Management and Regional Management

⁵ The information provided below from the primer has been modified slightly to reflect the terminology used within the ICM initiative.



Figure 1. Overall Framework for Regional and Corridor Collaboration & Coordination

procedures (i.e., ICM approaches and strategies, and a distribution of responsibilities / shared control to facilitate corridor operations). The collaborative spirit is motivated by a desire for measurable improvement in corridor transportation system *performance*. The five elements of the framework are interactive and evolving.

STRUCTURE

The **structure** that supports collaboration and coordination within a corridor is the set of relationships, institutions, and policy arrangements that shape the activity. It provides the institutional framework within which network operators and service providers come together to plan, develop, implement, and operate ICM.

Determining the most appropriate institutional structure for Integrated Corridor Management depends on the needs of the corridor, current network operations, any existing institutional relationships and processes involving the corridor stakeholders, and the collective vision for a corridor on the part of the transportation network operating agencies and service providers within the corridor. The institutional structure will vary, but may begin as an ad hoc arrangement among a few people and / or agencies within the corridor and evolve to more formal arrangements as corridor boundaries are finalized and as ICM operational approaches and strategies are finalized and implemented.

Figure 2 illustrates this range of organizational approaches in support of institutional integration.

\hat{U}	<i>LESS FORMAL</i>		\hat{U}	<i>MORE FORMAL</i>		\hat{P}
Ad hoc arrangements based on near-term issues and personal relationships and interests	Informal working groups that meet regularly to address topics of more effective use of existing corridor capacity	Formally established joint working groups with assigned responsibilities for ICM	Funded entity (i.e., a “corridor manager”) with full-time staff and well-defined responsibilities related to ICM operations	Legal entity (corridor manager) with dedicated resources, authorities, and a governing board that represents agencies in ICM development, implementation, and operation efforts		

Figure 2. Organizational Approaches for Corridor Integration

The *Planning for Operations Primer* identifies the following action steps associated with the “Structure” component: identify key constituencies, enlist champions/leaders who are committed to working together (and encouraging others to work with them), and develop a vision. Each of these and other considerations is briefly discussed below.

Key Constituencies

Successful management and operation of a corridor requires that the perspectives and concerns of several different constituencies be considered. These “stakeholders” include any person or group with a direct interest (a “stake” as it were) in the integrated operation of the corridor and the associated networks and cross-network linkages. The Regional ITS Architecture Guidance Document provides an extensive list of the range of stakeholders that have participated in regional ITS architecture development efforts around the country. Summarized in Table 1, this makes a good checklist of *possible* stakeholders that may be involved in the Integrated Corridor Management.

It is also important to involve an array of different representatives from those agencies that are responsible for the day-to-day operations of the networks within the corridor, including their respective decision makers, designers, implementers, operators, and technical staff. For example, agency decision makers and politicians may not understand ITS or the extent of potential ICM benefits as compared to infrastructure improvements, whereas it is often natural for network operators to think in terms of management and optimization of their individual network, with a possible lack of awareness of surrounding networks or the corridor as a whole.

Table 1. Candidate ICM Stakeholders

Transportation Agencies (Roadway)	Transit / Multi-Modal Agencies
<ul style="list-style-type: none"> ? State departments of transportation (DOT) ? Local agencies (City & County) <ul style="list-style-type: none"> ➤ Department of transportation ➤ Department of public works ? Federal highway administration (FHWA) ? State motor carrier agencies ? Toll/Turnpike & Bridge / Tunnel authorities 	<ul style="list-style-type: none"> ? Local transit (city/county/regional) <ul style="list-style-type: none"> ➤ Bus (local, express, BRT) ➤ Light Rail ➤ Commuter Rail ? Federal transit administration ? Paratransit operations ? Rail services (e.g., AMTRAK) ? Federal rail administration ? Port authorities ? Seaport authorities/terminal operators ? Department of airport or airport authority
Fleet Operators	Public Safety Agencies
<ul style="list-style-type: none"> ? Commercial vehicle operators (CVO) <ul style="list-style-type: none"> ➤ Long-Haul trucking firms ➤ Local delivery services ? Courier fleets (e.g., US Postal Services, Federal Express, UPS, etc.) ? Taxi companies 	<ul style="list-style-type: none"> ? Law enforcement <ul style="list-style-type: none"> ➤ State police and/or highway patrol ➤ County sheriff department ➤ City/Local police departments ➤ Transit / Port police ? Fire Departments / first responders <ul style="list-style-type: none"> ➤ County/city/local ? Emergency medical services ? Hazardous materials (HazMat) teams ? 911 Services ? Department of Homeland Security / FEMA
Travelers	Private Sector
<ul style="list-style-type: none"> ? Commuters, residents ? Tourists/Visitors ? Motorists (SOV) and their passengers (HOV) ? Transit riders ? Commercial vehicle operators ? Bicyclists/pedestrians 	<ul style="list-style-type: none"> ? Traffic reporting services / Information Service Providers ? Local TV & radio stations ? Travel demand management industry ? Telecommunications industry ? Automotive industry ? Private towing/recovery business

Table 1. Candidate ICM Stakeholders (continued)

Planning Organizations	Activity Centers
<ul style="list-style-type: none"> ? Metropolitan planning organizations (MPOs) ? Council of governments (COGs) ? Regional transportation planning agency (RTPA) 	<ul style="list-style-type: none"> ? Event centers (e.g. sports, concerts, festivals, ski resorts, casinos, etc.) ? National Park and US Forest Services ? Major employers ? Airport operators
Other Agencies	Other Agency Departments
<ul style="list-style-type: none"> ? Tourism boards/visitors associations ? School districts ? Local business leagues/associations ? Local Chambers of Commerce ? National Weather Services (NWS) ? Air and Water Quality Coalitions ? Bureau of Land Management (BLM) ? Academia interests, local Universities ? Military (including Coast Guard) ? US Army Corps of Engineers 	<ul style="list-style-type: none"> ? Information technology (IT) ? Planning ? Telecommunications ? Legal/Contracts

All appropriate stakeholders need to be brought into the picture early on to make sure their needs are considered, and to determine how they will be involved in the process to develop and implement an ICMS. Bringing together all the stakeholders throughout this process can serve to heighten awareness of the importance and need for integrated corridor management, and to cultivate an interest in integrated operations and corridor solutions. Moreover, it allows each entity (e.g., network owner / operator) to understand the specific functions and perspectives of their partner agencies, as well as their respective institutional constraints and barriers, thereby making the collaborations more productive.

Stakeholder involvement is a continuous, iterative activity. Stakeholders are the sources for the corridor vision and goals, operational approaches and strategies, and ICMS requirements. It is the stakeholders who must ultimately agree on ICM concepts and policies; the development and approval of ICM operational response plans and procedures (including the agency-specific responsibilities for implementing and monitoring the plans); the ICMS architecture and system designs; and the on-going operation, maintenance, evaluation, and improvement of the ICMS. The various participants will also address and finalize the corridor boundaries (which, should the boundaries change during the process, may alter stakeholder participants).

NCHRP Synthesis 337 (*Cooperative Agreements for Corridor Management*) stresses the importance of stakeholder involvement with the following conclusion: “it is vital to proactively confront the tough corridor management issues through direct involvement of

the affected parties.” Such stakeholder collaboration and coordination must be viewed as a “deliberate, continuous, and sustained activity.”

Public Safety Stakeholders

The Public Safety Agencies (also commonly referred to as Emergency Services) represent an important stakeholder group. Both the transportation and emergency service agencies have many shared and overlapping responsibilities, particularly during major incidents, special events and emergencies. Not only does the public safety community have a significant role as an ICM stakeholder; but a successful ICM program will require greater integration between the two communities. However, the public safety and transportation communities have typically been relatively isolated from one another, often interacting only in a reactive fashion, as opposed to the pro-active approach envisioned for ICM. As an example of this disconnect, a recent TRB Paper (*Transportation and Emergency Services: Identifying Critical Interfaces, Obstacles, and Opportunities*) examined the commitment to improved coordination among highway transportation and emergency services organizations, seeking to identify and evaluate the underlying obstacles and opportunities. Specific findings and conclusions⁶ are summarized below:

- ? Benefits: Both groups see benefits from emergency transportation operations (ETO), but their perception of these benefits is quite different. The top reasons for transportation professionals to seek ETO improvements were: (1) reduce time to restore normal traffic conditions following an incident, (2) improve incident response times, and (3) improve the accuracy and timeliness of information provided to motorists and the public. In contrast, the top reasons for emergency services professionals were: (1) improve scene and responder safety, (2) reduce the impact of major disasters, terrorist attacks, or other large scale events, and (3) avoid or reduce the frequency and severity of hazardous material releases.
- ? Understanding Missions, Capabilities, and Limitations: The majority of respondents from both groups felt that “limited knowledge and understanding of some aspects” best described the existing level of understanding. These results point to some fundamental gaps in mutual understanding – gaps that both groups recognize do exist. A fundamental conclusion from this research is that efforts to improve ETO should include measures to expand the shared knowledge and understanding of the core missions, capabilities, and limitations of all the partner agencies.
- ? Activities and Response Actions Most Needing Improved Coordination: The key actions identified as requiring improved coordination, regardless of the scenario, involve communication and planning. For both groups, the action most in need of improvement was “communication during emergency situations,” and both groups included “evacuation planning” in their top five choices.
- ? Resource Allocation and Funding Sources: The majority of respondents agreed that more funding is needed to accomplish ETO improvements, and that dedicated state and federal funding sources are required. However, the emergency services representatives believe that transportation agencies have more funding available and

⁶Most of the findings and conclusions are based on a survey administered to transportation and emergency services professionals in five southeastern states: Kentucky, Georgia, Tennessee, North Carolina, and South Carolina. The research also included a focus group comprised of transportation and emergency services officials in the Nashville and Knoxville metropolitan areas.

should therefore use those resources to pay for ETO. Most of the transportation respondents disagreed.

Obviously, a major challenge for Integrated Corridor Management is the importance and difficulty of engaging the public safety community in the ICM process and operational strategies. During the corridor site visits to Salt Lake City and the Gary – Chicago – Milwaukee Corridor, both locales found that this traditional isolation can be effectively overcome through the provision and conduct of extensive training and exercises. Such activities are strongly supported by the public safety community and serve to build a foundation of trust. In both locations that trust and understanding of each other's needs and capabilities has led to very close interactions on corridor management priorities, including the development of integrated public safety / transportation management incident reporting and dispatching databases.

The aforementioned TRB Paper reached a similar conclusion regarding the importance of training and exercises as a means of engaging public safety in corridor management. Specifically, the short-term strategies (for improving coordination) judged by the focus group to warrant the highest priority included:

- ? Include more transportation topics in training for emergency response personnel and more emergency services topics in training for transportation personnel.
- ? Implement new interagency (joint transportation and emergency services) training programs.
- ? Increase participation in multi-agency operations planning for all types of hazards.

Another consideration when dealing with public safety agencies – particularly during major incidents and events – is the **Incident Command System (ICS)**. The ICS concept has been developed to govern the communications that must occur among multiple public safety entities and first responders. The cornerstone of ICS is a formalized management structure and procedures for controlling personnel, facilities, equipment, and communications. This structure on which the ICS is based is divided into five basic functions – command, planning, operations, logistics, and finance / administration – all of which are overseen by the Incident Commander, who is responsible for on-scene management and command authority. Initially developed as a result of wild fires in southern California in 1970, the ICS concept has been widely adopted and endorsed by numerous organizations (e.g., American Public Works Association, International Association of Chiefs of Police, National Fire Academy) as the standard to use for responding to all types of incidents and emergencies. It is important that other corridor stakeholders – particularly those primarily involved in transportation management – recognize that such an ICS structure exists, and will likely be implemented during emergencies. Any ICM concept should be consistent and coordinated with the ICS structure.

Champions

What impetus is there for getting all the corridor agencies and affected entities together to discuss coordinated operations and integrated corridor management in the first place? Perhaps foremost is the need to overcome a sort of “institutional inertia” – to change the mindset within transportation agencies such that they begin to think of operations beyond their respective network boundaries. A major event often serves as such a catalyst (as does available funding). Nevertheless, “champions” are essential to take the lead in the ICM endeavor, to arrange and organize interagency meetings, to

continuously promote the need for ICM, and to show the individual network stakeholders the benefits that can accrue – on both a corridor and individual network basis – from integrated corridor management. The champions must also have the authority, ability, and credibility to influence decisions within all agencies and groups. Outreach to policy makers is a key part of building support and champions at the political level.

As noted in the Regional ITS Architecture Guidance Document: champions are usually not voted-in; they are selected “on the job” in the course of working together. In some instances, a single champion will be identified. If there are several people who rise to the occasion, several champions can be identified that take turns leading the meetings or agree upon some shared responsibilities that will keep everyone engaged. A champion’s skills include:

- ? Understanding of the subject.
- ? Knowledge of local ITS systems and projects.
- ? Vision for interconnectivity, partnership, and corridor integration.
- ? Consensus builder (facilitator).
- ? Executive level access to resources to gain support for corridor integration efforts.

In addition to individuals, a lead agency may also often helpful. It may be the MPO, a “regional” transportation agency, or a State DOT. Obviously, the ICM champion must function as an advocate. At the same time, however, any lead agency must be careful that it is not viewed by the other entities as using the ICM concept as a means to expand its own influence and control.

Vision

The aforementioned NCHRP Synthesis 337 notes the “importance of establishing a shared vision of the corridor and for each party to look at the corridor as a whole — not just from within or outside of the right-of-way (or, more specifically, their individual networks). The willingness of each party to work toward a common vision and to compromise for mutual benefit can form the basis of a lasting and effective agreement on corridor management.”

By definition, a vision statement should portray the future corridor-based system and its operation, providing a platform for establishing corridor goals and objectives. It must also be simple, easy to read and accessible to a wide audience. As an example, the vision statement for a generic corridor⁷ has been developed as follows:

In the future, the Generic Corridor will be a seamless transportation system in which travelers can conveniently shift between modes and routes in order to complete trips. All users will be able to readily access traveler information that is comprehensive, timely, accurate and useful. This information will let them travel more safely, and reach their destinations in a reasonable and predictable period of time. The Generic Corridor will work collectively: Each part of the transportation system will address performance in order to improve the movement of people and goods in the entire corridor. The operations, technology, and institutions of all system parts will be aligned to address problems and improve corridor performance.

⁷ Refer to “ICM Concept of Operations for a Generic Corridor.”

Coordination with Regional Entities and ITS Architecture

As previously noted, integrated corridor management and regional management are significantly different, particularly in terms of their respective geographic and operational focus. At the same time (discussed in Tech Memo 3.3⁸), it is important to remember that wherever ICM is being considered, the corridor in question will likely be part (i.e., a subset) of a larger region. Any regional concepts and ITS architecture can be used to leverage the development of the Integrated Corridor Management. For example, the regional ITS architecture can serve as a key enabler in identifying the appropriate stakeholders, establishing champions, and initiating the institutional relationships that will sustain integrated corridor management. Moreover, if any regional management attributes have already been, or soon will be, implemented — for example, information sharing; an institutional framework such as regional joint working groups or a regional coordination / management entity; or technical ITS standards for sharing information between agencies — the ICMS should incorporate and build upon these regional elements (i.e., institutional, operational, technical) to the greatest extent possible.

Human Relations

All of the institutional approaches identified in previous Figure 2 include (and often depend upon) personal relationships among leaders and staff members of key operating agencies and other service providers within the corridor. Integrated corridor management, and the associated institutional integration, is an ongoing, iterative effort requiring collaboration and coordination. The various agencies that are involved or impacted by the ICMS don't attend and participate in coordination meetings and decision-making processes, per se; rather, it is their representatives that discuss and (hopefully) resolve the numerous institutional, technical, and operational issues associated with integrated corridor management.

ICM requires the talents of many people. In fact, most institutional challenges and barriers are really about human relations. As stated in the FHWA "Guidelines for Successful Systems": "excellent human relations are therefore essential to a systems success. In fact, this may be the most critical aspect of the process. If the various participants cooperate, then a successful ICMS is almost assured. On the other hand, when the relationships between individuals disintegrate and they start to work at cross-purposes, the success of the system is seriously endangered." The importance of personal relationships among leaders and staff members of key operating agencies and neighboring jurisdictions, who recognize common problems and opportunities and agree to work together to improve the performance of the corridor, cannot be overemphasized.

The dependence on the social behavior of different individuals can be a bit unsettling. After all, the most critical element of the process to develop, implement, and operate an ICMS is also the least controllable. The aforementioned "Guidelines for Successful Systems" notes that the absence of good human relations can be attributed to a variety of causes, including:

- ? Poor communications between people and organizations, which in turn leads to misunderstandings. Face to face contact is very beneficial in this regard.
- ? Insufficient knowledge, experience and/ or information on the part of key individuals.
- ? Persons in position of responsibility without the appropriate authority.

⁸ "Relationship Between Corridor Management and Regional Management."

- ? Lack of continuity of key personnel throughout the process.
- ? Significant differences of opinion as to what is required from each organization involved in the process.

A sound process for developing and implementing ICM, based on the principles of systems engineering, will address many of these potential problems (refer to ICMS Implementation Guidance – Tech Memo 2.5). Additionally, there are a number of general principles which can help to promote and maintain good human relations, and therefore minimize many of the potential barriers to collaboration and coordination. These principles include:

- ? Empathy – viewing problems and issues as others do, which requires careful listening.
- ? Honesty – clearly presenting the facts and being truthful in all dealings.
- ? Individuality – approaching people as individuals, not as stereotypes.
- ? Thoughtfulness – showing respect for the opinions and talents of others.
- ? Positive Thinking – showing confidence in the concept of an ICMS.
- ? Flexibility – recognizing that circumstances change, and being open to new ideas.

Experience has shown that, far beyond any formal processes, structures, and written controls, system success depends on informal elements. That is, a successful ICMS must be a human and institutional success if it is ever to be a technical and operational one.

PROCESSES

Processes are the formal and informal activities performed in accordance with written or unwritten, but collaboratively developed and accepted, policies involving multiple agencies and jurisdictions within a corridor. The process aspect relates to the ways ICM options are created and analyzed, and decisions are made to improve corridor performance. Processes describe how the institutional “structure” works to achieve the goals and objectives of the corridor that can be facilitated by the implementation of integrated corridor management.

The process of corridor integration will often move along a spectrum from little to no information sharing and collaboration, to ad hoc relationships built around specific issues or special events, to more formal collaborative relationships with mutually agreed-upon objectives and strategies, and finally, in some instances, to joint ownership and control of transportation facilities and services. This spectrum, illustrated in Figure 3, shows some of the ways that a corridor’s public and private sector entities may interact.

\hat{U} LESS FORMAL PROCESSES	\hat{U} MORE FORMAL PROCESSES	\hat{P}
Coordinating	Cooperating	Collaborating
<ul style="list-style-type: none"> ▪ Informal information sharing ▪ Common use of terms ▪ Coordinated actions ▪ Coordinated service delivery 	<ul style="list-style-type: none"> ▪ Corridor information sharing ▪ Corridor performance measurement ▪ Corridor operating policy development ▪ Corridor concept of operations ▪ ICM requirements 	<ul style="list-style-type: none"> ▪ Shared corridor operations vision ▪ Formal institutional partnering ▪ Integration and interoperability planning ▪ Joint ICMS project development ▪ Shared use of resources

Figure 3. Spectrum of Corridor Integration Processes

The ICM operational approaches and strategies (discussed in Tech Memo 5.1-3) represent another form of ICM “process.” These are shown in Figure 4 (using a similar format as previous Figures 2 and 3 herein) as representing segments of a corridor “operational integration” spectrum. In all likelihood, a degree of correlation will exist between these various spectrums; that is, as one moves along the spectrum from less integration to more integration as shown in Figure 4, it will probably be necessary to also migrate from less to more formal processes (Figure 3), as well as to incorporate more formal institutional structures shown in Figure 2.

\hat{U} LESS INTEGRATION	\hat{U} MORE INTEGRATION	\hat{P}	
Information Sharing / Distribution	Operational Efficiency of Network Junctions	Accommodate / Promote Route & Modal Shifts	Manage Capacity – Demand Relationship (short / long term)
<ul style="list-style-type: none"> ▪ Information sharing (data, video) ▪ Information clearinghouse ▪ Corridor ATIS ▪ Using traveler information devices to describe conditions on other networks ▪ Shared control of CCTV 	<ul style="list-style-type: none"> ▪ Signal priority for transit ▪ Multi-modal electronic payment ▪ Transit hub connection protection ▪ Coordinated ramp metering / arterial signals 	<ul style="list-style-type: none"> ▪ Modify arterial signal timing / metering rates / transit priority to accommodate shifts ▪ Promote route / mode shifts via en-route traveler information devices ▪ Re-route buses 	<ul style="list-style-type: none"> ▪ Lane use control ▪ Convert regular lanes to transit ▪ Add transit capacity (additional vehicles / reduced headways) ▪ Open HOV lanes / shoulders ▪ Modify HOV requirements ▪ Variable speed limits ▪ Modify toll / transit / parking pricing

Figure 4. Spectrum of ICM Operational Approaches

Regardless of where a particular corridor may fall along the “Integration Processes” and “Operational Approaches” spectrums shown above, a key institutional issue will involve the identification and distribution of responsibilities between the corridor stakeholders. Such “process” responsibilities must be defined for all the activities that are part of developing, implementing, operating, and maintaining an ICMS. This can include, for example, defining the lead / support roles and the necessary approvals for coordinating stakeholder meetings; collecting data and inventory information in support of a corridor needs analysis; identifying and analyzing potential ICM approaches and strategies; defining the required changes to existing network systems; developing the ICMS Concept of Operations, requirements, and designs; translating the system designs into contract and other procurement documents; managing the system construction, integration, testing, and acceptance; reviewing and approving various system documentation; developing and inputting ICM response plans for various operational scenarios; operating and maintaining the ICMS on a day-to-day basis; and ongoing system evaluation and configuration management.

For those ICM strategies and processes that involve shared use of resources and / or shared control of ITS devices, the appropriate “protocols” must also be developed and incorporated into the ICMS (and documented in Operations and Response Plans). In this context, the term protocols not only refers to technical ITS standards for transmitting information between network systems within the corridor, but also to operating procedures and plans. As with the other institutional issues, there is a range of possible operational processes and protocols as shown in Figure 5. These ICMS protocols will be influenced by the degree of real-time control that each stakeholder desires to retain, as well as by the technical capabilities of any legacy network systems. The more formal organizational approaches for corridor integration (previous Figure 2) include a Corridor Manager – an individual or group responsible for the real-time management and operation of the corridor (including decision making and device control). Stakeholders may opt to assign this responsibility to a separate organization, or may assign the responsibility to a single stakeholder’s Transportation Management Center (TMC).

<i>LESS FORMAL</i>		<i>Ū</i>	<i>MORE FORMAL</i>
Alerts provided to stakeholder TMCs through Regional or Corridor ITS Architecture ITS information connectivity features. TMCs take action based on ICM Operations Plan and communication among the stakeholders.	Corridor manager <u>requests</u> stakeholder TMCs to provide particular controls according to ICM Operations Plan. Stakeholder may modify request before taking action. Modifications are reported to corridor manager.	Corridor manager <u>directs</u> stakeholder TMC to provide particular controls according to ICM Operations Plan.	Corridor manager directly controls corridor field devices (traveler information messages, signal timing, lane controls, transit priority, etc.) through ICMS according to ICM Operations Plan.

Figure 5. Spectrum of ICM Operational Protocols

PRODUCTS

The **products** of institutional collaboration and coordination are the results of the processes, informing corridor entities and stakeholders about the proposed and current operation of the ICM system. These products include the concept of operations, requirements document, system procurement documents (e.g., P, S, & E), operations and management plan, project management plan, verification and validation Plan, test / acceptance plans, operations and maintenance manuals, operational response / scenario plans, configuration management plan, system evaluations, and interagency agreements. (Note: These ICM products, and the associated activities / action steps are identified in the *ICM Implementation Guidance*).

RESOURCES

Resources govern what is available within the corridor for sustaining and implementing the ICM concept of operations and other strategies and plans on an ongoing basis. The resources include staff, equipment, and dollars. Also implied is the commitment on the part of participating institutions and individuals to allocate and share these resources.

This element of the framework governs the availability of resources for achieving a corridor-wide vision, implementing agreed upon ICM approaches and strategies, putting into practice a corridor concept of operations, and implementing scenario-based operations plans (possible through an ICM “system of systems” on an ongoing basis). Regardless of the institutional and procedural approaches that evolve from integrating the corridor, the key to a sustained commitment of resources lies in ensuring that all participants see the benefits of their contributions, both to the ICM system (i.e., corridor perspective), and to their own agency or network.

Funding

ICM and the continuing collaboration depend on the availability and commitment of resources to fund the corridor “system” (as identified in the concept of operations, requirements, and procurement documents) and other agreed-upon actions (i.e., ICM response plans and protocols). Most funding for ICM and operations will likely come from individual agency budgets. The stakeholders might consider innovative ways of funding ICM, such as “pooling” their respective funding sources, and sharing key resources (e.g., equipment and personnel) across jurisdictional boundaries among the network providers.

There is a sort of “chicken and egg” challenge here. As noted during one of the corridor site visits, “you need institutional integration (funding) to generate operational integration; however, you need some level of operational integration to demonstrate success and thus gain the support necessary to facilitate institutional integration.” As such, outreach is a critical activity for securing funding. As noted in the ITE publication *A Tool Box for Alleviating Traffic Congestion and Enhancing Mobility* “some of the most successful efforts at adopting transportation programs have exhibited the following characteristics:

- ? Waging an aggressive campaign to inform the public of what is likely to occur if something is not done.
- ? Clearly stating what the average citizen will gain from these actions.
- ? Providing opportunities for citizens and interest groups to participate in the planning and decision making process.
- ? Actively pursuing business support for the proposed actions.

- ? Seeking media support in editorials and news reporting.
- ? Developing a cost effective program that appeals to a broad a political base as possible.”

NCHRP Synthesis 337 (*Cooperative Agreements for Corridor Management*) further recommends: “Create frequent opportunities for educating partners and their stakeholders on the importance of the corridor management effort. Most agencies experience some setbacks in their corridor management efforts, even with formal cooperative agreements. Those having success recognize that corridor management is an ongoing process that benefits from continuous education and periodic technical assistance.

Range of Resource Strategies

How ICM and the concomitant collaborative processes are funded and staffed reflects a commitment to and vision for the effort. Typically, when the agencies and institutions within the corridor see a need to solve a problem or improve performance (incident management or emergency evacuation), or when they agree to work together on a project of corridor and / or regional importance (special event planning), resources may then be applied in the form of in-kind contributions from participating organizations or through program funds administered by a single agency on behalf of all participants. As the collaborative activities mature, participating entities (including both public and private sectors) may choose to pool resources and eventually align with, or form entities that assume responsibility on behalf of participating agencies and jurisdictions. These entities should also establish positions with authority, accountability, and responsibility for coordinated operations (e.g., the aforementioned “Corridor Manager”). Figure 6 illustrates the range of resource strategies.

<i>Û</i>	<i>Û</i>	<i>P</i>
<i>LESS FORMAL</i>	<i>MORE FORMAL</i>	
In Kind	Pooled Resources	Funded Entity
<ul style="list-style-type: none"> ▪ Individuals commit to periodic meetings to address corridor issues ▪ Agencies assign staff members and other resources (equipment, facilities) to support integrated corridor management 	<ul style="list-style-type: none"> ▪ Jurisdictions and public and private organizations pool funds, people, assets and other resources to sustain collaboration and to support ICMS deployment ▪ Agencies and jurisdictions commit resources (people, assets) to be used in ICM operations 	<ul style="list-style-type: none"> ▪ Jurisdictions and public and private organizations allocate funds to support a corridor / regional entity responsible for ICM development and operations ▪ Entities are formed and funded to operate networks within the corridor (and ICMS) on behalf of multiple jurisdictions.

Figure 6. Range of Resource Strategies

PERFORMANCE

The **performance** element comprises how performance will be measured, and individual and collective responsibilities for monitoring and improving ICM system performance. Performance measurement is important for the following reasons – it provides the basis for identifying the location and severity of problems (such as congestion, service delays, high accident rates); it permits the evaluation of the effectiveness of the implemented corridor management strategies with respect to meeting the operational goals and objectives for the corridor; it allows comparison of operations from year to year, and comparison of performance relative to other areas / corridors; and it provides information to decision makers, stakeholders, and to the public (e.g., justification for the continued operation / expansion of the ICMS project).

Several references provide guidelines for selecting performance measures and the attributes of good performance measures as summarized below:

- ? Goals and objectives – Performance measures should be identified to reflect the goals and objectives of the corridor. These corridor goals and objectives should start with the goals and objectives of the individual networks that comprise the corridor, and then build the foundation for a corridor-wide performance perspective.
- ? Stakeholder Involvement – Performance should be reported in terms that are clearly understood by all stakeholders. This also includes the concerns of the corridor users.
- ? Limited number of measures – All other things being equal, fewer rather than more measures is better. Too much information, too many kinds of information, or information presented at too fine a level of desegregation can overwhelm decision makers and travelers.
- ? Easy to measure – The data required for performance measures should be easy to collect and analyze, preferably directly and automatically from the various network - based transportation management systems that comprise the ICM.
- ? Data needs – At the same time, performance measures should not be solely defined by what data are readily available. Data needs and the methods for analyzing the data should be determined by what it will take to create or “populate” the desired measures. As such, it may be necessary to enhance the data collection capabilities along some networks to provide the necessary corridor performance information.
- ? Sensitivity – Performance measurement must be designed in such a way that change is measured at the same order-of-magnitude as will likely result from the implemented actions. From a corridor perspective, this includes assessing a change on one network such that an appropriate response can be implemented among other networks.
- ? Facilitate Improvement – The ultimate purpose of performance measures must clearly be to improve the operation of an integrated corridor. Performance measures must therefore provide the ability to diagnose problems and to assess outcomes that reveal actual operational results. In a corridor environment, the measures must play a dual role of identifying corridor problems, and also providing enough information to determine each network’s role in the problem.
- ? Simple and understandable – Within the constraints of required precision, accuracy, and facilitating improvement, performance measures should prove simple in their application with consistent definitions and interpretations, thereby allowing operators and travelers to make informed and better decisions.

One approach for ICM is to utilize those performance measures that have been traditionally used for each of the modes included in the corridor. The selected measures are either the same for each mode, or a closely allied measure is selected. Although the measures may be computed on an individual mode basis, presentations of the data may be made on a parallel basis. This general approach, as applied to a corridor by Florida DOT resulted in the following measures:

- ? Person Throughput
 - o Roadway – number of travelers
 - o Transit – number of passengers
- ? Vehicle Miles of Travel
 - o Roadway – vehicle miles
 - o Transit – train or bus Miles
- ? Average Vehicle Occupancy
 - o Roadway – persons/ vehicle
 - o Transit – persons / bus or train
- ? Average Travel Time
- ? Average Travel Speed

In some instances, mode specific performance measures may not have any relationship to one another. For example, a roadway network may utilize the volume / capacity ratio or level of service; while transit modes may use such measures as:

- ? Boardings per Revenue Hour.
- ? Boardings per Revenue Mile.
- ? Total Operating Cost per Revenue Hour.
- ? Total Operating Cost per Revenue Mile.
- ? Net deficit per Boarding (difference between operating cost per boarding and revenue per boarding).
- ? Crowding – passengers per seat for peak and off peak.
- ? Reliability – percent trips on time, percent late departures, percent on time arrivals, percent late arrivals, Service Reliability Index (total number of passengers minus number of passengers affected by delays divided by the total number), headway adherence.

Very few, if any, such measures are applicable to a corridor as an integrated whole. What is required for measuring performance of an ICMS is mode-independent measures. Potential performance measures in this regard are identified in Table 2. It is emphasized that these “corridor-wide” performance measures are in addition to any network-specific performance measures.

Performance measures can have different uses: evaluating and choosing between different alternatives and identifying the “worth” of the implemented strategies, comparing the results against a “null” (i.e. do-nothing) alternative. In both instances, reliable simulation is necessary. As an example, during a major incident, there are going to be widespread delays even with the implementation of information, coordination, and route / mode shift strategies — and the users are going to experience those delays.

There needs to be a way to indicate what the delays would have been without such strategies. (Note: It is not possible for practitioners to not implement the strategies so that the users see the difference first hand. The only time that has really happened is the ramp metering scenario in Minnesota (Twin Cities) a few years ago). Accordingly, the output of simulation models should be based on the selected performance measures or at least provide parameters from which the performance measures can be easily derived.

Table 2. Potential Corridor-wide Performance Measures

- ? Average Travel Time per Person.
- ? Average Delay per Person (this can also be segregated by scenario / event – recurring, incident, work zone, weather, special event).
- ? Total Delay.
- ? Number and percent of person-trips with travel times x percent greater than the average travel time.
- ? Travel Time Index (a ratio of travel times in the peak period or other corridor condition to a target or acceptable travel time (typically free-flow / on-schedule conditions are used). The travel time index indicates how much longer a trip will take during a peak time or other corridor condition.
- ? Buffer Index – this measure expresses the amount of extra “buffer” time needed to be on-time 95 percent of the time (late one day per month). Travelers could multiply their average trip time by the buffer index, and then add that buffer time to their trip to ensure they will be on-time 95 percent of all trips. An advantage of expressing the reliability (or lack thereof) in this way is that a percent value is distance and time neutral.
- ? Emissions (VOC, NO_x, SO_x, CO, CO₂).
- ? Number of days in exceedance of NAAQS.
- ? Customer satisfaction - percent favorable response to ICM.

INTERAGENCY AGREEMENTS

The preceding sections of the document have used the regional collaboration and coordination framework to discuss and analyze how to facilitate this same type of collaboration and coordination at a corridor level to facilitate integrated operations. This section discusses the mechanisms (i.e. interagency agreements) that need to be developed and implemented in order to move from the framework to an actual implementation. These interagency agreements need to establish what is agreed to in relation to each of the elements of corridor collaboration and coordination, but also interconnect these elements in order to build a foundation for ICM.

Agreements among the different stakeholder agencies and organizations are typically required to realize the coordination, cooperation, and integration associated with an ICMS. The number of agreements and the level of formality and structure of each agreement will be determined by the agencies and organizations involved. Using the “spectrum” concepts discussed previously, as integrated corridor management moves from the left to the right (i.e., increasing complexity of ICMS operational approaches and

strategies, more formal organizational approaches and institutional frameworks, increasing levels of coordination and integration processes, more formal resource strategies), the need for interagency agreements also becomes greater. Interagency agreements are also needed to document the distribution of responsibilities between the corridor stakeholders (e.g., lead / support roles and the necessary approvals for the various ICM activities and documents), and to document the “protocols” for the shared use of resources and / or shared control of ITS devices.

As discussed in *NCHRP Synthesis 337: Cooperative Agreements for Corridor Management*,⁹ cooperation between agencies may take the form of resolutions, memorandums of understanding (MOUs) or agreement, intergovernmental agreements, or some combination of these methods, as defined below:

- ? A **resolution** can be generally defined as the formal expression of an opinion or the will of a governing body on a given policy at a particular point in time. As such, resolutions are not legally binding and are subject to change. However, a resolution in support of corridor management may serve as an initial step toward a more formal and legally binding cooperative agreement.
- ? A **memorandum of understanding (MOU)** goes beyond a resolution to document the desire of involved parties to engage in a particular course of action. For corridor management, an MOU is generally used to define roles and responsibilities of participating entities, as well as to establish common direction on a particular course of action. An MOU could serve as an intermediate step toward more extensive cooperation or it may be the only form of declaration in those places where a more formal or binding agreement cannot be attained or is not necessary given the ICM approaches to be deployed.
- ? An **intergovernmental agreement** may be defined as “a legal pact authorized by state law between two or more units of government, in which the parties contract for or agree on the performance of a specific activity through either mutual or delegated provision” Because they are tantamount to contracts, intergovernmental agreements work best when responsibilities, financial obligations, and procedures are detailed. They also are the most binding, from a legal perspective.

While not mentioned in NCHRP Synthesis 337, the concept of a *handshake agreement* is also important. It often represents an early agreement between one or more partners (e.g., agreeing to the need for ICM, commencing the process to develop and deploy an ICMS). Regardless of the specific structure, most of the agreements contain similar key elements as summarized in Table 3.

The ITMS Conference “White Paper on Maintenance and Operations” states: “the development of agreements should be started well in advance of when the agreements are needed. An important strategy used for meetings where agreements are discussed is to consider all agencies to be equal and not have one of them be in charge of the meeting” (i.e., meetings are arranged, facilitated and documented by non-agency

⁹ The objective of the synthesis was to identify the state of current practice in developing and implementing cooperative agreements for corridor management, elements of such agreements, and best practices or lessons learned. The focus is on cooperative agreements between two or more government agencies. In the context of the synthesis, “Corridor Management” involves the application of strategies in one or more of the following areas: access management, land use and subdivision management, right-of-way needs and preservation, operational strategies, intergovernmental coordination, and financing of corridor management improvements.

resources). This strategy reduced the risk of any agency forcing their agenda on the other agencies just because that agency was responsible for the meeting.

Table 3. Elements of CM Agreements

- ? **Participants and Geographic Coverage:** An agreement must identify each party to the agreement and the geographic area it covers. All parties involved in an MOU or agreement, regardless of number, are generally identified in the first paragraph. The number of parties to an agreement varies according to limitations established by state law, the purpose of the agreement, and the geographic area involved.
- ? **Purpose, Need, and Authority:** The purpose and need section of an intergovernmental agreement should indicate the activity or activities to be handled through the agreement, any standards that the activity should meet, and any exceptions to those standards. Statutes and regulations appropriate to the agreement should be cited.
- ? **Roles and Responsibilities:** The discussion of roles and responsibilities is often the lengthiest and most detailed part of a cooperative agreement. However, the level of detail varies depending on the subject of the agreement and whether it is an MOU or a more binding form of intergovernmental agreement.
- ? **Adoption, Duration, Amendment, and Termination:** This element may include such information as the effective date, the period covered by the agreement measured in time or completion, terms for renewal or amendment, and termination requirements.
- ? **Funding and Financial Arrangements:** A crucial element of any agreement that involves shared financial obligations is a detailed statement about which party (or parties) is responsible for bearing the cost of various portions of the agreement. Such arrangements may encompass personnel, service, funds, equipment, property, or facilities.
- ? **Appendices:** Corridor management agreements are often accompanied by appendices that contain management plans or other technical supporting documents. One potential benefit of separating agreements from technical support documents is that it enables authors to negotiate specific details of an agreement or plan separately in small groups or committees. Then, the detailed plan may be adopted as a separate document or appendix to an agreement through one of the methods as described, such as a resolution, MOU, or intergovernmental agreement.

Source: NCHRP 337

NCHRP Synthesis 337 (Cooperative Agreements for Corridor Management) summarizes several characteristics of effective agreements (listed below), which also pertain to the broader challenge of achieving institutional integration:

- ? An agreement should be pursued in a spirit of mutual compromise. A willingness to compromise and to treat others as equal partners helps establish an environment that is conducive to cooperation. Each participant should take the time to gain an understanding of the issues that affect the other partners and to be cognizant of those issues when generating alternatives. The potential benefits to each party

through participating in and supporting the process should be made as clear as possible.

- ? It is vital to proactively confront the tough corridor management issues through direct involvement of the affected parties. It is important to keep all parties to the agreement apprised of substantive developments throughout the process to ensure a smooth transition from the corridor management plan to the agreement.
- ? Partners should be asked to incorporate the substance of the agreement into their plans, policies, and regulations to facilitate enforcement. Continuity of enforcement was clearly a factor for agencies that have experience with corridor management agreements. The strongest suggestion for improving enforcement is to encourage local governments to incorporate the necessary policies, design standards, and regulations into local comprehensive plans, design manuals, and codes.
- ? Action should be taken to incorporate formal mechanisms and time lines for addressing needed changes to corridor management plans. Establishing a monitoring or renegotiation clause provides a way to proactively address issues or problems that may be experienced in implementation.
- ? Establish a joint committee or multiparty amendment process for administering a corridor management plan. Establishing an administrative structure through the agreement, such as a committee to administer a corridor management plan or a provision for multiparty approval of amendments, can help formalize the decision-making process, improve intergovernmental coordination and communication, and reduce the potential for amendments that conflict with corridor management objectives.
- ? Create frequent opportunities for educating partners and their stakeholders on the importance of the corridor management effort. Most agencies experience some setbacks in their corridor management efforts, even with formal cooperative agreements. Those having success recognize that corridor management is an ongoing process that benefits from continuous education and periodic technical assistance. As noted by one respondent, “a change in administration or elected officials can lead to a loss of understanding of the original purpose for the agreement and a subsequent loss of ability to accomplish the intended outcome.”
- ? Many other respondents identified a need for technical assistance to local governments. Parties to a corridor management agreement should look for opportunities to provide ongoing education and technical assistance in support of their efforts, both within the agency and among the various stakeholders.

The conclusions section of NCHRP Synthesis 5337 also includes several recurrent themes on what can derail a corridor management agreement, including: “institutional factors were agency resistance to long-term commitments, agency reluctance to assume a leadership or mediation role, and a lack of internal cooperation among divisions or functions in an organization. Political factors such as turnover of elected officials, short-term orientation, and intergovernmental competition for tax base, are also identified.

SUMMARY

The regional and now corridor collaboration and coordination framework was used to identify and discuss the institutional integration needed to support the implementation of ICM. The differences between the regional level integration for regional management and corridor level integration for integrated operations was compared and contrasted. There were many similarities, but also a new level of detail and complexity that must be

addressed. Besides the framework the document also took the next step to present and explain the spectrum of interagency agreements that can be used to establish the institutional integration required by a corridor electing to implement ICM.

